Zumbro River Watershed Total Maximum Daily Load Report

MINNESOTA POLLUTION CONTROL AGENCY

LimnoTech

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TMDL Summary Table

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Applicable Water Quality Standards/ Numeric Targets	Section 2	8
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	Bacteria: Section 4.3.1	46
	TSS: Section 4.4.1	68
Wasteload Allocation	Phosphorus: Section 4.2.3	45
	Bacteria: Section 4.3.3	47
	TSS: Section 4.4.3	68
Load Allocation	Phosphorus: Section 4.2.2	44
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	TSS: Section 4.4.2	68
Margin of Safety	Phosphorus: Section 4.2.4	45
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Acronyms

AUID	Assessment Unit ID
BMP	best management practice
CAFO(s)	Concentrated Animal Feeding Operation(s)
Chl-*a*	Chlorophyll-*a*
DNR	Minnesota Department of Natural Resources
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
FIBI	Fish Index of Biotic Integrity
HSPF	Hydrologic Simulation Program-Fortran
IBI	Index of Biotic Integrity
km^2	square kilometer
LA	load allocation
LGU	Local Government Unit
m	meter
mg/L	milligrams per liter
MIBI	Macroinvertebrate Index of Biotic Integrity
mL	milliliter
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
SONAR	Statement of Need and Reasonableness
SSTS	Subsurface Sewage Treatment Systems
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	total suspended solid
WLA	wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy
WWTF	Wastewater Treatment Facilities
ZRW	Zumbro River Watershed

Executive Summary

The Clean Water Act (1972) requires that each state develop a plan to identify and restore any waterbody that is deemed impaired by state regulations, known as a Total Maximum Daily Load Study (TMDL). A TMDL identifies the pollutant that is causing the impairment and how much of that pollutant can enter the waterbody and still meet water quality standards, and apportions pollutant loads to sources in the watershed.

This TMDL study includes calculations for 1 lake with a phosphorus impairment, as well as 20 stream reaches with bacteria and/or total suspended solid (TSS) impairments located in the Zumbro River Watershed (ZRW) (HUC 07040004) in southeastern Minnesota. A few of these listings are on the approved 2012 EPA 303(d) list of impaired waters, while the remainder are on the proposed 2016 EPA 303(d) list of impaired waters.

Information from multiple sources was used to evaluate the ecological health of each waterbody:

- All available water quality data over the past 10 years
- Zumbro River Watershed Monitoring and Assessment Report (https://www.pca.state.mn.us/sites/default/files/wq-ws3-07040004b.pdf)
- Published studies
- Zumbro River Watershed Stressor Identification (SID) Report (https://www.pca.state.mn.us/sites/default/files/wq-ws5-07040004a.pdf)
- BATHTUB model
- Hydrologic Simulation Program-Fortran (HSPF) Model
- Stakeholder input

Watershed runoff, municipal and industrial wastewater facilities (WWTFs), Municipal Separate Storm Sewer Systems (MS4) communities, construction and industrial stormwater runoff, and feedlots and individual septic treatment systems (ISTS) are all important pollutant sources in the ZRW. Internal loading of phosphorus is the driver of water quality in Rice Lake. An inventory of these and other pollutant sources was used to inform the lake response models and stream load duration curves. These models were then used to determine the pollutant reductions for Rice Lake, and the loads for each stream that correspond to state water quality standard attainment.

The findings from this TMDL study will be used in conjunction with the Zumbro River Watershed Restoration and Protection Strategy (WRAPS). The purpose of the WRAPS report is to support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning. The WRAPS provides additional discussion of pollutant sources, implementation strategies, and tools for prioritization. Following completion, the WRAPS and TMDLs documents will be publically available on the Minnesota Pollution Control Agency (MPCA) ZRW website: https://www.pca.state.mn.us/water/watersheds/zumbro-river.

1. Project Overview

1.1 Purpose

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and resources to state and local governments to accelerate efforts to monitor, assess, and restore impaired waters and to protect unimpaired waters. The result has been a comprehensive watershed approach that integrates water resource management efforts with local government and local stakeholders and develops restoration and protection studies for Minnesota's 80 major watersheds.

For the ZRW, the approach began with intensive watershed monitoring in 2012, focusing on biological monitoring (fish and macroinvertebrates) to assess overall stream health. This assessment was completed in 2016 and was used to develop this TMDL report, as well as the WRAPS report, both scheduled for completion in 2017. This TMDL study addresses aquatic recreation and aquatic life impairments on one lake Assessment Unit ID (AUID) and 20 stream AUIDs in the ZRW.

Completed studies for this watershed that are referenced in this TMDL report include:

- ZRW Turbidity TMDL Project (MPCA 2012)
- ZRW Monitoring and Assessment Report (MPCA 2016a)
- ZRW SID Report (MPCA 2016b)
- ZRW HSPF Model Development Project (hereafter referred to as ZRWHSPF model, LimnoTech 2014)

More related information is summarized in the WRAPS report; those works listed above can be reviewed at the MPCA's ZRW website: https://www.pca.state.mn.us/water/watersheds/zumbro-river.

Given the accumulation of data and conclusions achieved throughout these component processes, the documents cross-reference frequently and should thus be considered a "package" of information that comprehensively addresses condition monitoring, restoration, and protection in the ZRW.

The findings from this TMDL study can be used in conjunction with the WRAPS report and supporting information to guide management in the ZRW. Together, these works will support local projects in developing scientifically-supported restoration and protection strategies to be used for subsequent implementation planning.

The goal of this TMDL study was to quantify, where applicable, the pollutant reductions needed to meet state water quality standards for select waterbodies in the ZRW. This ZRW TMDL study was established in accordance with Section 303(d) of the Clean Water Act and provides wasteload allocations (WLAs) and load allocations (LAs) for the watershed areas as appropriate.

1.1.1 Previously Completed TMDLs

The presence of fecal pathogens in surface water is a regional problem in southeast Minnesota. The issue was well-described in a stakeholder driven process that culminated in approval of 39 fecal coliform TMDLs for streams and rivers in the region. The *Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota*, approved in 2006, can be reviewed at the MPCA web site: http://www.pca.state.mn.us/index.php/view-document.html?gid=8006. Subsequent to TMDL approval, stakeholders completed an implementation plan: http://www.pca.state.mn.us/index.php/view-document.html?gid=8013. According to the findings and strategies summarized in these documents, numerous projects have been executed in efforts to reduce pathogen loading to the region's surface waters. Feedlot runoff, unsewered and under-sewered communities and over-grazed pastures (among others) have all been addressed via grant funding. The *E. coli* TMDLs in this report should be considered (for planning purposes) an addendum to the regional TMDL work.

In 2012, the ZRW Turbidity TMDL was approved and addressed 17 impaired stream AUIDs (https://www.pca.state.mn.us/sites/default/files/wq-iw9-13e.pdf). In August of 2012, the MPCA approved the comprehensive management plan (sediment reduction component) developed by the Zumbro Watershed Partnership (https://www.pca.state.mn.us/sites/default/files/wq-iw9-13c.pdf).

Because there are already approved TMDLs for *E. coli* and TSS impairments downstream of all the watershed's MS4s, their permits and associated planning documents should already reflect BMPs to address these pollutants. As such, the new MS4 WLAs noted in the TMDL tables will require consideration and will be added to existing lists of downstream WLAs for *E. coli* and TSS.

1.1.2 Future TMDL Considerations

The draft 2016 impaired waters list includes four phosphorus listings in the ZRW (Table 1). The MPCA is considering site specific standards for Lake Zumbro (55-0004) and the South Fork Zumbro River (07040004-507). As such, the watershed TMDLs report does not include phosphorus TMDLs for those assessment units. Once the water quality goals are finalized, an assessment and if necessary a subsequent comprehensive analysis of impairments (including South Branch Middle Fork Zumbro River (07040004-978)) and sources in the Lake Zumbro Watershed will be completed. This may include TMDLs and WLAs for point sources that are protective of downstream river and reservoir water quality.

Table 1. Phosphorus impairments in the Zumbro River Watershed.

HUC-10 Watershed	Listed Waterbody Name	Location Description	Reach (AUID)	Listing Year
South Branch Middle Fork Zumbro River	Rice Lake	Lake or Reservoir	74-0001-00	2016
Zumbro River	Zumbro Lake	Lake or Reservoir	55-0004-00	2002
South Branch Middle Fork Zumbro River	Zumbro River, Middle Fork, South Branch	75th St NW to M Fk Zumbro R	07040004-978	2016
South Fork Zumbro River	Zumbro River, South Fork	Cascade Cr to Zumbro Lk	07040004-507	2016

1.2 Identification of Waterbodies

This TMDL report addresses 25 water quality impairments on 1 lake AUID and 20 stream AUIDs throughout the ZRW (Figure 1). In the case of the stream impairments, four of the use support decisions drew heavily on biota data, which required further examination (herein referred to as SID) to determine whether or not pollutants are causing the impairments (Table 2). Pollutant stressors are addressed via TMDLs. Two segments on the South Branch Middle Fork Zumbro River, (AUIDs 07040004-976 and -980) have pollutant stressors (TSS), but are not addressed in this TMDL document. The AUIDs are splits from a larger parent AUID. The entire South Branch Middle Fork Zumbro River was addressed in the 2012 ZRW Turbidity TMDL (see AUIDs 07040004-525 and -526). These approved TMDLs carry over to the child AUIDs.

A TSS TMDL was approved for Dodge Center Creek AUID -592 in 2012. Subsequent to that approval, the AUID was split to allow for redesignation of use classification in the upper end of the reach. The new AUID -989 terminates at the mouth of Dodge Center Creek (same as did -592). The TSS TMDL for AUID -989 replaces that for -592 (the TMDL numbers are very similar; only the high flow loading capacity changed somewhat due to applying a greater period of record to compute the flow duration statistics; the WLAs have not changed (0.25 tons/day total).

Non-pollutant stressors are not subject to load quantification and therefore do not require TMDLs. If a non-pollutant stressor is linked to a pollutant (e.g. habitat issues driven by TSS or low dissolved oxygen (DO) caused by excess phosphorus) a TMDL is required. However, in many cases habitat stressors are not linked to pollutants. With respect to the two identified DO stressors in the ZRW, there are insufficient means for conclusively linking the condition to a pollutant cause. Note that all aquatic life use impairments – not just those with associated TMDLs – are addressed in the WRAPS report.

Table 3 and Appendix A (which includes notes regarding aquatic life impairments for which TMDLs are not computed) summarize ZRW impairments and those addressed by TMDLs in this document. Impairments were categorized as follows:

- 18 AUIDs do not support aquatic recreation use (1 lake AUID and 17 stream AUIDs)
- 7 AUIDs do not support aquatic life

More information regarding assessments of lakes, rivers, and streams (e.g. how many were assessed, percentages of each that are impaired) is available in the ZRW Monitoring and Assessment Report (MPCA 2016).

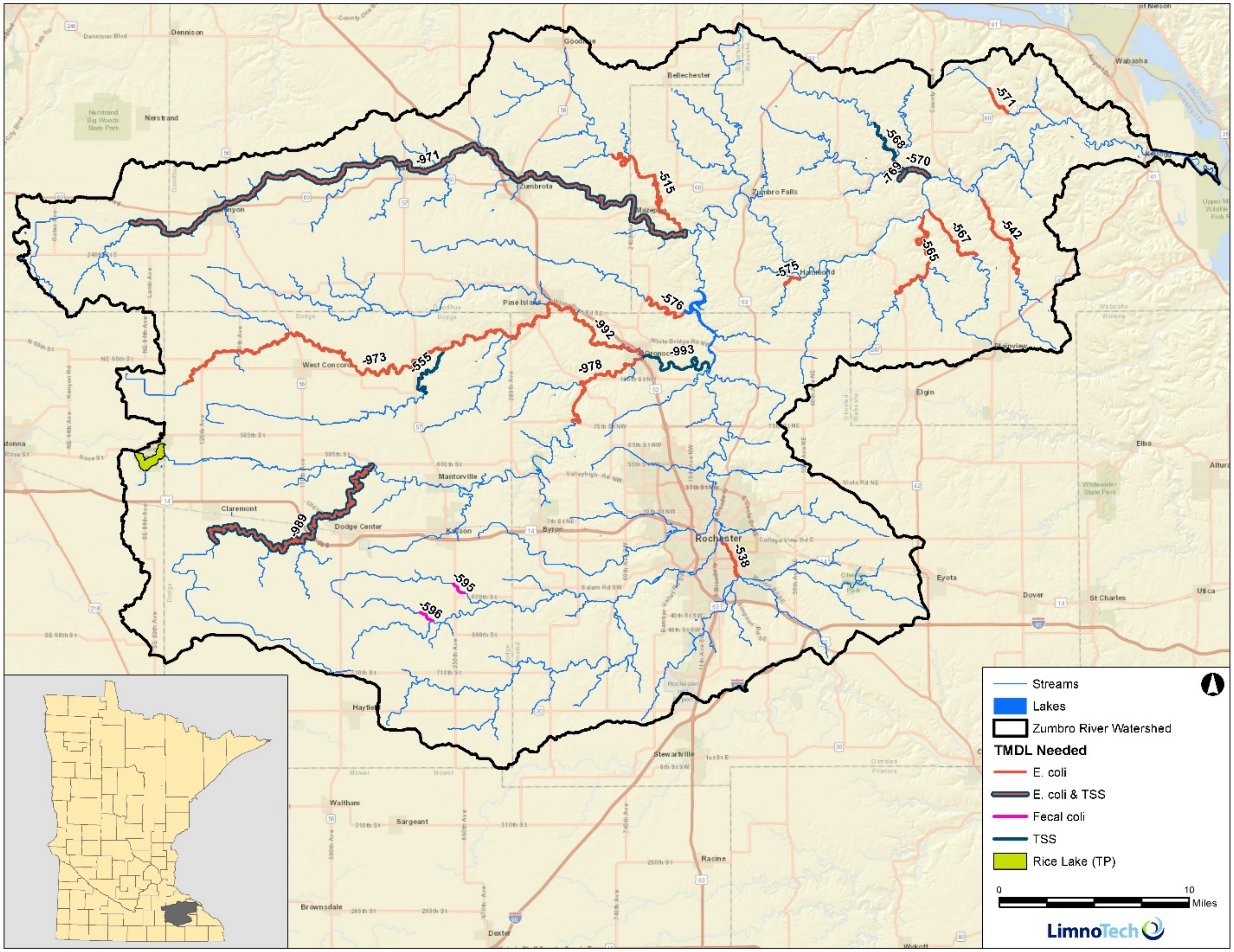

Figure 1. The ZRW and all impaired AUIDs that are addressed in this TMDL report.

Table 2. List of 303(d) reaches in the ZRW that are impaired for aquatic life use.

Listed Waterbody Name	Location Description	Reach (AUID)	Basis for Aquatic Listing			Addressed in TMDL Report
			MIBI	FIBI	Turbidity	
Unnamed Creek	Unnamed cr to unnamed cr	07040004-503	x			No
Zumbro River, South Fork	Cascade Cr to Zumbro Lk	07040004-507	x		x	No
Cold Creek	T110 R14W S25, north line to Zumbro R	07040004-510	x			No
Trout Brook	T110 R15W S24, west line to N Fk Zumbro R	07040004-515	x			Yes - as Aquatic Rec only
Zumbro River, South Fork	Salem Cr to Bear Cr	07040004-536	x		x	No
Silver Creek	Unnamed cr to unnamed cr	07040004-552			x	No
Milliken Creek	Unnamed cr to M Fk Zumbro R	07040004-555			x	Yes
Shingle Creek	Unnamed cr to N Fk Zumbro R	07040004-562	x			No
Spring Creek	Unnamed cr to Unnamed cr	07040004-568	x			Yes
Spring Creek	Unnamed cr to Zumbro R	07040004-570		x		Yes
Unnamed Creek	Headwaters to M Fk Zumbro R	07040004-578	x			No
Unnamed Creek	Headwaters to N Fk Zumbro R	07040004-579	x			No
Cascade Creek	Unnamed cr to S Fk Zumbro R	07040004-581	x			No
Trout Brook	Hope Coulee to Zumbro R	07040004-585	x	x		No
Spring Creek Tributary	T110 R12W S28, south line to Spring Cr	07040004-769			x (Secchi Tube)	Yes
Unnamed Creek	Unnamed cr to unnamed cr	07040004-597	x	x		No
Unnamed Creek	Unnamed cr to N Fk Zumbro R	07040004-605	x			No
Spring Creek	Unnamed cr to unnamed cr	07040004-606	x			No
Henslin Creek	Unnamed cr to Dodge Center Creek	07040004-618	x			No
Badger Run	Unnamed cr to Bear Cr	07040004-620		x		No
Unnamed Creek	Unnamed cr to unnamed cr	07040004-621		x		No
Unnamed Creek	Unnamed cr to Willow Cr	07040004-800	x	x		No
Unnamed Creek	Unnamed cr to N Fk Zumbro R	07040004-964	x			No
Zumbro River, North Fork	T109 R19W S11, west line to Trout Bk	07040004-971	x			Yes
Zumbro River, Middle Fork	T108 R18W S20, west line to N Br M Fk Zumbro R	07040004-973	x		x	Yes - as Aquatic Rec only
Zumbro River, Middle Fork, South Branch	Dodge Center Cr to Unnamed cr	07040004-976	x		x	No
Zumbro River, Middle Fork, South Branch	Unnamed cr to Dodge Center Cr	07040004-980	x			No
Judicial Ditch 1	T106 R18W S28, east line to Unnamed cr	07040004-987	x			No
Dodge Center Creek	Unnamed cr to -92.99 44.0212	07040004-988	x	x		No
Dodge Center Creek	-92.99 44.0212 to S Vr M Fk Zumbro R	07040004-989	x		x	Yes
Cascade Creek	Unnamed cr to unnamed cr	07040004-991		x		No
Zumbro River, Middle Fork (Shady Lake)	S Br M Fk Zumbro R to Zumbro Lk	07040004-993			x	Yes

*TSS TMDLs have been approved as part of the 2012 Zumbro Turbidity TMDL study.

Table 3. List of 303(d) impaired lakes and streams in the ZRW grouped by HUC-10 and their pollutant listing that are addressed in this TMDL study. Blue and white row colors indicate HUC-10 groupings.

HUC-10 Watershed	Listed Waterbody Name	Location Description	Reach (AUID)	Impaired Use	Listed Pollutant	Listing Year	Target Start & Completion Dates
Middle Fork Zumbro River	Milliken Creek	Unnamed cr to M Fk Zumbro R	07040004-555	Aquatic Life	TSS	2010	2012 - 2017
Middle Fork Zumbro River	Zumbro River	T108 R18W S20, west line to N Br M Fk Zumbro R	07040004-973	Aquatic Recreation	*E. coli*	2016	
Middle Fork Zumbro River	Zumbro River	N Br M Fk Zumbro R to S Br M Fk Zumbro R	07040004-992	Aquatic Recreation	*E. coli*	2016	
Middle Fork Zumbro River	Zumbro River	S Br M Fk Zumbro R to Zumbro Lk	07040004-993	Aquatic Life	TSS	2010	
North Fork Zumbro River	Trout Brook	T110 R15W S24, west line to N Fk Zumbro R	07040004-515	Aquatic Recreation	*E. coli*	2016	
North Fork Zumbro River	Zumbro River	T109 R19W S11, west line to Trout Bk	07040004-971	Aquatic Life Aquatic Recreation	TSS *E. coli*	2016	
South Branch Middle Fork Zumbro River	Rice Lake		74-0001-00	Aquatic Recreation	Phosphorus	2016	
South Branch Middle Fork Zumbro River	Zumbro River	75th St NW to M Fk Zumbro R	07040004-978	Aquatic Recreation	*E. coli*	2016	
South Branch Middle Fork Zumbro River	Dodge Center Creek	-92.99, 44.0212 to S Br M Fk Zumbro R	07040004-989	Aquatic Life Aquatic Recreation	TSS *E. coli*	2016	
South Fork Zumbro River	Bear Creek	Willow Cr to S Fk Zumbro R	07040004-538	Aquatic Recreation	*E. coli*	2016	
South Fork Zumbro River	Unnamed Creek	Unnamed creek to unnamed creek	07040004-595	Aquatic Recreation	Fecal coli	2008	
South Fork Zumbro River	Unnamed Creek	Unnamed Cr to Salem Cr	07040004-596	Aquatic Recreation	Fecal coli	2008	
Zumbro River	West Indian Creek	T109 R11W S21, south line to T109 R11W S6, north line	07040004-542	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Long Creek	Unnamed Cr to M Fk Zumbro River	07040004-565	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Middle Creek	T109 T11W S18, south line to Zumbro R	07040004-567	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Spring Creek	Unnamed cr to Unnamed cr	07040004-568	Aquatic Life	TSS	2016	
Zumbro River	Spring Creek	Unnamed cr to Zumbro R	07040004-570	Aquatic Life Aquatic Recreation	TSS *E. coli*	2016	
Zumbro River	Trout Brook	T110 R11W S5, west line to T110 R11W S8, east line	07040004-571	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Hammond Creek	Unnamed cr to Zumbro R	07040004-575	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Dry Run Creek	Unnamed cr to Zumbro Lk	07040004-576	Aquatic Recreation	*E. coli*	2016	
Zumbro River	Spring Creek Tributary	T110 R12W S28, south line to Spring Cr	07040004-769	Aquatic Life Aquatic Recreation	TSS *E. coli*	2016	

1.3 Priority Ranking

The MPCA's schedule for TMDL completions, as indicated on the 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL. The MPCA has aligned our TMDL priorities with the watershed approach and our WRAPS cycle. The schedule for TMDL completion corresponds to the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan Minnesota's TMDL Priority Framework Report to meet the needs of EPA's national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the Clean Water Act Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments, which will be addressed by TMDLs by 2022. The ZRW waters addressed by this TMDL are part of that MPCA prioritization plan to meet the EPA's national measure.

1.4 Summary of the Impairments and Pollutant Stressors

The following section describes the lake and stream impairments and the pollutant stressors that are addressed by the 25 TMDLs in this study (Table 4). A total of 17 bacteria, 1 phosphorus, and 7 TSS TMDLs were completed.

Table 4. Pollutants addressed in this TMDL report by AUID and use class.

HUC-10 Watershed	Listed Waterbody Name	Reach (AUID)	Designated Use Class	Bacteria	Phosphorus	TSS
Middle Fork Zumbro River	Milliken Creek	07040004-555	2B, 3C			x
Middle Fork Zumbro River	Zumbro River	07040004-973	2B, 3C	x		
Middle Fork Zumbro River	Zumbro River	07040004-992	2B, 3C	x		
Middle Fork Zumbro River	Zumbro River	07040004-993	2B, 3C			x
North Fork Zumbro River	Trout Brook	07040004-515	1B, 2A, 3B	x		
North Fork Zumbro River	Zumbro River	07040004-971	2B, 3C	x		x
South Branch Middle Fork Zumbro River	Rice Lake	74-0001-00	2B, 3C		x	
South Branch Middle Fork Zumbro River	Zumbro River	07040004-978	2B, 3C	x		
South Branch Middle Fork Zumbro River	Dodge Center Creek	07040004-989	2B, 3C	x		x
South Fork Zumbro River	Bear Creek	07040004-538	2B, 3C	x		
South Fork Zumbro River	Unnamed Creek	07040004-595	2B, 3C	x		
South Fork Zumbro River	Unnamed Creek	07040004-596	2B, 3C	x		
Zumbro River	West Indian Creek	07040004-542	1B, 2A, 3B	x		
Zumbro River	Long Creek	07040004-565	1B, 2A, 3B	x		
Zumbro River	Middle Creek	07040004-567	1B, 2A, 3B	x		
Zumbro River	Spring Creek	07040004-568	1B, 2A, 3B			x
Zumbro River	Spring Creek	07040004-570	1B, 2A, 3B	x		x
Zumbro River	Trout Brook	07040004-571	1B, 2A, 3B	x		
Zumbro River	Hammond Creek	07040004-575	1B, 2A, 3B	x		
Zumbro River	Dry Run Creek	07040004-576	2B, 3C	x		
Zumbro River	Spring Creek Tributary	07040004-769	1B, 2A, 3B	x		x

2. Applicable Water Quality Standards and Numeric Water Quality Targets

2.1 State of Minnesota Designated Uses

Each lake and stream reach has a Designated Use Classification defined by Minn. R. 7050.1040, which sets the optimal purpose for that waterbody. The streams addressed by this TMDL fall into one of the following two designated use classifications:

1B, 2A, 3B – drinking water use after disinfectant; a healthy cold water aquatic community; non-food industrial use with moderate treatment

2B, 3C – a healthy warm water aquatic community; industrial cooling and materials transport without a high level of treatment

Class 1 waters are protected for domestic consumption, Class 2 waters are protected for aquatic life, aquatic consumption, and aquatic recreations, and Class 3 waters are protected for industrial consumption as defined by Minn. R. 7050.0140. The most protective of these classes is 1B. These water bodies are currently assessed by the MPCA for the beneficial use of domestic consumption for the EPA's Safe Drinking Water Act (SDWA) nitrate primary standards.

The Minnesota narrative water quality standards for all Class 2 waters (Minn. R. 7050.0150, subp. 3) states that "the aquatic habitat, which includes the waters of the state and stream bed, shall not be degraded in any material manner, there shall be no material increase in undesirable slime growths or aquatic plans, including algae, nor shall there be any significant increase in harmful pesticide or other residues in the waters, sediments, and aquatic flora and fauna; the normal fishery and lower aquatic biota upon which it is dependent and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of the fish and other biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste, or other wastes to the waters".

The impaired waters addressed in this TMDL are both Class 2B waters for which aquatic life and recreation are the protected beneficial uses and Class 1B/2A for which aquatic life, aquatic recreation and drinking water are the protected beneficial uses.

2.2 State of Minnesota Standards and Criteria for Listing

The state of Minnesota water quality standards for the lake and stream impairments addressed in this TMDL are summarized in Table 5 and Table 6, respectively.

Table 5. Shallow Lake Eutrophication Standards in the Western Corn Belt Plains ecoregion.

Ecoregion	TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Western Corn Belt Plains (shallow lakes)	90	30	>= 0.7

Table 6. Water quality standards applicable to impaired streams in the ZRW.

Pollutant	Water Quality Standard	Notes	
E. coli	126 org/100 mL	geometric mean of ≥ 5 samples per calendar month	April 1 through October 31
	1,260 org/100 mL	≤ 10% of all samples exceed standard per calendar month	
Fecal coliform	200 org/100 mL	geometric mean of ≥ 5 samples per calendar month	
	2,000 org/100 mL	≤ 10% of all samples exceed standard per calendar month	
Turbidity & TSS	10 mg/L	Southern MN region - for coldwater streams standard exceeded ≤ 10% of the time	April 1 through September 30
	65 mg/L	Southern MN region - for warmwater streams standard exceeded ≤ 10% of the time	

2.2.1 Lake Eutrophication

The lake eutrophication impairment in the ZRW (Rice Lake) was characterized by phosphorus and Chlorophyll-*a* (Chl-*a)* concentrations that exceed state water quality standards and Secchi transparency depths below the state water quality standards (See Section 4.2.1 for water quality data). Excessive nutrient loads, in particular TP, lead to an increase in algae blooms and reduced transparency – both of which may significantly impair or prohibit the use of lakes for aquatic recreation.

TP is often the limiting factor controlling primary production in freshwater lakes: as in-lake phosphorus concentrations increase, algal growth increases resulting in higher Chl-*a* concentrations and lower water transparency. In addition to meeting phosphorus limits, Chl-*a* and Secchi transparency depth standards must also be met. In developing the lake nutrient standards for Minnesota lakes (Minn. R. 7050), the MPCA evaluated data from a large cross-section of lakes within each of the state's ecoregions (Heiskary and Wilson 2005). Clear relationships were established between the causal factor TP and the response variables Chl-*a* and Secchi transparency. Based on these relationships, it is expected that by meeting the phosphorus target in each lake, the Chl-*a* and Secchi standards will likewise be met.

Rice Lake is assessed against the Western Corn Belt Plains (WCBP) Ecoregion water quality standards (Figure 2). A separate water quality standard was developed for shallow lakes, which tend to have poorer water quality than deeper lakes in this ecoregion. According to the MPCA definition of shallow lakes, a lake is considered shallow if its maximum depth is less than 15 feet, or if the littoral zone (area where depth is less than 15 feet) covers at least 80% of the lake's surface area. Rice Lake has a mean depth of approximately 1 meter (3.28 feet) and a max depth of approximately 1.5 meters (4.92 feet).

To be listed as impaired (Minn. R. 7050.0150, subp. 5), the summer growing season (June through September) monitoring data must show that the standards for both TP (the causal factor) and either Chl-*a* or Secchi transparency (the response variables) were exceeded. If a lake is impaired with respect to only one of these criteria, it may be placed on a review list; a weight of evidence approach is then used to determine if it will be listed as impaired. For more details regarding the listing process, see the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* (MPCA 2014a).

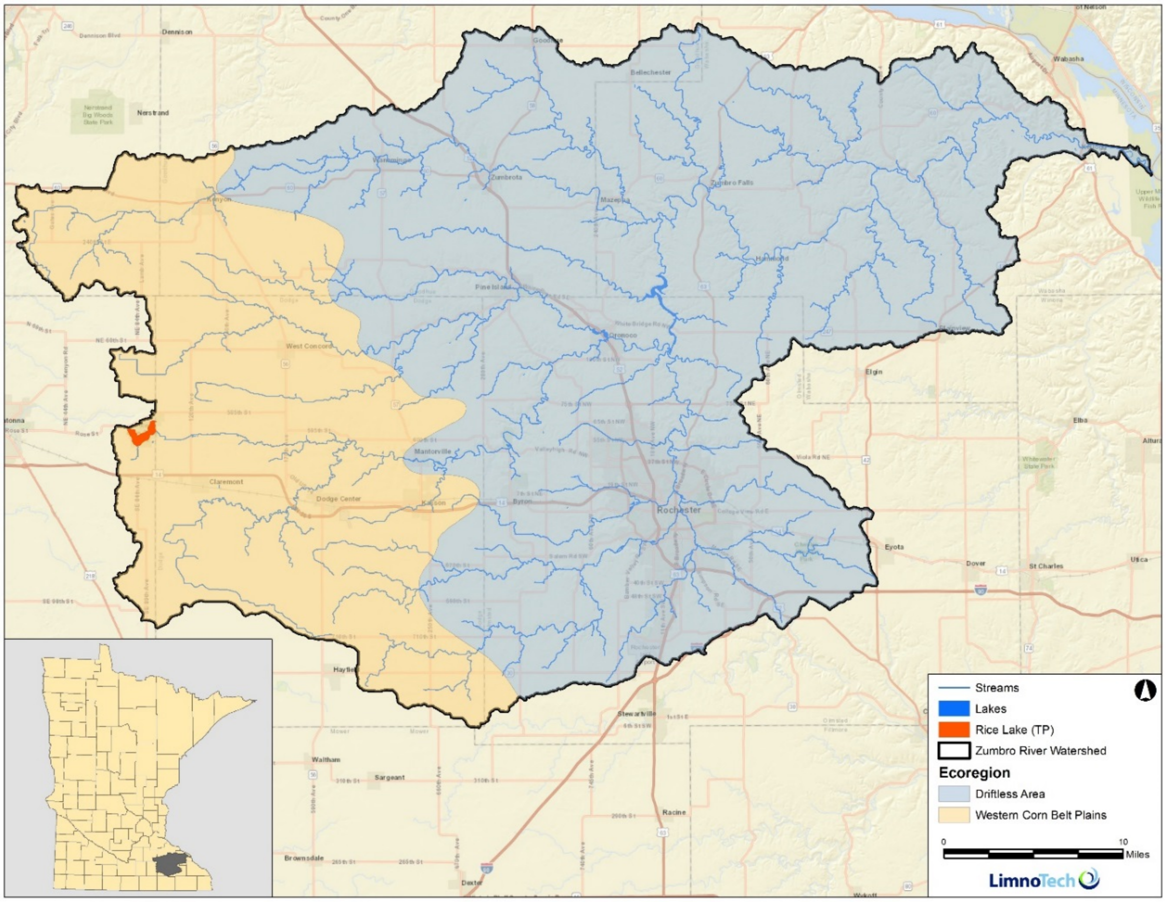

Figure 2. Two Level 3 ecoregions within the ZRW – Western Corn Belt Pains and Driftless Area.

2.2.2 Biotic Integrity

Minnesota's standard for biotic integrity is set forth in Minn. R. 7050.0150 (3) and (6). The standard uses an Index of Biotic Integrity (IBI), which evaluates and integrates multiple attributes of the aquatic community, or "metrics," to evaluate a complex biological system. Each metric is based upon a structural (e.g. species composition) or functional (e.g. feeding habits) aspect of the aquatic community that changes in a predictable way in response to human disturbance. Fish and macroinvertebrate IBIs are expressed as a score that ranges from 0-100, with 100 being the best score possible. The MPCA has evaluated fish and macroinvertebrate communities at numerous reference sites across Minnesota that have been minimally impacted by human activity, and has established IBI impairment thresholds based on stream drainage area, ecoregion, and major basin. A stream's biota is considered to be impaired when the IBI falls below the threshold established for that category of stream. IBIs are a line of evidence used in making aquatic life support decisions. The MPCA has two documents that further describe the development of fish and macroinvertebrate IBIs (MIBI) (MPCA 2014b and MPCA 2014c).

2.2.3 Bacteria (*E. coli* and Fecal Coliform)

E. coli

With the revisions of Minnesota's water quality rules in 2008, the state changed to an *E. coli* standard because it is a superior potential illness indicator and costs for lab analysis are less (CRWP and MPCA 2007). The revised standards now state:

"*E. coli concentrations are not to exceed **126** colony forming units per 100 milliliters (cfu/100 ml) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed **1,260** cfu/100 ml. The standard applies only between April 1 and October 31.*"

Fecal coliform

Previous water quality standards for fecal coliform stated concentrations shall "not exceed 200 organisms per 100 mLs as a geometric mean of not less than five samples in any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 2000 organisms per 100 mLs. The standard applies only between April 1 and October 31." Impairment assessment is based on the procedures contained in the Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment (MPCA 2014a).

The *E. coli* concentration standard of 126 cfu/100 ml was considered reasonably equivalent to the fecal coliform standard of 200 cfu/100 ml from a public health protection standpoint. The SONAR (Statement of Need and Reasonableness) section that supports this rationale uses a log plot to show the relationship between these two parameters. The relationship has an R^2 value of 0.69. The following regression equation was deemed reasonable to convert fecal coliform data to *E. coli* equivalents:

$$E.\ coli \text{ concentration (equivalents)} = 1.80 \times (\text{Fecal Coliform Concentration})^{0.81}$$

Although surface water quality standards are now based on *E. coli*, wastewater treatment facilities (WWTF) are permitted based on fecal coliform concentrations. There are also two AUIDs in the ZRW that were listed in 2008 as being impaired for fecal coliform. The *E. coli* equivalent was used to develop the load duration curve and TMDL table.

2.2.4 Turbidity and Total Suspended Solids

Turbidity is a measure of reduced transparency that can increase due to suspended particles such as sediment, algae, and organic matter. The Minnesota turbidity standard was 10 Nephelometric Turbidity Units (NTU) for class 2A waters and 25 NTU for class 2B waters. The state of Minnesota, in 2014, amended state water quality standards and replaced stream water quality standards for turbidity with standards for TSS. One component of the rationale for this change is that that turbidity unit (NTUs) is not concentration-based and therefore not well-suited to load-based studies (Markus 2011).

The new TSS criteria detailed in Minn. R. 7050.0222 are stratified by geographic region and stream class due to differences in natural background conditions resulting from the varied geology of the state and biological sensitivity. The assessment period for these samples is April through September; any TSS data collected outside of this period was not considered for assessment purposes. The TSS standard for all class 2A streams (coldwater) is 10 mg/L, and the TSS standard for class 2B streams (warmwater) in the South River Nutrient Region is 65 mg/L. For assessment, this concentration is not to be exceeded in more than 10% of samples within a 10-year period. The TSS results are available for the watershed from state-certified laboratories, and the existing data covers a large spatial and temporal scale in the watershed.

3. Watershed and Waterbody Characterization

3.1 Zumbro River Watershed Description

The ZRW covers approximately 909,000 acres and is located within the WCBP and Driftless Area Ecoregions of Minnesota. The major branches of the ZRW consist of the South Fork, Middle Fork, North Fork, Lake Zumbro, and the Lower Zumbro River. The watershed drains portions of Olmsted, Dodge, Wabasha, Goodhue, Steele, and Rice counties. The South Fork and Middle Fork branches merge near Oronoco. The North Fork branch meets with the Zumbro River between Mazeppa and Zumbro Falls before converging with the Mississippi River near Wabasha and Kellogg. The South Fork's course through Rochester has been channelized as part of a flood control project, and is dammed by the Lake Zumbro Hydroelectric Generating Plant, owned by Rochester Public Utilities (RPU), to form Lake Zumbro (USDA NRCS 2013a).

Tall prairie grasslands and oak savannas comprised much of the western reaches of the watershed prior to western settlement. The eastern blufflands were surrounded by stands of white pines. Prior to western influence on development, the pre-settlement vegetation comprised 57.1% prairie (includes brush and wet prairie lands), 31.3% oak openings, 5.5% aspen-oak, 3.5% big hardwood, 2.5% river bottom forest, and 0.1% lakes (also see Figure 3). Like other watersheds in southeastern Minnesota, the Zumbro Watershed has few natural lakes but several reservoirs; the most prominent in the watershed, Zumbro Lake, was constructed in 1919 and spans 600 acres. The hydroelectric dam provides power to the city of Rochester upstream (Rochester 2013).

The indigenous Dakota tribe inhabited the region until the 1852 Treaty of Traverse de Sioux was signed and forced their removal. European immigrants founded many of the watershed's towns shortly thereafter; choosing locations along the banks of the Zumbro's many rivers for their potential to serve as power sources for timber and flour mills. Forests were cleared and the watershed's rich prairie soils were cultivated.

Much of the modern landscape of ZRW has been modified by agriculture and human development. Remaining natural prairies are limited to the steep slopes of the blufflands; traditional pine forests have transitioned to deciduous hardwood forests and have grown in size due to fire suppression. In 1961, the Richard J Dorer Memorial Hardwood State Forest, which includes the Zumbro Bottoms State Forest, was created to promote conservation and responsible land use and restore a landscape damaged by flooding, a result of the land's overuse. A significant acreage of the forest lies within the watershed's eastern boundaries and serves as a valuable resource for wildlife and recreation in southeastern Minnesota (Minnesota Department of Natural Resources (DNR).

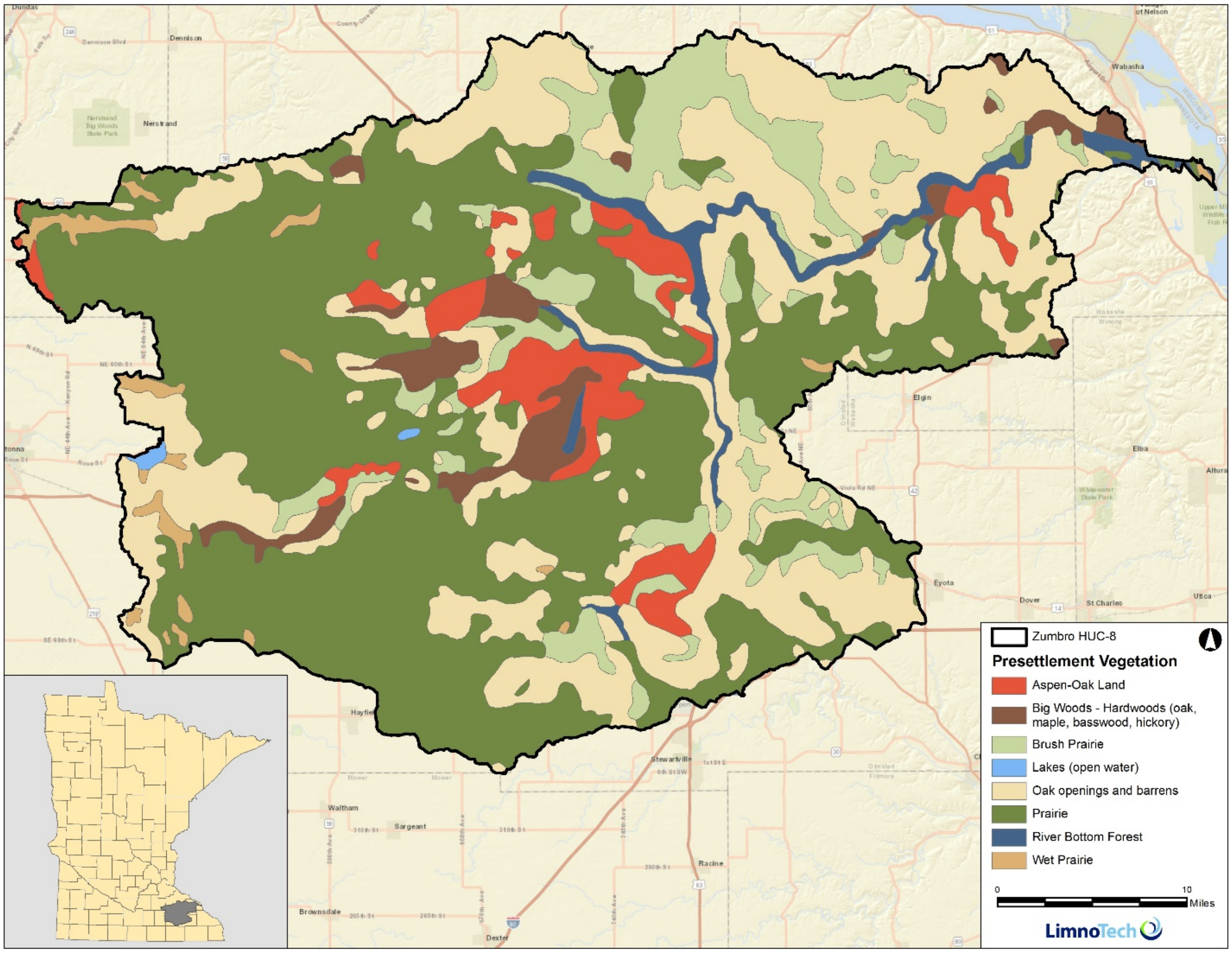

Figure 3. Pre-settlement vegetation in the ZRW (MnGeospatial Commons – based on Marschner's Public Land Survey analysis).

The general climate of the ZRW is a continental climate with winter temperatures around 10°F and summer temperatures around 70°F. Annual precipitation in the ZRW ranges from 29 to 33 inches per year. A large portion of the eastern drainage area is located within a geologic region known as the "Driftless Area", with geology comprised of a unique landform known as "Karst" (MPCA 2012). Features of Karst are characterized by underground streams, sinkholes, blind valleys and springs.

The elevation of the watershed ranges from 900 ft to 1,500 ft above sea level. The predominant average percent slope of the watershed falls within the 4% to 10% range and covers 50% of the watershed area. The remaining watershed area contains average percent slopes of less than 2% over 18% of the land area, 2% to 4% over 19% of the land area, and greater than 10% over 12% of the land area. The soils in the watershed range from very poorly drained to excessively drained (MPCA 2012, USDA NRCS 2013a). The western side of the watershed has a higher proportion of poorly drained soils with most of the land drained for crop production by surface and sub-surface drainage networks (MPCA 2012, ZWP 2012, USDA NRCS 2013a). The central to eastern side of the watershed is dominated by more well drained soils (USDA NRCS 2013a).

The main resource concerns in the watershed are sediment and erosion control, stormwater management, drinking and source water protection, waste management, nutrient management and wetland management (USDA NRCS 2013a). Many of the resource concerns relate directly to topography, agricultural practices and increased development in the region resulting in flooding and increased sediment and pollutant (*E. coli*, nitrogen, phosphorus) loadings to surface and ground waters (MPCA 2012, USDA NRCS 2013a).

3.2 Lakes

Morphometric information for Rice Lake is listed in Table 7. The watershed contributing to Rice Lake is shown in Figure 4, and is located in the South Branch Middle Fork Zumbro River Subwatershed.

Table 7. Morphometric characteristics of Rice Lake.

	Rice Lake 74-0001-00 Characteristics
HUC-10 Watershed	South Branch Middle Fork Zumbro River
Watershed Area (ac)	4352
Surface Area (ac)	609
Mean Depth (m)	0.9*
Max Depth (m)	2.1*

*From DNR, based on 69 depth measurements collected during 2016 habitat survey.

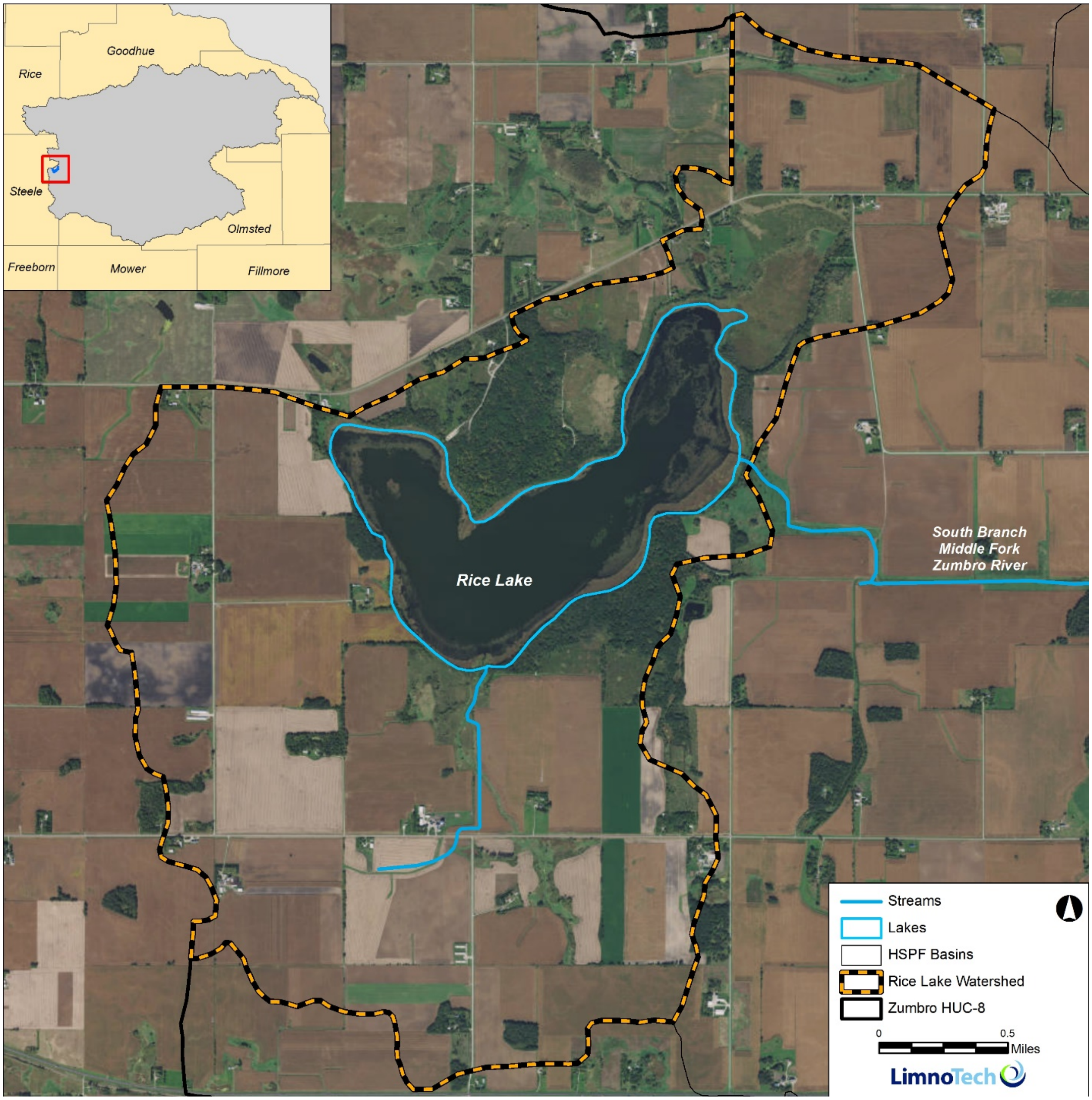

Figure 4. Location of Rice Lake watershed within the ZRW.

3.3 Streams

The total watershed areas of the impaired stream reaches are listed in Table 8. Total watershed areas were delineated from ZRWHSPF model subbasins except for Spring Creek (07040004-568), Trout Brook (07040004-571), Hammond Creek (07040004-575), Dry Run Creek (07040004-576), Spring Creek Tributary (07040004-769), Zumbro River (07040004-978), Zumbro River (07040004-992), and Zumbro River (07040004-993). The downstream end of each of these reaches did not match with a downstream HSPF subbasin, so the USGS StreamStats 4.0 web application was used to delineate the total reach drainage area. This application can be found here: https://streamstatsags.cr.usgs.gov/streamstats/.

Table 8. Watershed areas of impaired stream reaches.

HUC-10 Watershed	Listed Waterbody Name	Reach (AUID)	AUID Length (miles)	Watershed Area (ac)
Middle Fork Zumbro River	Milliken Creek	07040004-555	4.72	19,975
Middle Fork Zumbro River	Zumbro River	07040004-973	34.25	82,102
Middle Fork Zumbro River	Zumbro River	07040004-992	9.01	132,563*
Middle Fork Zumbro River	Zumbro River	07040004-993	6.37	275,942*
North Fork Zumbro River	Trout Brook	07040004-515	10.73	35,625
North Fork Zumbro River	Zumbro River	07040007-971	45.22	116,786
South Branch Middle Fork Zumbro River	Zumbro River	07040004-978	8.56	140,453*
South Branch Middle Fork Zumbro River	Judicial Ditch 1	07040004-987	4.68	19,191
South Branch Middle Fork Zumbro River	Dodge Center Creek	07040004-989	24.47	57,374
South Fork Zumbro River	Bear Creek	07040004-538	2.95	51,812
South Fork Zumbro River	Unnamed Creek	07040004-595	0.84	8,552
South Fork Zumbro River	Unnamed Creek	07040004-596	0.91	3,268
Zumbro River	West Indian Creek	07040004-542	6.52	16,856
Zumbro River	Long Creek	07040004-565	8.94	21,026
Zumbro River	Middle Creek	07040004-567	4.88	11,404
Zumbro River	Spring Creek	07040004-568	4.19	21,069*
Zumbro River	Spring Creek	07040004-570	1.96	40,862
Zumbro River	Trout Brook	07040004-571	2.1	6,042*
Zumbro River	Hammond Creek	07040004-575	1.57	7,210*
Zumbro River	Dry Run Creek	07040004-576	4.25	19,236*
Zumbro River	Spring Creek Tributary	07040004-769	0.6	966*

*denotes impaired reaches where USGS StreamStats 4.0 was used to delineate total watershed area

3.4 Subwatersheds

The HUC-8 ZRW is divided into five HUC-10 subwatersheds. The subwatersheds in Figure 5 were obtained from the DNR Watershed Suite dataset downloaded from the Minnesota Geospatial Commons website (https://gisdata.mn.gov/dataset/geos-dnr-watersheds).

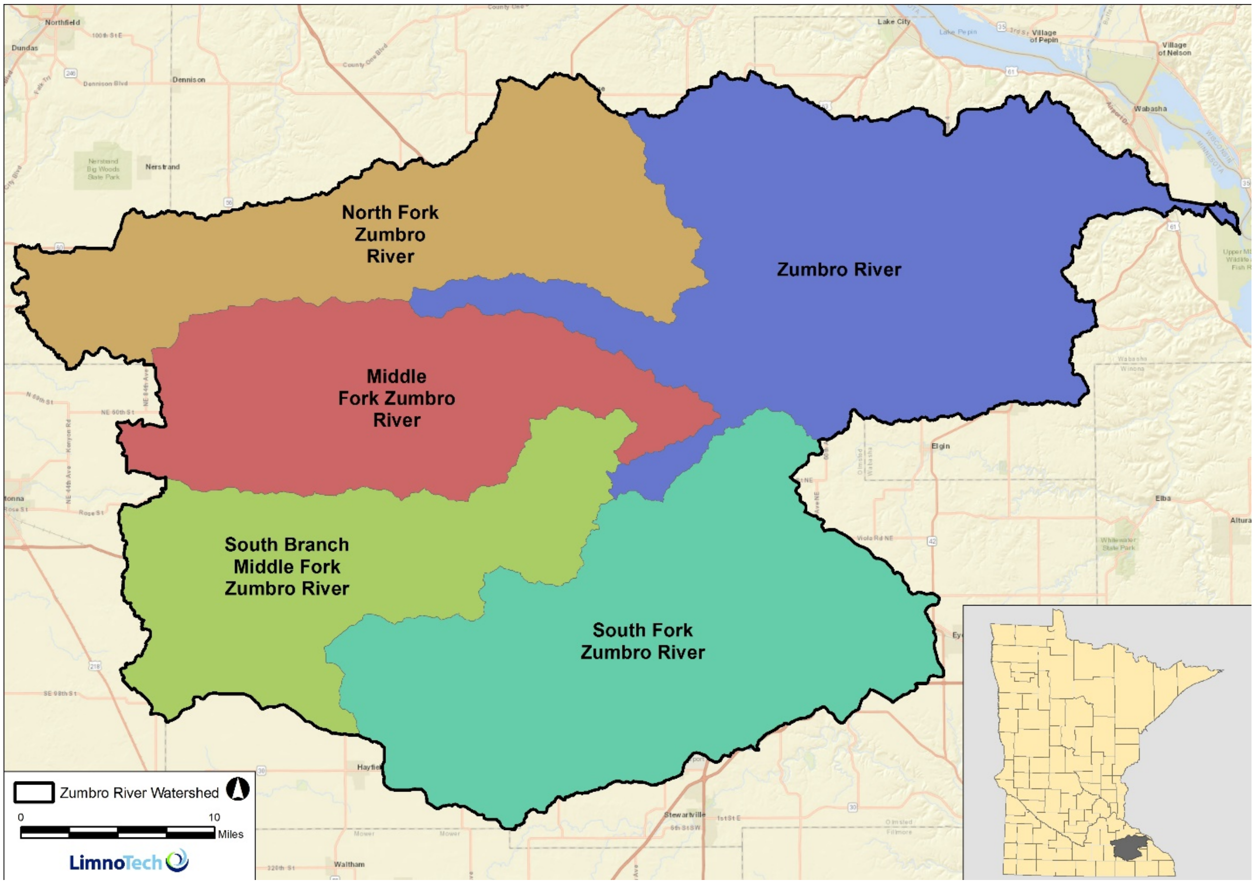

Figure 5. HUC-10 divisions within the ZRW.

3.5 Land Use

Today, the ZRW's land use can be characterized as cropland (56.0%), rangeland (grassland and pasture, 23.3%), forest/shrub (9.7%), developed (9.0%), wetland (1.5%), open water (0.5%) and barren land (less than 0.1%) (Figure 6). A majority of the watershed's land is privately owned, roughly 98% (NRCS 2016). The northern, southern and western regions of the watershed are dominated by row crop agriculture with scattered livestock operations. The Natural Resources Conservation Service (NRCS; NRCS 2016) estimates that there are 2,730 farms in the watershed; 8% are greater than 1,000 acres, 42% are less than 180 acres, and 50% are of median size (180 to 1000 acres) (NRCS).

There are currently 1,068 registered Animal Feedlot Operations (AFO) in the watershed. Animal livestock units in the watershed are divided as follows: 36% swine, 34% dairy, 26% cattle, 4% poultry, and 1% other (based on total animal units (AUs)). Wabasha County ranks as the state's fifth leading dairy producer, followed by Goodhue County. Goodhue County ranks as the state's eighth leading cattle producer (MDA 2013b and 2013d).

Moving east in the watershed, rangeland and forested uses increase. Rangeland typically surrounds heavily forested blufflands as its steep terrain limits utility for crop production. Forested land use is greatest on the watershed's eastern boundaries. Frac sand mining is a growing industry in the watershed but this land use is not reflected in the land use coverage utilized in this report.

While the watershed is predominately rural, it also encompasses Rochester, Minnesota's third largest city (population: 111,402). As such, Olmsted County has the state's eighth largest population (MDA

2013). Rural population centers in the watershed include smaller towns (Kasson: 6,074, Byron: 5,191, Zumbrota: 3,349, Dodge Center: 2,691, Pine Island: 2,590, Kenyon: 1,817, Mantorville: 1,206 and Wanamingo: 1,084) and rural communities (Mazeppa: 829, West Concord: 799, Viola: 596, Claremont: 540, Kellogg: 439, Zumbro Falls: 244, Millville: 179 and Hammond: 135) (2010 U.S. Census Bureau). Development in the greater Rochester area is expected to continue to grow; population estimates by the Minnesota Legislature estimate the region's population to increase in the range of 35% to 103% between the years 2000 and 2030 (MPSDC 2002).

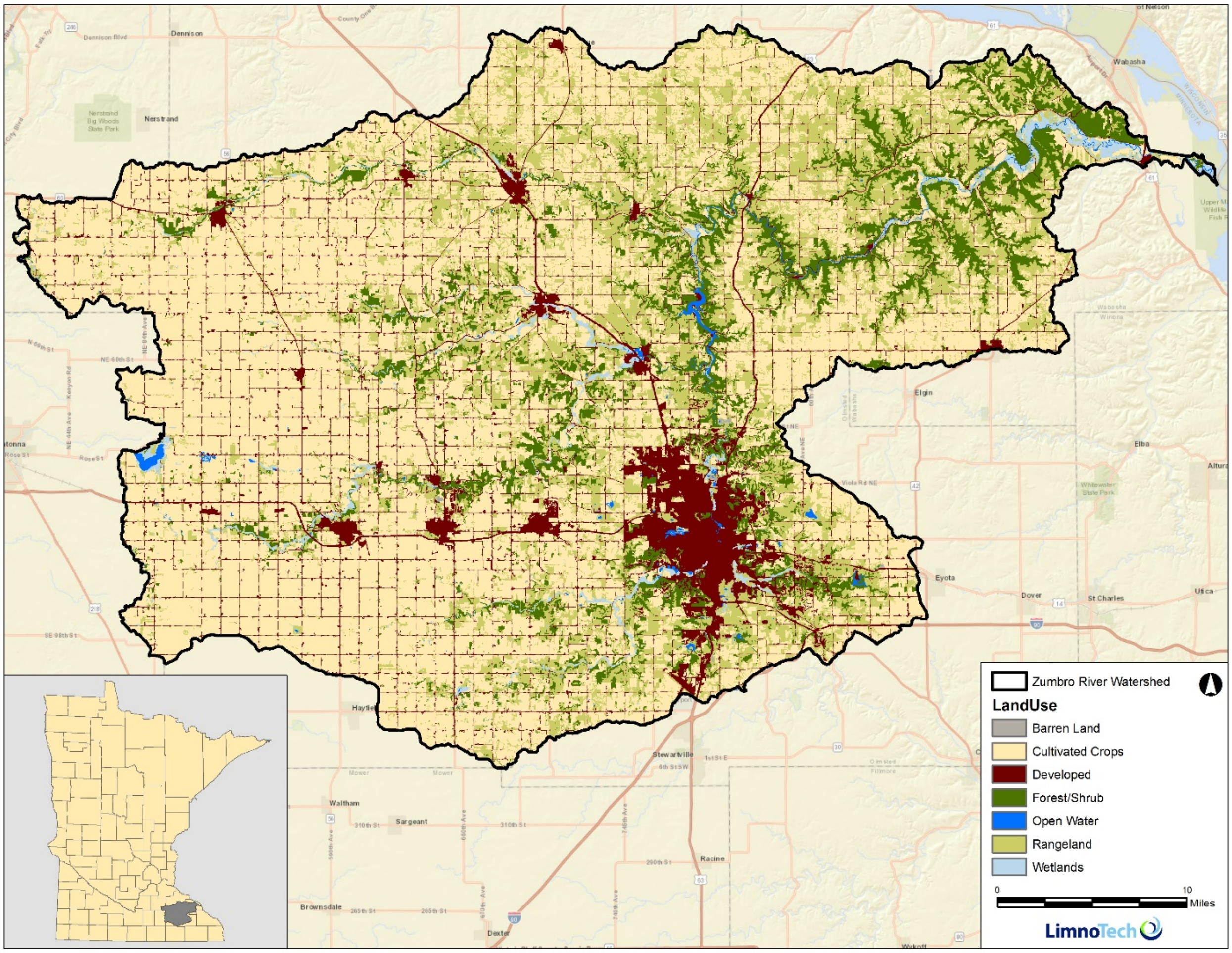

Figure 6. National Land Cover Dataset land use coverage in the ZRW (from NLCD 2011 dataset)

3.6 Current/Historic Water Quality

The existing stream water quality conditions were quantified using data downloaded from the MPCA Environmental Quality Information System (EQuIS) database that was available for the 10-year period from 2005 to 2014 to identify impairments in the ZRW. *E. coli* and TSS data for streams were summarized based on the TMDLs identified to address the assessed impairments. HUC-10 level summaries of the impaired AUIDs are in the following sections. The purpose of this brief summary is to illustrate the frequency of exceedances. Some impaired AUIDs may have little or no chemical water quality data in EQuIS (2005 to 2014) because the primary line of evidence used in making the impairment decisions was biota data. Short-term sampling was conducted (after 2014) to develop the SID, which can provide linkage to pollutant stressors. Additional monitoring and assessment data, including indices of biological integrity for each stream, can be found in the ZRW Monitoring and

Assessment Report. Identified stressors beyond those for which TMDLs were computed (see Appendix A) are found in the SID and WRAPS reports. A map showing the biological monitoring locations used to develop the SID is provided as Figure 7.

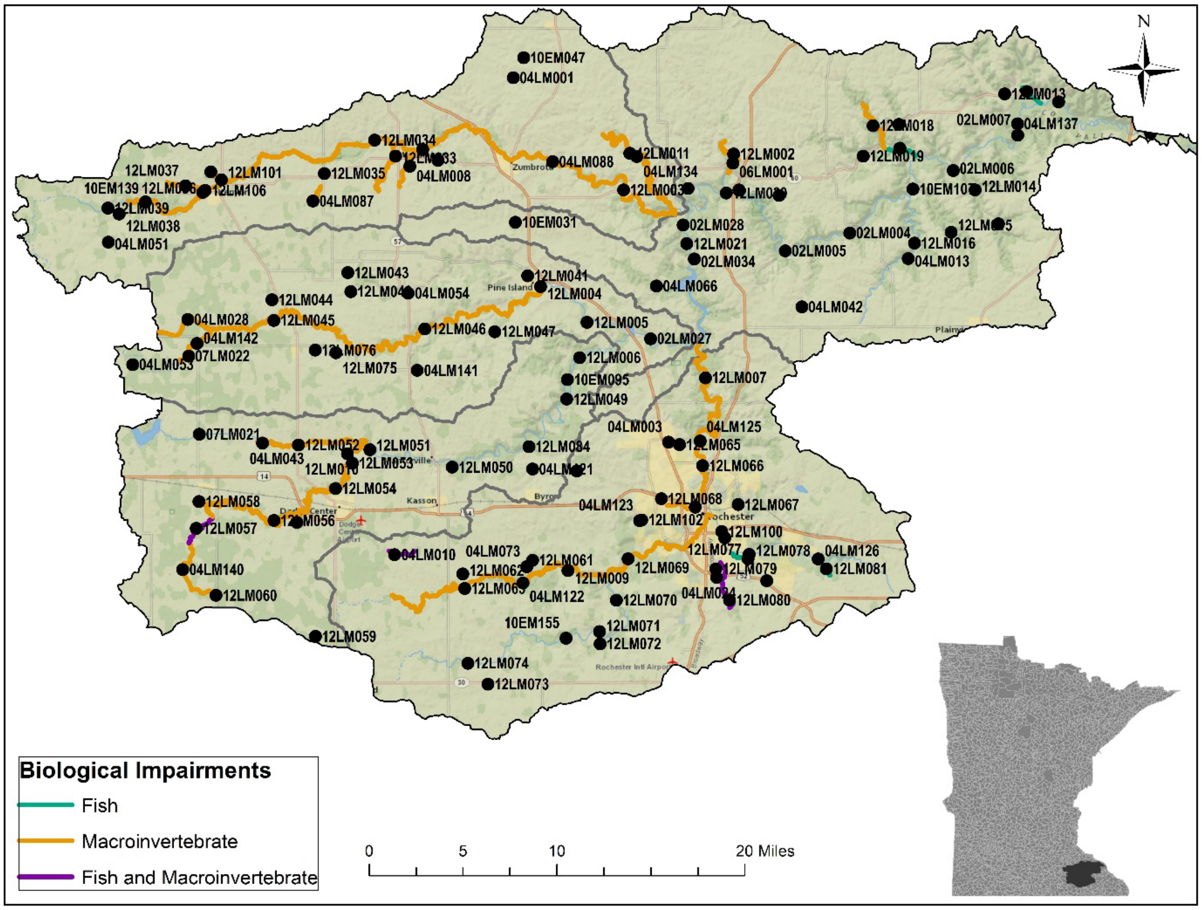

Figure 7. Biological monitoring locations in the ZRW used in developing the SID report.

Natural background is the landscape condition that occurs outside of human influence. Minn. R. 7050.0150, subp. 4, defines the term "Natural causes" as the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. Natural background considerations are discussed further in Section 4.1.1.

3.6.1 Middle Fork Zumbro River HUC-10

The Middle Fork Zumbro River Subwatershed includes four impaired AUIDs; two for aquatic recreation and two for aquatic life. Milliken Creek (07040004-555) was listed in 2010 based on turbidity data. The AUID immediately upstream of 07040004-555 (Milliken Creek 07040004-554) has TSS data that meets water quality standards. Additional monitoring on both of these AUIDs will allow for continued examination of use support status.

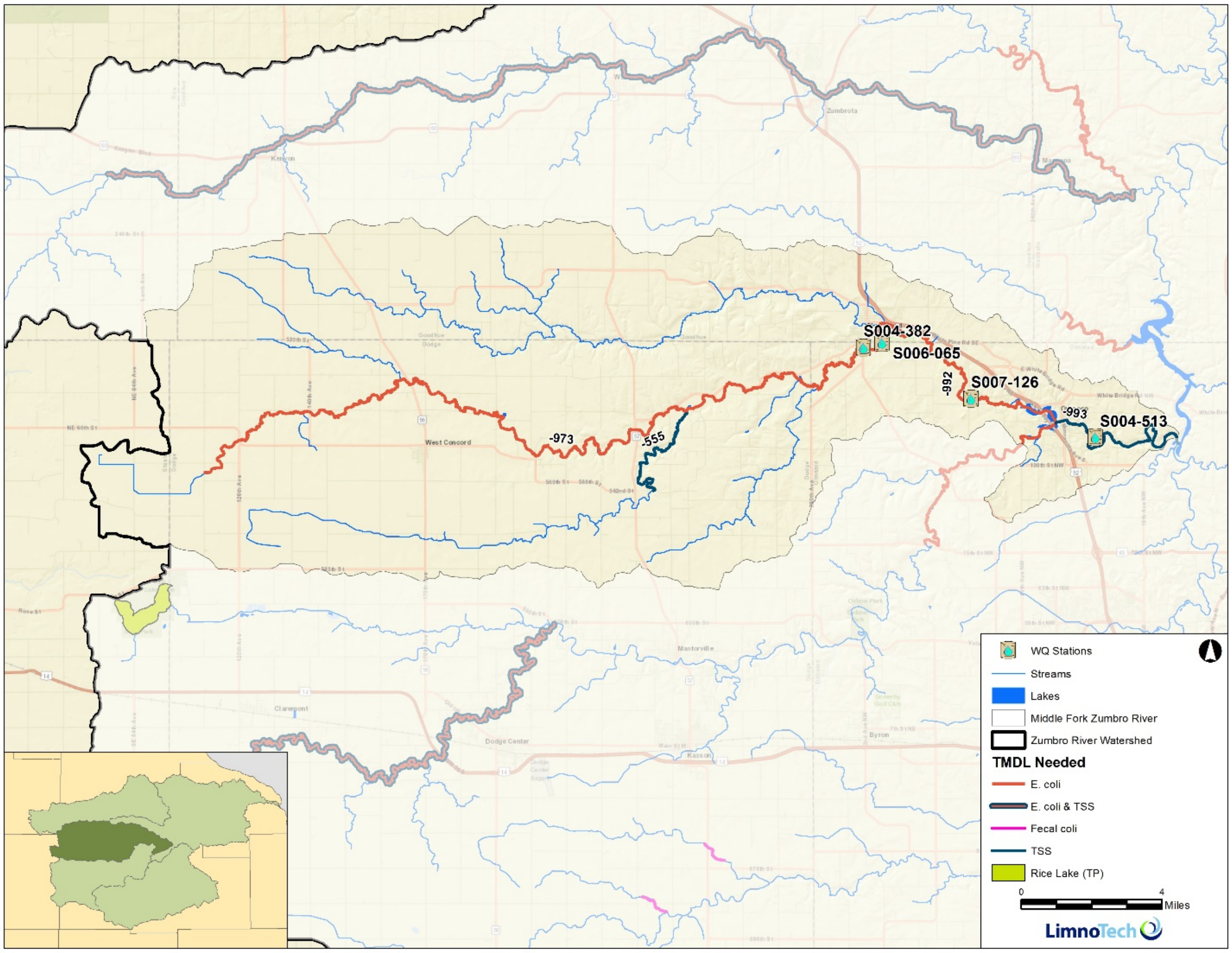

Figure 8. Impaired stream reaches in the Middle Fork Zumbro River Subwatershed.

Table 9. Aquatic Recreation impairments in the Middle Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# Samples Above 126 MPN/100 mL	*E. Coli* Geomean (MPN/100 mL)	Sample Date
Zumbro River	07040004-973	S004-382	3/4	291.7	2008
		S006-065	15/15	436.5	2012 - 2013
Zumbro River	07040004-992	S007-126	12/19	220.1	2008; 2012 - 2013

Table 10. Aquatic Life impairments in the Middle Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# TSS Samples Above 65 mg/L	Sample Date
Milliken Creek	07040004-555	-	no TSS data	-
Zumbro River	07040004-993	S004-513	18/40	2007 - 2008

3.6.2 North Fork Zumbro River HUC-10

The North Fork Zumbro River Subwatershed includes three impaired AUIDs; two for aquatic recreation and one for aquatic life.

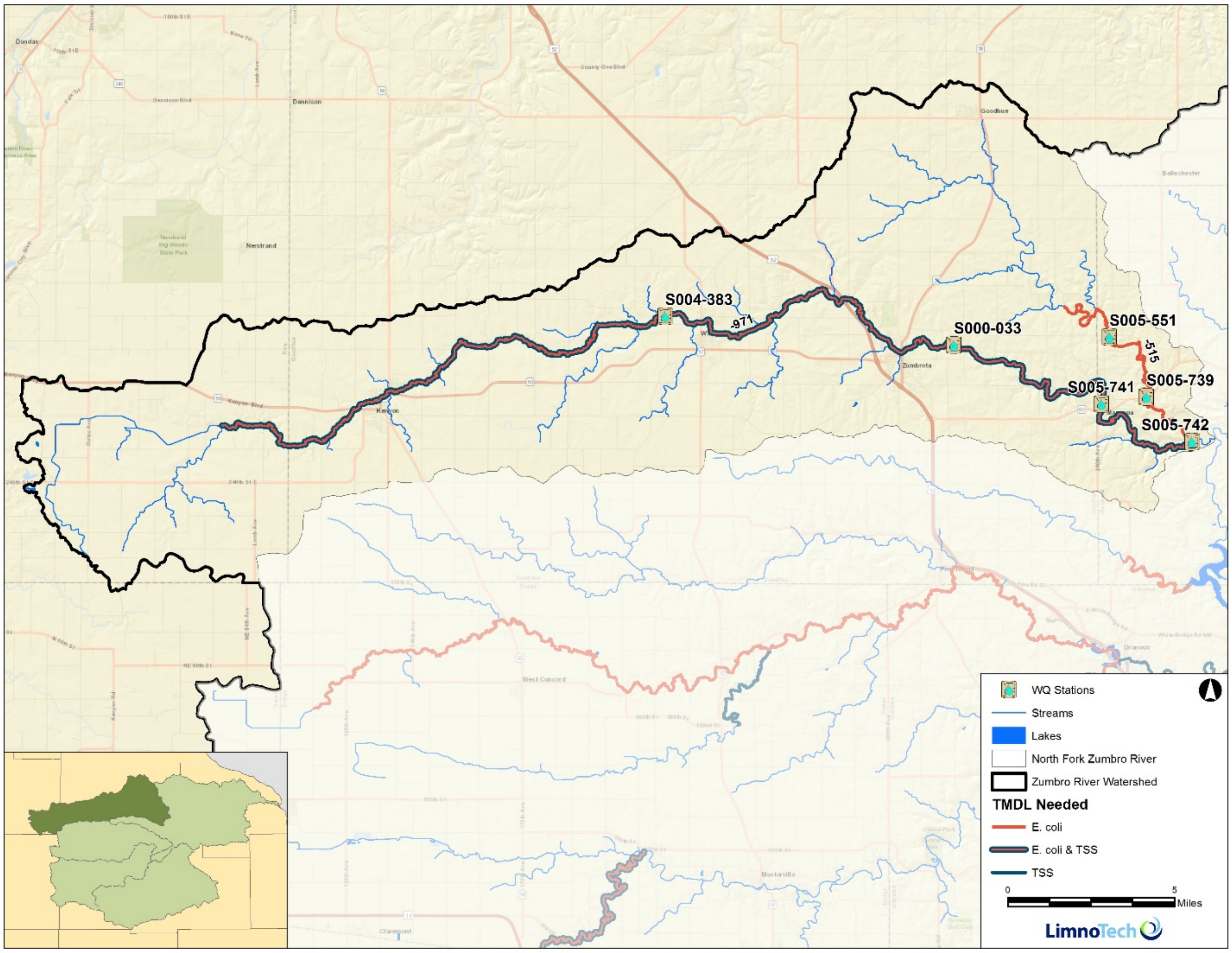

Figure 9. Impaired stream reaches in the North Fork Zumbro River Subwatershed.

Table 11. Aquatic Recreation impairments in the North Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# Samples Above 126 MPN/100 mL	*E. Coli* Geomean (MPN/100 mL)	Sample Date
Trout Brook	07040004-515	S005-551	33/43	225.2	2009 - 2010; 2012 - 2013
		S005-739	17/17	601.1	2009 - 2011
Zumbro River	07040004-971	S000-033	17/20	347.2	2009 - 2010
		S005-741	29/32	436.2	2009 - 2013
		S005-742	14/18	302.8	2009 - 2011

Table 12. Aquatic Life impairments in the North Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# TSS Samples Above 65 mg/L	Sample Date
Zumbro River	07040004-971	S000-033	1/21	2009 - 2010
		S004-383	13/28	2007 - 2008
		S005-741	0/12	2012 - 2013

3.6.3 South Branch Middle Fork Zumbro River HUC-10

The South Branch Middle Fork Zumbro River Subwatershed includes three impaired AUIDs; two for aquatic recreation and one for aquatic life.

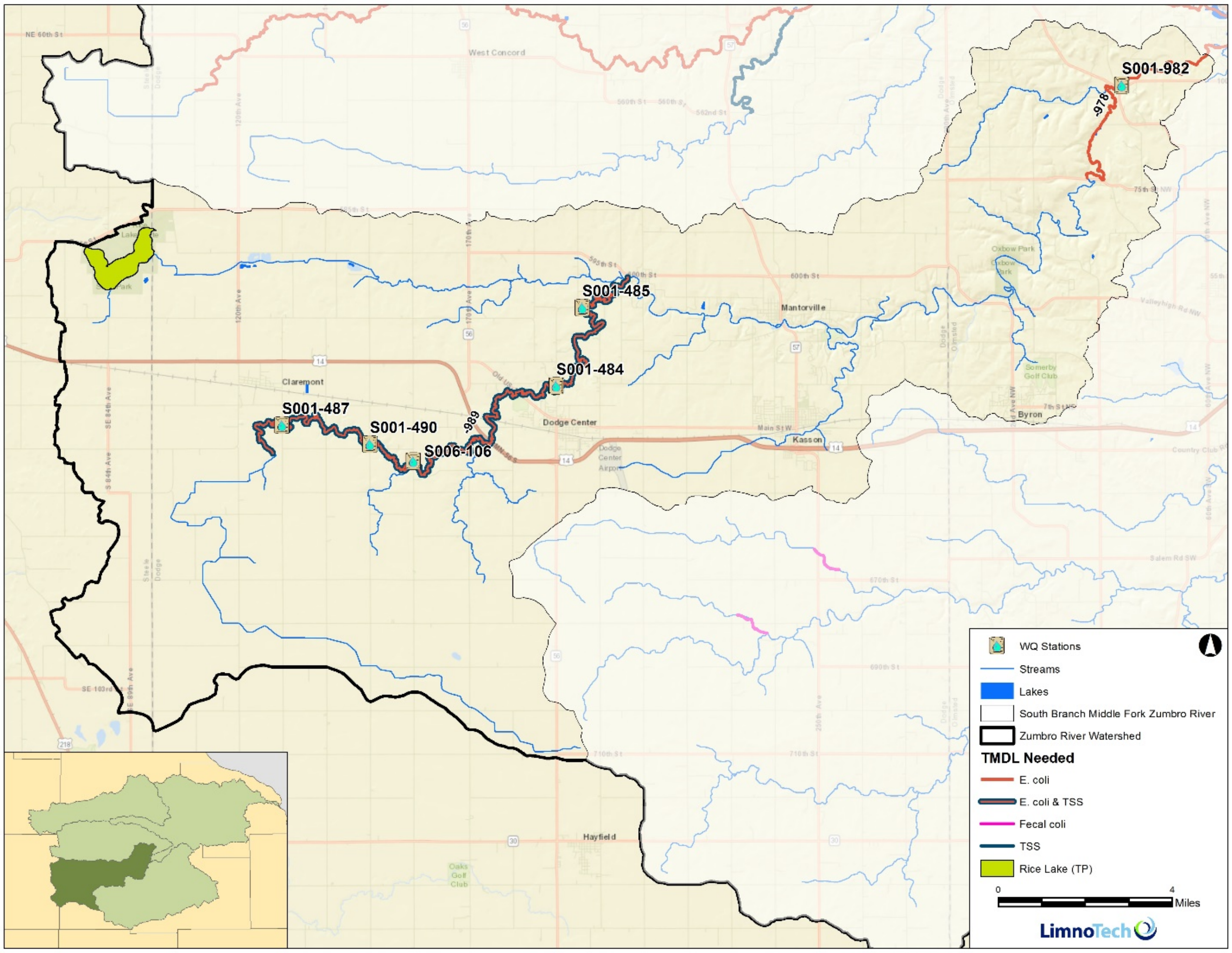

Figure 10. Impaired stream reaches in the South Branch Middle Fork Zumbro River Subwatershed.

Table 13. Aquatic Recreation impairments in the South Branch Middle Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# Samples Above 126 MPN/100 mL	*E. Coli* Geomean (MPN/100 mL)	Sample Date
Zumbro River	07040004-978	S001-982	14/15	292.6	2012 2013
Dodge Center Creek	07040004-989	S001-485	14/14	447.0	2012 - 2013

Table 14. Aquatic Life impairments in the South Branch Middle Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# TSS Samples Above 65 mg/L	Sample Date
Dodge Center Creek	07040004-989	S001-484	3/7	2014
		S001-485	4/16	2012; 2014
		S001-487	1/6	2014
		S001-490	0/4	2014
		S006-106	1/6	2014

3.6.4 South Fork Zumbro River HUC-10

The South Fork Zumbro River Subwatershed includes three AUIDs impaired for aquatic recreation.

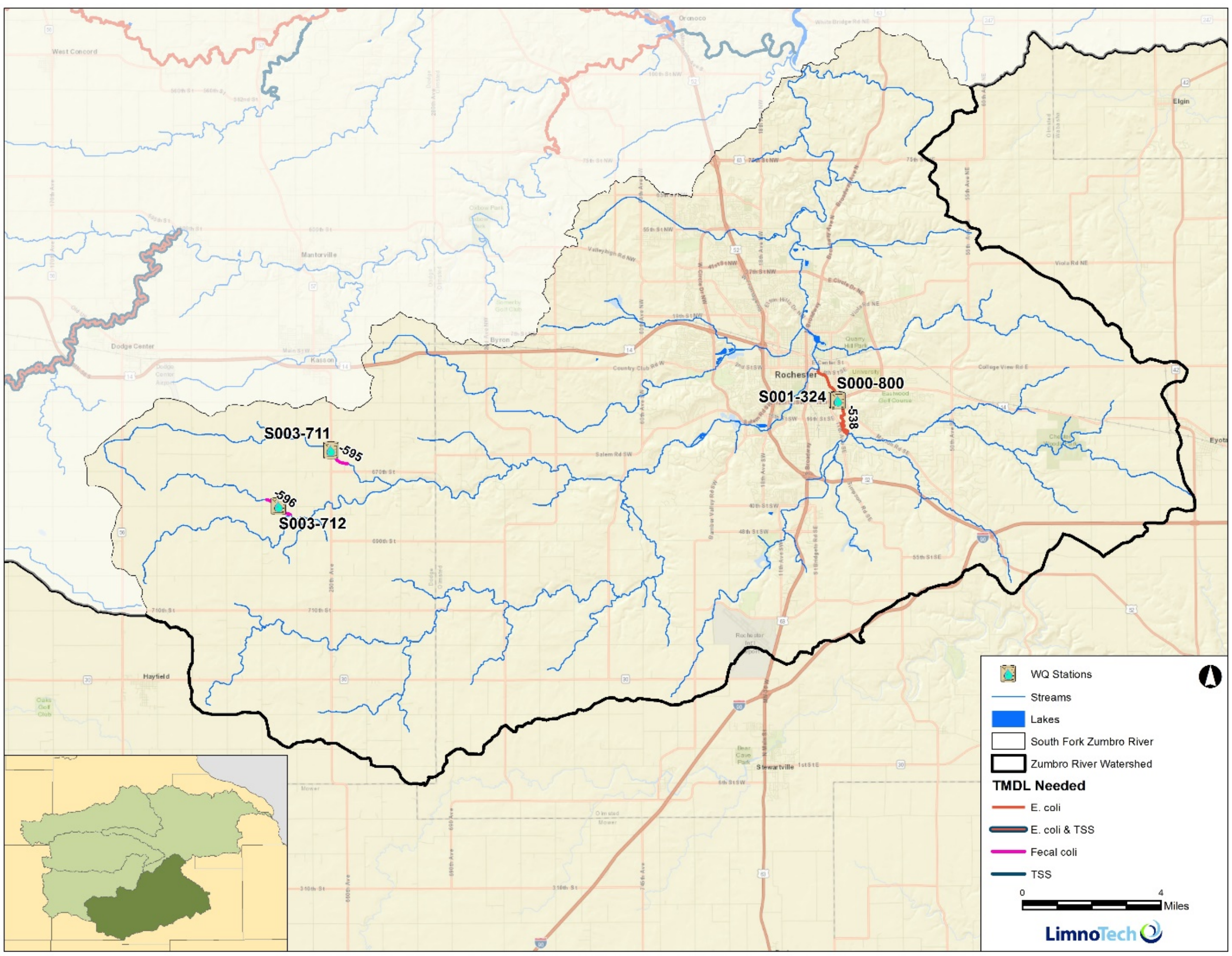

Figure 11. Impaired stream reaches in the South Fork Zumbro River Subwatershed.

Table 15. Aquatic Recreation impairments in the South Fork Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# Samples Above 126 MPN/100 mL	*E. Coli* Geomean (MPN/100 mL)	Sample Date
Bear Creek	07040004-538	S000-800	3/4	180.1	2008
		S001-324	15/15	708.4	2012 - 2013
Unnamed Creek	07040004-595	S003-711	11/14	388.8 - *E. coli* equivalent	2004
Unnamed Creek	07040004-596	S003-712	45/60	286.9 - *E. coli* equivalent	2002 - 2003

3.6.5 Zumbro River HUC-10

The Zumbro River Subwatershed has eleven impaired AUIDs; eight for aquatic recreation and three for aquatic life. Spring Creek (07040004-568) has no TSS data in the EQuIS database (through 2014). Fieldwork in 2012 and subsequent SID concluded that TSS is a stressor of macroinvertebrate communities (MPCA 2016c). Spring Creek Tributary (07040004-769) also has no TSS data; however, Secchi tube data indicate an impairment.

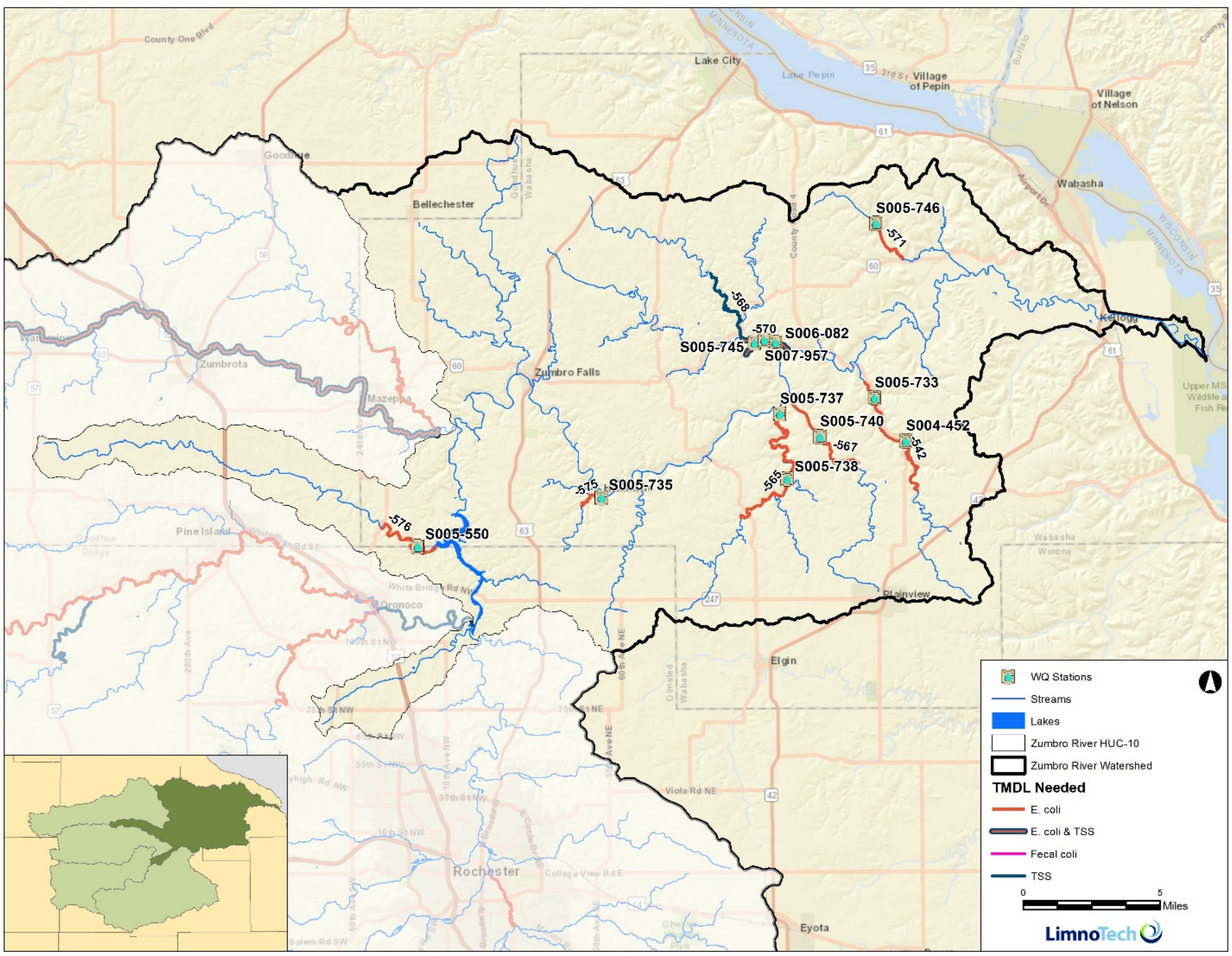

Figure 12. Impaired stream reaches in the Zumbro River Subwatershed.

Table 16. Aquatic Recreation impairments in the Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# Samples Above 126 MPN/100 mL	*E. Coli* Geomean (MPN/100 mL)	Sample Date
West Indian Creek	07040004-542	S004-452	14/18	344.9	2009 - 2011
		S005-733	15/18	285.4	2009 - 2011
Long Creek	07040004-565	S005-737	10/18	205.0	2009 - 2011
		S005-738	14/18	218.7	2009 - 2011
Middle Creek	07040004-567	S005-740	15/19	250.4	2009 - 2011
Spring Creek	07040004-570	S006-082	15/15	724.7	2012 - 2013
Trout Brook	07040004-571	S005-746	11/18	269.7	2009 - 2011
Hammond Creek	07040004-575	S005-735	16/18	398.5	2009 - 2011
Dry Run Creek	07040004-576	S005-550	20/26	423.3	2009 - 2010
Spring Creek Tributary	07040004-769	S005-745	18/18	758.4	2009 - 2011

Table 17. Aquatic Life impairments in the Zumbro River Subwatershed.

Listed Waterbody Name	Reach (AUID)	WQ Station ID	# TSS Samples Above 10 mg/L	Sample Date
Spring Creek	07040004-568	-	no TSS data	-
Spring Creek	07040004-570	S006-082	3/11	2012; 2014
		S007-957	2/2	2014
Spring Creek Tributary	07040004-769	-	no TSS data	-

3.7 Pollutant Source Summary

3.7.1 Point Sources

Permitted point sources are shown in Figure 13 below and summarized in Table 18. Given that the ZRW is a predominantly rural landscape, point sources account for a relatively small component of sediment and pathogen loads. Point sources can play a significant role in phosphorus loading and water quality conditions, particularly during low flows. Phosphorus loads from point sources can be examined using the MPCA's phosphorus in wastewater tool: https://www.pca.state.mn.us/water/phosphorus-wastewater.

In total, there are 45 permitted facilities in the ZRW, 32 of which were assigned a specific WLA based on their design flow and permit limits. The remaining 13 facilities were lumped into the Construction and Industrial Stormwater Runoff category and assigned a categorical WLA as described in Section 4.

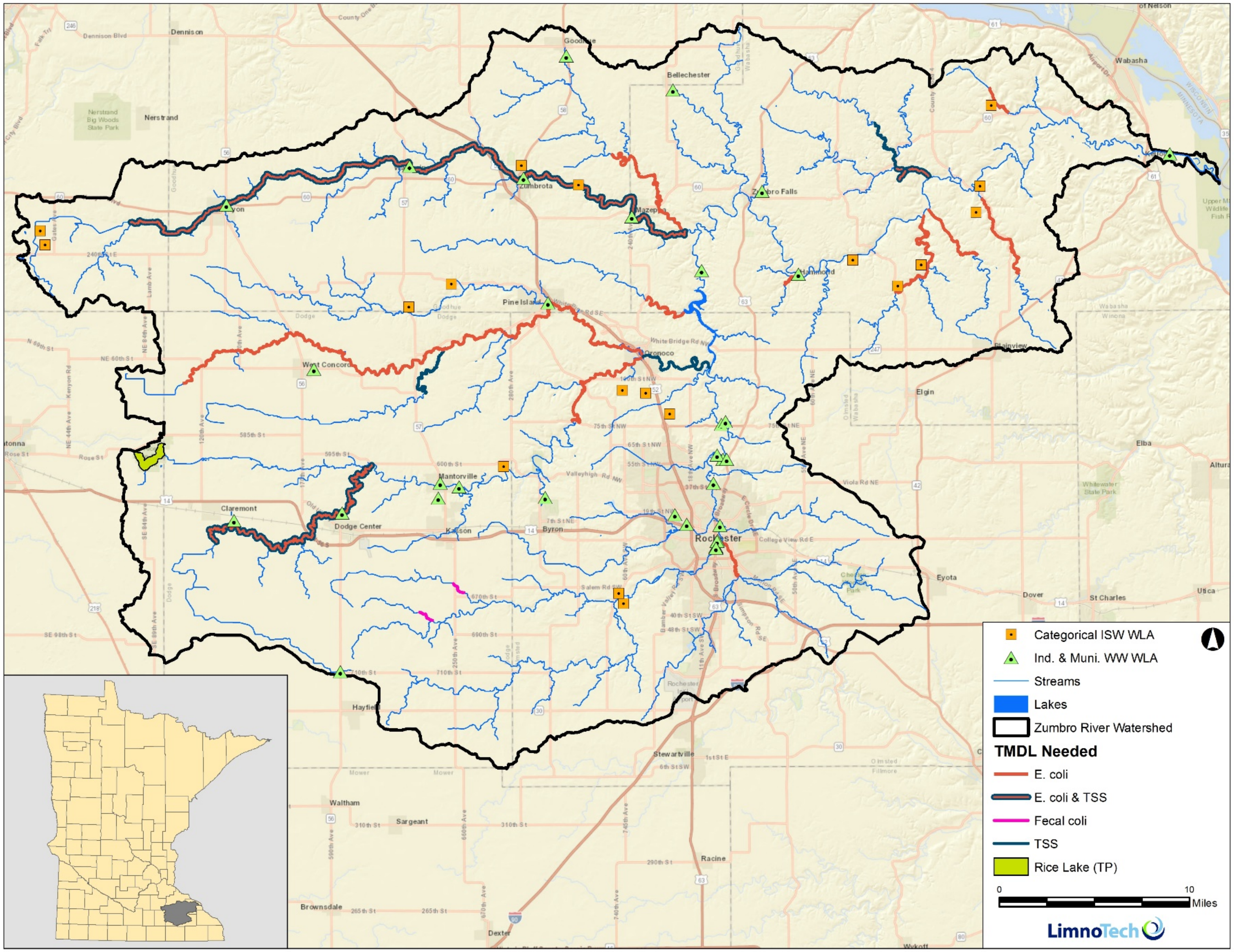

Figure 13. Location of active permitted wastewater facilities in the ZRW.

Table 18. List of active permitted wastewater facilities in the ZRW that were used in the TMDL report to develop WLAs.

Facility	NPDES Permit No	WLA Type
AMPI - Rochester - MNG255 General	MNG255051	Industrial & Municipal WWTF
Bellechester WWTP	MN0022764	Industrial & Municipal WWTF
Byron WWTP	MN0049239	Industrial & Municipal WWTF
Camp Victory WWTP	MN0067032	Industrial & Municipal WWTF
Claremont WWTP	MN0022187	Industrial & Municipal WWTF
Dodge Center WWTP	MN0021016	Industrial & Municipal WWTF
Franklin Heating Station (2 outfalls)	MN0041271	Industrial & Municipal WWTF
Goodhue WWTP	MN0020958	Industrial & Municipal WWTF
Hallmark Terrace Inc	MN0030368	Industrial & Municipal WWTF
Hammond WWTP	MN0066940	Industrial & Municipal WWTF
Hayfield WWTP	MN0023612	Industrial & Municipal WWTF
Kasson WWTP	MN0050725	Industrial & Municipal WWTF
Kellogg WWTP	MNG580027	Industrial & Municipal WWTF
Kemps LLC - Milk Plant	MN0059803	Industrial & Municipal WWTF
Kenyon WWTP	MN0021628	Industrial & Municipal WWTF
Kerry Inc	MNG250047	Industrial & Municipal WWTF
Mantorville WWTP	MN0021059	Industrial & Municipal WWTF
Mathy Construction – Aggregate (4 outfalls)	MNG490081	Industrial & Municipal WWTF
Mazeppa WWTP	MN0046752	Industrial & Municipal WWTF
Milestone Materials - Goldberg Quarry*	MN0062227	Industrial & Municipal WWTF
Milestone Materials - North Quarry	MN0069523	Industrial & Municipal WWTF
Pine Island WWTP	MN0024511	Industrial & Municipal WWTF
Rochester Athletic Club	MN0062537	Industrial & Municipal WWTF
Rochester Public Utilities - Silver Lake Plant	MN0001139	Industrial & Municipal WWTF
Rochester WWTP/Water Reclamation Plant	MN0024619	Industrial & Municipal WWTF
Seneca Foods Corp - Rochester	MN0000477	Industrial & Municipal WWTF
Stussy Construction Inc	MNG490134	Industrial & Municipal WWTF
Wanamingo WWTP	MN0022209	Industrial & Municipal WWTF
West Concord WWTP	MN0025241	Industrial & Municipal WWTF
Zumbro Falls WWTP	MN0051004	Industrial & Municipal WWTF
Zumbro Ridge Estates Mobile Home Park	MN0038661	Industrial & Municipal WWTF
Zumbrota WWTP	MN0025330	Industrial & Municipal WWTF
Al-Corn Clean Fuel	MN0063002	Categorical Construction & Industrial Stormwater Runoff
B&B Screen Plant	MNG490227	Categorical Construction & Industrial Stormwater Runoff
Bennett & Sons Sand & Gravel	MNG490308	Categorical Construction & Industrial Stormwater Runoff
Bituminous Materials LLC - Faribault	MNG490004	Categorical Construction & Industrial Stormwater Runoff
Bruening Rock Products Inc - Harmony (5 outfalls)	MNG490115	Categorical Construction & Industrial Stormwater Runoff
Daniel DeCook Sand & Gravel LLC	MNG490172	Categorical Construction & Industrial Stormwater Runoff
Fraser Construction Co - Kaul Pit	MNG490310	Categorical Construction & Industrial Stormwater Runoff
Jech Excavating - Howard Olson Residence	MNG490127	Categorical Construction & Industrial Stormwater Runoff
Kielmeyer Construction Inc (3 outfalls)	MNG490085	Categorical Construction & Industrial Stormwater Runoff
Riverside Sand & Gravel	MNG490135	Categorical Construction & Industrial Stormwater Runoff
Roberson Lime & Rock - Dumfries Quarry	MNG490226	Categorical Construction & Industrial Stormwater Runoff
Rochester Asphalt Inc	MNG490311	Categorical Construction & Industrial Stormwater Runoff
SL Contracting Inc	MNG490266	Categorical Construction & Industrial Stormwater Runoff

*this discharge is also covered by general permit MNG490081 SD-117. WLA is applicable to either one of the permits

3.7.2 Phosphorus

This section provides a brief description of the potential sources in the watershed contributing to excess nutrients in the impaired lakes. Land-based sources of phosphorus can include fertilizer and manure.

Phosphorus can also be released from the decay of organic matter, which can enter waterbodies. Organic material such as leaves and grass clippings can leach dissolved phosphorus into standing water and runoff or be conveyed directly to waterbodies where biological action breaks down the organic matter and releases phosphorus. Additionally, phosphorus can adsorb to soil particles; wind and water action erode the soil, detaching particles and conveying them in stormwater runoff to nearby waterbodies where the phosphorus becomes available for algal growth.

3.7.2.1 Permitted

Generally, regulated sources of phosphorus include National Pollutant Discharge Elimination System (NPDES) permitted WWTF effluent, MS4 stormwater, construction sites, and industrial sites. There are no NPDES permitted WWTF or MS4 communities within the Rice Lake drainage area.

3.7.2.2 Non-permitted

Several investigations related to sediment source apportionment have been conducted within the past 5 to 15 years for watershed areas in southeast Minnesota, and for Lake Pepin just upstream of the outlet of the ZRW. These studies have generally involved sediment "fingerprinting" through the geochemical analysis of sediments and the representation of distinct sediment sources within HSPF models developed for the MPCA (LimnoTech 2013). Because phosphorus, given the nature of the ZRW, shares many general sources and pathways with those of sediment, these investigations are useful in considering both pollutants. In a literature review conducted in 2013, LimnoTech examined the following:

- Sediment fingerprinting for Lake Pepin and its tributary systems (Kelly and Nater 2000, Schottler et al. 2010);
- Minnesota River HSPF model development and calibration (TetraTech 2009);
- Sediment fingerprinting for the LeSueur Watershed west of the ZRW (Belmont 2012);
- Sediment fingerprinting for source and transport pathways in the Root River southeast of the ZRW (Belmont 2011, Stout 2012); and
- Root River HSPF model development and calibration (TetraTech 2013).

A summary of general findings of the literature review:

- Overall sediment delivery from tributaries to the Upper Mississippi River in southeast Minnesota has increased substantially since European settlement and the onset of agricultural activities in the tributary watersheds;
- The relative contributions of "non-field" sources of sediment to the overall watershed sediment yield appears to be increasing over time, with a likely link to the "flashier" hydrology (i.e. rapidly increasing and decreasing flow volumes) resulting from agricultural land use and associated drainage and urban development (LimnoTech 2013).

Regarding phosphorus, the Minnesota NRS summary findings are included below:

- The primary sources of phosphorus transported to surface waters are cropland runoff, atmospheric deposition, permitted wastewater, and streambank erosion. These four sources combined are 71%, 76%, and 83% of the statewide phosphorus load under dry, average, and wet years, respectively.

- During dry conditions, NPDES permitted wastewater discharges and atmospheric deposition becomes more prominent sources of phosphorus.
- The most significant phosphorus sources by major basin during an average precipitation year include cropland runoff, wastewater point sources, and streambank erosion in the Mississippi River Major Basin (MPCA 2014c).

Other resources useful in examining sediment and phosphorus sources in the ZRW include the Lower Mississippi River Basin Regional Sediment Data Evaluation Project (Barr Engineering 2004, http://www.pca.state.mn.us/index.php/view-document.html?gid=5983), Detailed Assessments of Phosphorus Sources to Minnesota Watersheds (Barr Engineering 2004 and 2007, https://www.pca.state.mn.us/water/detailed-assessments-phosphorus-sources-minnesota-watersheds) and Minnesota's NRS (https://www.pca.state.mn.us/water/nutrient-reduction-strategy).

Livestock Feedlots

While feedlots are not considered one of the major sources of phosphorus to the Mississippi River (MPCA 2014c), local impacts to water resources in the ZRW could in some cases be significant. As part of the Cannon River Watershed TMDL (HUC-8 watershed adjacent to Zumbro on the north and west borders, MPCA 2016c), several BATHTUB models were developed for upper Cannon lakes impaired by phosphorus. Heiskary and Martin (2015) used feedlot inventories in the context of these BATHTUB models to examine potential feedlot phosphorus loads to those upper Cannon lakes. A similar analysis applied to Rice Lake, along with knowledge from local government units (LGUs) can help to identify and address feedlot pollution hazards. There are several feedlot operations within the Rice Lake drainage area, two of which fall under the NPDES Concentrated Animal Feeding Operation (CAFO) program. More information on livestock feedlots can be found in Section 3.7.3.

Tributary Load

The calibrated HSPF model was used to determine inflowing volumes and loads to Rice Lake. The HSPF predicted loads include permitted and non-permitted sources.

Atmospheric Deposition

Atmospheric deposition represents the phosphorus that is bound to particulates in the atmosphere and is deposited directly onto surface waters. The BATHTUB default average phosphorus atmospheric deposition loading rates were 30 mg/m^2-yr of TP per year for an average rainfall year. This rate was applied to the lake surface area to determine the total atmospheric deposition load per year to the impaired lakes.

Internal Phosphorus Loads in Lakes

Internal cycling of phosphorus can be an important driver of phytoplankton growth. The phosphorus loads to the lakes and reservoirs in the ZRW include both watershed and internal components. Approximating both is important in understanding how watershed work to reduce phosphorus loads may (or may not) impact water quality for a given lake. For example, in 2004 Chesapeake Biogeochemical Associates examined sediment release of phosphorus at four stations in the Byllesby

Reservoir. They estimated that on average, internal recycling accounts for approximately 7% of the TP loading and 16% of the soluble reactive phosphorus loading to the reservoir.

Internal phosphorus loading is also important to understand in the context of “unaccounted for” loads. With Rice Lake, as was the case for several lakes in the Cannon River Watershed TMDL, predicted model results of in lake phosphorus were still not meeting water quality standards even when tributary loads were set to zero. Heiskary and Martin found that in these cases, the “unaccounted for” portion can be assigned to internal loading (Heiskary and Martin 2015).

Internal phosphorus loading in lakes typically occurs through wind-driven sediment resuspension, bioturbation (e.g. sediment disturbance by benthic-dwelling fish), macrophyte senescence (e.g. curly-leaf pondweed) and/or diffusive sediment flux under anoxic conditions (Sondergaard et al. 2003). Rice Lake is a relatively shallow lake that does not typically stratify for prolonged periods. Its fish community is dominated by a few species that are tolerant of hypoxia and warm water temperatures. Aquatic plants are naturally abundant in the lake (DNR 2016). The internal load of phosphorus in Rice Lake is a key driver of water quality: carp gained access to Rice Lake in 1952 and have had a profound impact on internal cycling of nutrients via destruction of aquatic plant and invertebrate populations and aggravating lake sediments. Management strategies that focus on internal nutrient cycling have been successful in the past and will be useful going forward (DNR 2016).

3.7.3 Bacteria Contribution to Stream Impairments

Water-borne pathogens pose a potential health risk to those who come into contact with inoculated surface water. These pathogens – bacteria, protozoa, viruses and others – come from a variety of sources, including agricultural runoff, inadequately treated domestic sewage, and wildlife. Some of these pathogens may cause disease. The following discussion addresses probable point and nonpoint sources of pathogens and the associated indicators: fecal coliform and *E. coli*, the latter being the indicator currently used in Minnesota’s water quality standard. Language in the following sections that references fecal coliform was crafted at a time when the state still used fecal coliform as the water quality standard indicator. While the specific indicator has changed, the discussion of likely pathogen sources at a southeast Minnesota regional scale applies to the ZRW; specific source information was inserted where appropriate.

3.7.3.1 Permitted

Wastewater Treatment Facilities and Municipal Stormwater

Permitted sources of bacteria include industrial and municipal WWTF effluent and MS4 stormwater. Wastewater facilities in the ZRW are required via permit to treat below the bacteria water quality standard. See Section 3.7.1 for more information on watershed point sources, and see Section 3.7.3.2 for discussion of both urban and rural landscapes as sources of bacteria.

Livestock Feedlots

Animal waste containing fecal bacteria can be transported in watershed runoff to surface waters. The MPCA regulates animal feedlots in Minnesota, though counties may be delegated by the MPCA to administer the program for feedlots that are not under federal regulation. The primary goal of the state program for Animal Feeding Operations (AFOs) is to ensure that surface waters are not contaminated by the runoff from feeding facilities, manure storage or stockpiles, and cropland with improperly applied manure. Livestock also occur at hobby farms and small-scale farms that are not large enough to require registration, but may have small-scale feeding operations and associated manure application or stockpiles.

Livestock manure is often either surface applied or incorporated into farm fields as a fertilizer and soil amendment. This land application of manure has the potential to be a substantial source of fecal contamination, entering waterways from overland runoff and drain tile intakes. This is not the only source of bacteria loading into streams. A discussion on naturalized *E. coli* based on current research is provided in Section 3.7.3.2. Minn. R. ch. 7020 contains manure application setback requirements based on research related to phosphorus transport, and not bacterial transport, and the effectiveness of these current setbacks on bacterial transport to surface waters is not known.

All feedlots in Minnesota are regulated by Minn. R. ch. 7020. The MPCA has regulatory authority of feedlots but counties may choose to participate in a delegation of the feedlot regulatory authority to the local unit of government. Delegated counties are then able to enforce Minn. R. ch. 7020 (along with any other local rules and regulations) within their respective counties for facilities that are under the CAFO threshold. In the ZRW, the counties of Goodhue, Rice and Steele counties are delegated the feedlot regulatory authority.

The composition of the AFOs (1,068 registered) in the ZRW is approximately 34% dairy, 26% cattle, 36% swine, 4% poultry, and 1% other. In Minnesota, AFOs are required to register (with their delegated county if they are in one) an animal feedlot capable of holding 50 or more animal units (AUs), or a manure storage area capable of holding the manure produced by 50 or more AUs; and 2) an animal feedlot capable of holding 10 or more and fewer than 50 AUs, or a manure storage area capable of holding the manure produced by 10 or more and fewer than 50 AUs, that is located within shoreland. Further explanation of registration requirements can be found in Minn. R. ch. 7020.0350.

Of the approximately of 1,068 feedlots in the ZRW, there are 38 active NPDES permitted operations, and all are classified as CAFOs. CAFO is an EPA definition that implies not only a certain number of animals but also specific animal types - e.g. 2500 swine is a CAFO, 1000 cattle are a CAFO, but a site with 2499 swine and 999 cattle is not a CAFO according to the EPA definition. The MPCA currently uses the federal definition of a CAFO in its regulation of animal feedlots. In Minnesota, the following types of livestock facilities are issued, and must operate under, a NPDES Permit or a State Disposal System (SDS) Permit (Permit): a) all federally defined (CAFOs), some of which are under 1000 AUs in size, which have or had a discharge; and b) all CAFOs and non-CAFOs, which have 1000 or more AUs. These feedlots must be designed to totally contain runoff, and manure management planning requirements are more stringent than for smaller feedlots. CAFOs are inspected by the MPCA in accordance with the MPCA NPDES Compliance Monitoring Strategy approved by the EPA. All CAFOs (NPDES permitted, SDS permitted and not required to be permitted) are inspected by the MPCA on a routine basis with an appropriate mix of field inspections, offsite monitoring and compliance assistance. The number of AUs by animal type registered with the MPCA feedlot database are summarized in Table 19 for the permitted CAFOs in the ZRW.

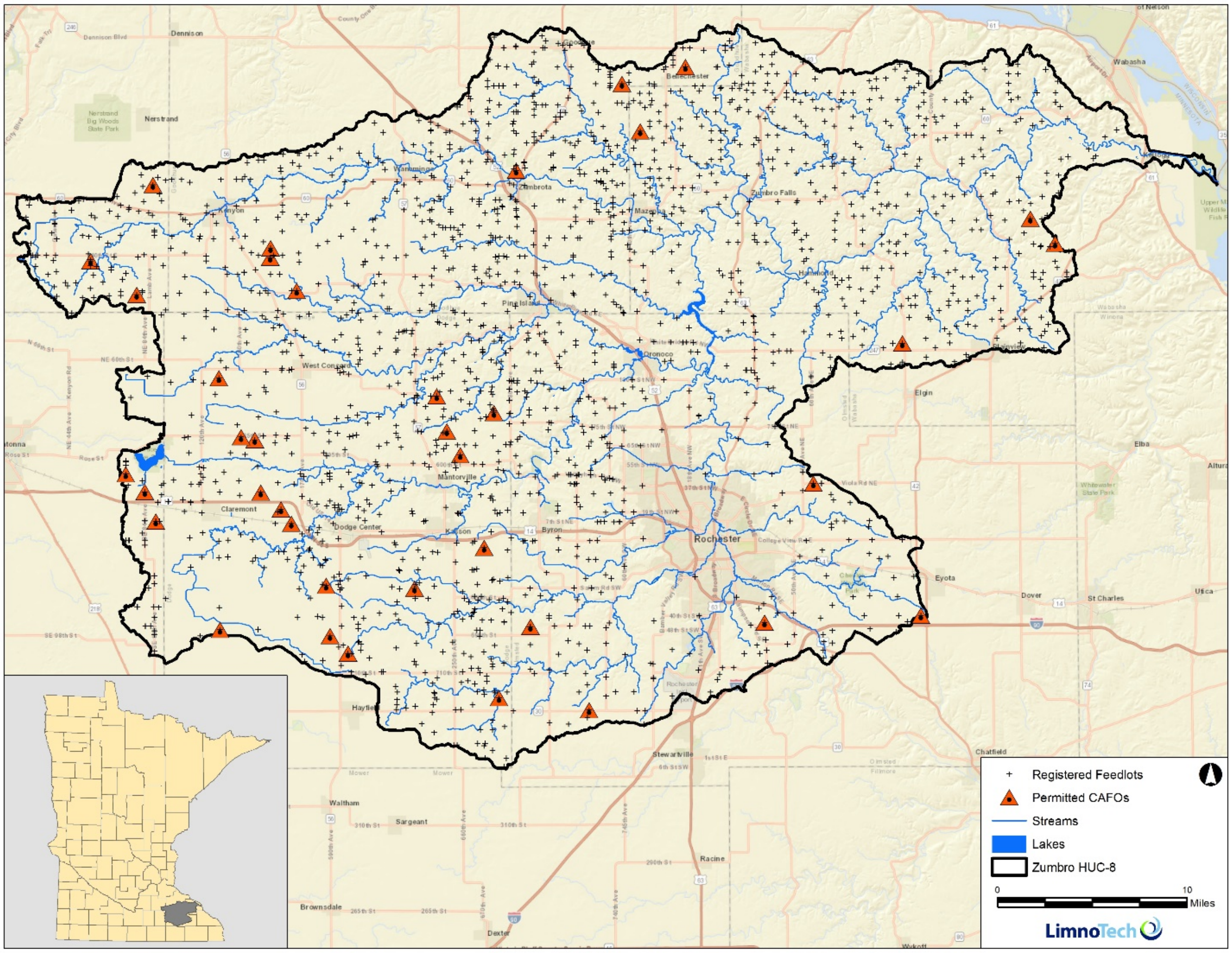

Figure 14. Location of all feedlots within the ZRW. Feedlots with an NPDES Permit are identified in orange.

Table 19. The number of AUs registered in the MPCA feedlot database for permitted CAFOs.

Facility Name	NPDES Permit No	Livestock Type	AUs
BC Calf Farm	MNG441289	Cows	980
Belvidere Group Partner - Merle	MNG440031	Swine	1260
Brian Edgar Farm - Sec 18	MNG440449	Swine	1200
Brian Herbst Farm Sec 2	MNG441115	Swine	1022
Central Livestock Assn - Zumbrota Market	MNG441119	Cows, Horse, Sheep, & Swine	1530
Craig & Carly Benedix Farm - Craig 3000	MNG440445	Swine	900
Craig & Caryl Benedix Farm - Ridge	MNG440445	Swine	900
Daley Brothers LLC	MN0067911	Cows	1428
David C Johnson Farm Sec - 20	MNG440260	Swine	1124.4
David Gosch Farm	MNG441180	Cows & Swine	972
Donley Farm Inc	MNG441101	Cows & Swine	1382.4
Durst Bros Dairy - Site I	MNG440646	Cows	2240
Ellingsberg Farm	MNG441030	Swine	864
Eric Dressel	MNG441214	Swine	1470
Fieseler Farms	MNG440787	Swine	1200
Grandview Hogs of Dodge Center LLP - Sow	MNG440054	Swine	912.6
Grant T Erler Farm	MNG441240	Swine	895
Jason Tebay Farm	MNG441032	Swine	1320
Jennie-O Turkey Store - Claremont Farm	MNG440039	Poultry	1839
Kevin Hoebing Farm	MNG441192	Swine	1459.5
Knott Farms	MNG440030	Swine	1200

Facility Name	NPDES Permit No	Livestock Type	AUs
Luke Scherger	MNG441008	Swine	2250
Manco of FMT Inc	MNG440042	Swine	1500
Mathew & Daniel Arendt Farm	MNG440942	Swine	1020
McNallan Dairy	MNG440504	Cows	1196
Minnesota Family Farms - Sow Site 1	MNG440044	Swine	1096
Nicholas Hanson Farm	MNG440765	Swine	1500
Richard Wolf Farm	MNG440963	Cows, Goats, & Swine	946.5
Schoenfelder Farms LLP - Main Farm	MN0063517	Cows, Horse, & Swine	4317
Schumacher Farms of Elgin Inc	MN0070025	Cows	2417
Shane Wagner Farm South	MNG440575	Swine	900
Shane Wagner Farm West	MNG440575	Swine	1320
Toquam Hogs	MNG440043	Swine	1176
VanZuilen Enterprises	MNG440323	Swine	1200
VZ Hogs LLP - North Finishers	MNG440265	Swine	1200
VZ Hogs LLP - Sow Site 1	MNG440265	Swine	1032
Wayne Evers Farm	MNG441278	Cows	2523
William Schmidt Farm 1	MNG440451	Swine	900

3.7.3.2 Non-permitted

The following text, which provides an overview of nonpoint sources of fecal coliform and *E. coli* bacteria and associated pathogens, is excerpted and adapted from *the Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota* (MPCA 2006) (Note: refer to 2006 report for references in this section). Additional reference to research conducted by Chandrasekaran et al. (2015) is also noted. At the time the MPCA 2006 study was conducted, Minnesota's water quality standard was described in terms of fecal coliform colonies as indicators of fecal pathogens; it has since changed to make use of *E. coli* counts (the water quality standard used in these TMDLs) for the same purpose.

The relationship between land use and fecal coliform concentrations found in streams is complex, involving both pollutant transport and rate of survival in different types of aquatic environments. Intensive sampling at numerous sites in southeastern Minnesota shows a strong positive correlation between stream flow, precipitation, and fecal coliform bacteria concentrations. In the Vermillion River Watershed northwest of the ZRW, storm-event samples often showed concentrations in the thousands of organisms per 100 mLs, far above non-storm-event samples. A study of the Straight River Watershed west of the ZRW divided sources into continuous (failing individual sewage treatment systems, unsewered communities, industrial and institutional sources, WWTFs) and weather-driven (feedlot runoff, manured fields, urban stormwater categories). The study hypothesized that when precipitation and stream flows are high; the influence of continuous sources is overshadowed by weather-driven sources, which generate extremely high fecal coliform concentrations. However, during drought, low-flow conditions continuous sources can generate high concentrations of fecal coliform, the study indicated. Besides precipitation and flow, factors such as temperature, livestock management practices, wildlife activity, fecal deposit age, and channel and bank storage also affect bacterial concentrations in runoff (Baxter-Potter and Gilliland1988). Fine sediment particles in the streambed can serve as a substrate harboring fecal coliform bacteria. "Extended survival of fecal bacteria in sediment can obscure the source and extent of fecal contamination in agricultural settings," (Howell et al. 1996). Sadowsky et al. studied growth and survival of *E. coli* in ditch sediments and water in the Seven Mile Creek

Watershed; their work concluded that while cattle are likely major contributors to fecal pollution in the sediments of Seven Mile Creek, it is also likely that some *E. coli* strains grow in the sediments and thus some sites probably contain a mixture of newly acquired and resident strains (Sadowsky et al. 2010). A study published in 2015 by Chandrasekaran et al. (Sadowsky being a co-author), continued research in the Seven Mile Creek Watershed. Results from this study concluded that populations of *E. coli* can exist in ditch sediments as temporal sinks and be a source of bacteria to streams. The authors highlight the issue with using only livestock manure operations as an indicator of source impacts to water quality.

Hydrogeologic features in southeastern Minnesota may favor the survival of fecal coliform bacteria. Cold groundwater (GW), shaded streams, and sinkholes may protect fecal coliform from light, heat, drying, and predation. Sampling in the South Branch of the Root River showed concentrations of up to 2,000 organisms/100 ml coming from springs, pointing to a strong connection between surface water and ground water (MPCA 2016d). The presence of fecal coliform bacteria has been detected in private well water in southeastern Minnesota. However, many have been traced to problems of well construction, wellhead management, or flooding, not from widespread contamination of the deeper aquifers used for drinking water. Finally, fecal coliform survival appears to be shortened through exposure to sunlight. This is possibly the reason why, at several sampling sites downstream of reservoirs, fecal coliform concentrations were markedly lower than at monitoring sites upstream of the reservoirs. This has been demonstrated at the Byllesby Reservoir on the Cannon River north of the ZRW. Despite the complexity of the relationship between sources and in-stream concentrations of fecal coliform, the following can be considered major source categories:

Urban and Rural Stormwater

Untreated stormwater from cities, small towns, and rural residential or commercial areas can be a source for many pollutants including fecal coliform bacteria and associated pathogens. Sources of fecal coliform in urban and residential stormwater include pet and wildlife waste that can be directly conveyed to streams and rivers via impervious surfaces and storm sewer systems. There is a large goose population around the city of Rochester that could also be a potential source of fecal coliform in that area.

Newer urban development often includes stormwater treatment in the form of such practices as sedimentation basins, infiltration areas, and vegetated filter strips. Smaller communities or even rural residences not covered by MS4 Permits may be sources of stormwater and associated pollutants. There are nine existing permitted MS4 communities in the ZRW (Figure 15). Oronoco Township is planned as a future MS4 and as such will eventually be permitted. Table 20 summarizes the percent of the total AUID drainage area that is MS4 for those AUIDs that have MS4 communities upstream. Individual MS4 areas contributing to Bear Creek (AUID 07040004-538) were obtained from the Zumbro Watershed Comprehensive Management Plan (ZWP 2012), which included a detailed examination of MS4 intersections with various Zumbro AUID drainages (including -538).

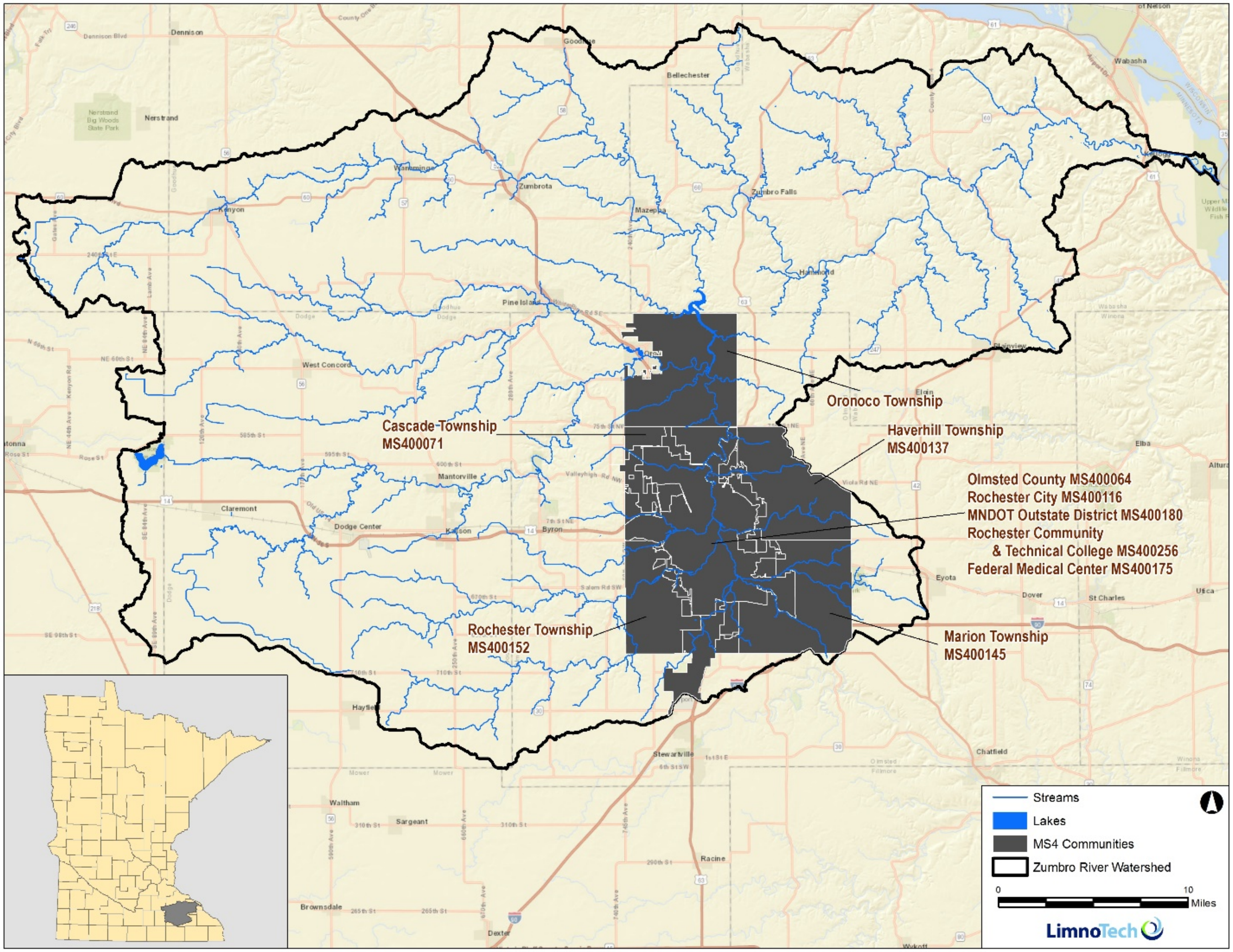

Figure 15. Permitted MS4 communities in the ZRW.

Table 20. Percent of total AUID drainage area that is MS4 for AUIDs with upstream MS4 communities.

<table>
<tr><th>Water Body Name</th><th>Reach (AUID)</th><th>Watershed Area (ac)</th><th>MS4 Area (ac)</th><th>% MS4 Area</th><th colspan="2">List of MS4 Communities</th><th>Parameter</th></tr>
<tr><td>Zumbro River</td><td>07040004-978</td><td>140,453</td><td>739</td><td>0.53%</td><td colspan="2">Oronoco Township (FUTURE)</td><td>E. coli</td></tr>
<tr><td>Zumbro River</td><td>07040004-993</td><td>275,942</td><td>5,685</td><td>2.06%</td><td colspan="2">Oronoco Township (FUTURE)</td><td>TSS</td></tr>
<tr><td rowspan="8">Bear Creek</td><td rowspan="8">07040004-538</td><td rowspan="8">51,812</td><td rowspan="8">10,882</td><td rowspan="8">21.0%</td><td>Federal Medical Center</td><td>17 ac.</td><td rowspan="8">E. coli</td></tr>
<tr><td>Haverhill Township</td><td>2 ac.</td></tr>
<tr><td>Marion Township</td><td>2,017 ac</td></tr>
<tr><td>MnDOT Outstate</td><td>855 ac.</td></tr>
<tr><td>Olmsted County</td><td>214 ac.</td></tr>
<tr><td>Rochester City</td><td>6,753 ac.</td></tr>
<tr><td>Rochester Comm & Tech College</td><td>101 ac.</td></tr>
<tr><td>Rochester Township</td><td>923 ac.</td></tr>
<tr><td>Dry Run Creek</td><td>07040004-576</td><td>19,236</td><td>1,566</td><td>8.14%</td><td colspan="2">Oronoco Township (FUTURE)</td><td>E. coli</td></tr>
</table>

Individual Sewer Treatment Systems

Nonconforming septic systems are an important source of fecal coliform bacteria, particularly during periods of low precipitation and runoff when this continuous source may dominate fecal coliform loads. Unsewered or under-sewered communities include older individual systems that are generally failing, and/or collection systems that discharge directly to surface water. This may result in locally high concentrations of wastewater contaminants in surface water, including fecal coliform bacteria, in locations close to population centers where risk of exposure is relatively high. The Subsurface Sewage Treatment Systems (SSTS) program at the MPCA keeps records of estimated non-compliant systems and imminent public health threats (IPHT); a sample of these data is provided below in Table 21 (note that the numbers pertain to counties and not watersheds).

Table 21. Subsurface sewage treatment system estimates by county.

County	Total SSTS	Non-Compliant SSTS	Imminent Public Health Threats
Dodge	2867	917	287
Goodhue	5200	1040	1456
Olmsted	3480	661	278
Rice	7151	1345	1345
Steele	3051	793	305
Wabasha	4259	681	256

3.7.4 Total Suspended Solids

3.7.4.1 Permitted

The regulated sources of TSS within the watersheds of the TSS impairments addressed in this TMDL include NPDES permitted WWTF effluent, MS4 stormwater, construction stormwater, and industrial stormwater. Permitted WWTFs that have regulated TSS limits include dewatering pits from quarries and gravel pits. Wastewater facilities in the ZRW are required via permit to treat below the TSS water quality standard, and MS4 permittees are required via permit to address downstream impairments. See 3.7.1 for more information on watershed point sources, and see 3.7.3.2 for discussion of both urban and rural landscapes including a map of the watershed MS4s.

3.7.4.2 Non-permitted

This section is partly addressed in Section 3.7.2.2 with the nonpoint source phosphorus loads. These two parameters share many of the same sources and are therefore addressed together in discussion of pollutant sources in this document and the WRAPS report. Additional source assessment from the ZRWHSPF model is provided in Table 22 and Figure 16. Upland sources contribute 42% of the sediment load for the entire watershed. This is slightly higher than the 30% to 40% range set in the sediment source apportionment memorandum developed by LimnoTech (2013), but consistent with the observation in that memorandum that a larger percentage may be appropriate for the Zumbro River given the predominance of type “C” or highly erodible/unstable soils. The next highest sediment source is bed and bank erosion at 39% followed by gully and ravine erosion at 18%. Point sources and tile drainage contribute relatively small fractions to the overall sediment delivery. The 5 mg/L sediment concentration assigned to groundwater outflow contributed less than 0.01% of the sediment load watershed wide.

Table 22. Breakdown of sediment sources by major drainage area and for the entire ZRWHSPF model (1996 – 2009).

Drainage Area	Gully/Ravine	Upland	Tile Drains	Point Sources	Bed/Bank Erosion
South Fork	21%	52%	0.3%	0.4%	27%
Middle Fork	19%	42%	0.8%	0.0%	38%
North Fork	17%	50%	0.2%	0.1%	33%
Mainstem	14%	31%	0.0%	0.0%	55%
Entire Watershed	18%	42%	0.4%	0.1%	39%

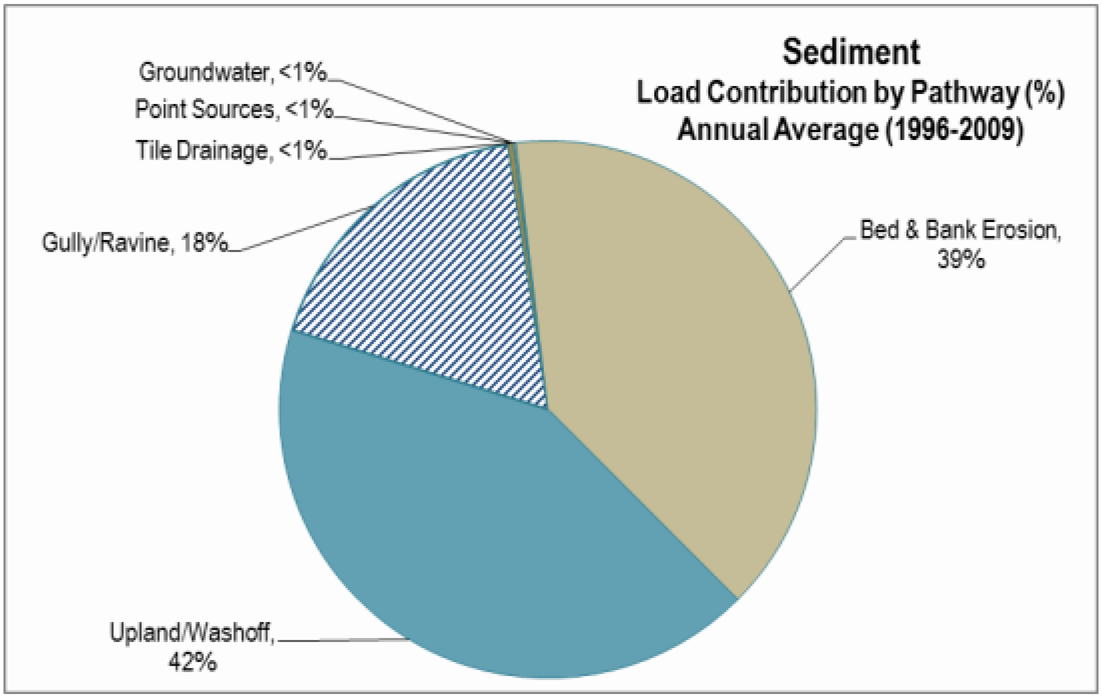

Figure 16. Breakdown of sediment sources for the ZRWHSPF model (1996 – 2009).

The ZRWHSPF model also summarizes Unit Area Loading (UAL) values for a number of pollutants. A summary of the phosphorus UALs is included in Figure 17.

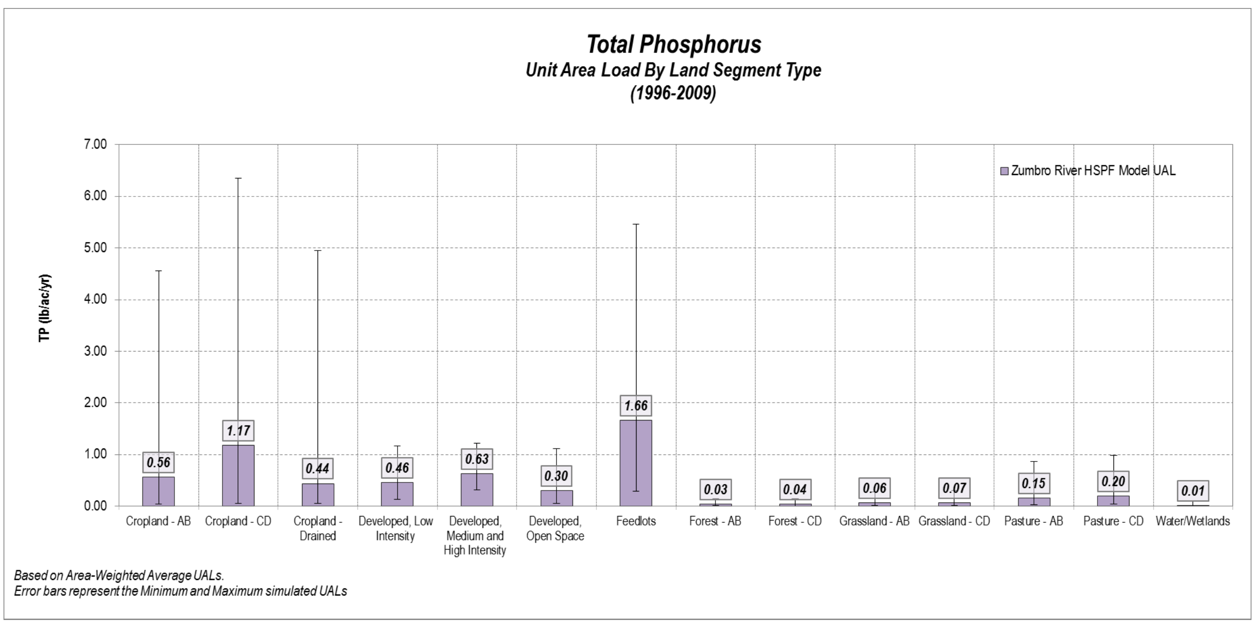

Figure 17. Total phosphorus unit area loads by land segment type for the 1996 – 2009 simulation period.

4 TMDL Development

4.1 Watershed TMDLs Overview

Impaired Stream Reaches

The approach used in calculating the TMDLs for each impaired reach was consistent with the methods used in the Cannon River Watershed TMDL Report drafted by LimnoTech and the MPCA. The TMDL, which is represented as the total loading capacity (TLC), is calculated using the following equation:

$$TLC = WLA + LA + MOS + RC$$

Where:

Total Loading Capacity (TLC): the maximum allowed pollutant load calculated at the downstream end of a waterbody such that it does not exceed water quality standards

Wasteload Allocation (WLA): the sum of all point source pollutant loads within the waterbody's drainage area, which includes NPDES permitted industrial and municipal WWTFs, regulated construction and industrial stormwater, and MS4 communities (both present and future)

Load Allocation (LA): remaining pollutant load that is allocated to nonpoint source loads that do not require a NPDES permit

Margin of Safety (MOS): expressed as a percent of the TLC and accounts for any uncertainty in the calculations of WLA and LA components

Reserve Capacity (RC): accounts for any potential future loading sources that need to be included in the TLC

Baseline conditions for each TMDL were defined as the midpoint of the water quality datasets from Section 3.6. These baseline years are summarized in Table 23. Additionally, baseline flow conditions are based on the calibrated HSPF model for the 1996 through 2009 simulation period.

Table 23. Baseline condition years for each stream AUID addressed in this report.

HUC-10 Watershed	Listed Waterbody Name	Location Description	Reach (AUID)	Listed Pollutant	Baseline Year
Middle Fork Zumbro River	Milliken Creek	Unnamed cr to M Fk Zumbro R	07040004-555	TSS - no EQuIS data for this station, used midpoint of HSPF simulation period	2002
Middle Fork Zumbro River	Zumbro River	T108 R18W S20, west line to N Br M Fk Zumbro R	07040004-973	*E. coli*	2010
Middle Fork Zumbro River	Zumbro River	N Br M Fk Zumbro R to S Br M Fk Zumbro R	07040004-992	*E. coli*	2010
Middle Fork Zumbro River	Zumbro River	S Br M Fk Zumbro R to Zumbro Lk	07040004-993	TSS	2008
North Fork Zumbro River	Trout Brook	T110 R15W S24, west line to N Fk Zumbro R	07040004-515	*E. coli*	2011
North Fork Zumbro River	Zumbro River	T109 R19W S11, west line to Trout Bk	07040004-971	TSS	2010
				E. coli	2011
South Branch Middle Fork Zumbro River	Zumbro River	75th St NW to M Fk Zumbro R	07040004-978	*E. coli*	2013
South Branch Middle Fork Zumbro River	Dodge Center Creek	-92.99, 44.0212 to S Br M Fk Zumbro R	07040004-989	TSS	2014
				E. coli	2013
South Fork Zumbro River	Bear Creek	Willow Cr to S Fk Zumbro R	07040004-538	*E. coli*	2010
South Fork Zumbro River	Unnamed Creek	Unnamed creek to unnamed creek	07040004-595	Fecal coli	2004
South Fork Zumbro River	Unnamed Creek	Unnamed Cr to Salem Cr	07040004-596	Fecal coli	2003
Zumbro River	West Indian Creek	T109 R11W S21, south line to T109 R11W S6, north line	07040004-542	*E. coli*	2010
Zumbro River	Long Creek	Unnamed Cr to M Fk Zumbro River	07040004-565	*E. coli*	2010
Zumbro River	Middle Creek	T109 T11W S18, south line to Zumbro R	07040004-567	*E. coli*	2010
Zumbro River	Spring Creek	Unnamed cr to Unnamed cr	07040004-568	TSS - no EQuIS data in simulation period, used SID dataset for baseline year	2012
Zumbro River	Spring Creek	Unnamed cr to Zumbro R	07040004-570	TSS	2013
				E. coli	2013
Zumbro River	Trout Brook	T110 R11W S5, west line to T110 R11W S8, east line	07040004-571	*E. coli*	2010
Zumbro River	Hammond Creek	Unnamed cr to Zumbro R	07040004-575	*E. coli*	2010
Zumbro River	Dry Run Creek	Unnamed cr to Zumbro Lk	07040004-576	*E. coli*	2010
Zumbro River	Spring Creek Tributary	T110 R12W S28, south line to Spring Cr	07040004-769	TSS - no EQuIS data for this station, used midpoint of HSPF simulation period	2002
				E. coli	2010

4.1.1 Natural Background Considerations

Natural background conditions refer to pollutant inputs that would be expected under natural, undisturbed conditions. Natural background sources can include natural geologic processes such as soil loss from upland erosion and stream development, atmospheric deposition, and loading from forested land, wildlife, etc. Natural background conditions were also evaluated, where possible, within the modeling and source assessment portion (Section 3.7) of this study. These source assessment exercises indicate natural background inputs are generally low compared to livestock, cropland, streambank, urban stormwater, WWTFs, failing SSTSs and other anthropogenic sources. Separate LAs were not determined for natural background sources in this report due to the factors outlined above as well as a lack of research or data that would be required to differentiate between nonpoint and natural background sources of the pollutants.

Based on the MPCA's waterbody assessment process and the TMDL source assessment exercises, there is no evidence at this time to suggest natural background sources are a major driver of any of the impairments and/or affect their ability to meet state water quality standards. For all impairments addressed in this study, natural background sources are implicitly included in the LA portion of the TMDL allocation tables and TMDL reductions should focus on the major anthropogenic sources identified in the source assessment.

4.2 Phosphorus

There is one phosphorus impairment in the ZRW – Rice Lake. Three additional phosphorus impairments will be completed at a later date following consideration of site-specific criteria for the South Fork Zumbro River and Lake Zumbro (see Section 1.1.2).

4.2.1 Loading Capacity

Lake Response Model

The modeling software BATHTUB (Version 6.1) was selected to link phosphorus loads with in-lake water quality. A publicly available model, BATHTUB was developed by William W. Walker for the U.S. Army Corps of Engineers (Walker 1999). It has been used successfully in many lake studies in Minnesota and throughout the United States. BATHTUB is a steady-state annual or seasonal model that predicts a lake's summer (June through September) mean surface water quality. BATHTUB's time-scales are appropriate because water quality targets are expressed as summer season averages. The heart of BATHTUB is a mass-balance phosphorus model that accounts for water and phosphorus inputs from tributaries, watershed runoff, the atmosphere, and sources internal to the lake; and outputs through the lake outlet, water loss via evaporation, and phosphorus sedimentation and retention in the lake sediments. Chl-*a* concentrations are estimated via the use of empirical correlation to predicted phosphorus concentrations; while water transparency is estimated via the use of empirical correlation to predicted Chl-*a*.

This section describes the development and application of the BATHTUB model to calculate the TMDL for phosphorus for Rice Lake. It is divided into sections of:

- Model Development
- Model Calibration

- Model Application

Model Development

This section gives an overview of the model inputs required for BATHTUB application, and how they were derived for Rice Lake. The following categories of inputs are required for BATHTUB:

- Model options
- Global variables
- Reservoir segmentation and geometry
- Tributary loads

Model Options

BATHTUB provides a multitude of model options to estimate nutrient concentrations in a reservoir. Model options were entered as shown in Table 24 for Rice Lake.

Table 24. Selected models in BATHTUB for Rice Lake modeling.

MODEL	MODEL OPTION SELECTED
Conservative substance	Not computed
Total phosphorus	Canfield and Bachmann - LAKES
Total nitrogen	Not computed
Chl-*a*	P, Light, T*
Transparency	Chl-*a* and turbidity
Longitudinal dispersion	Fischer-numeric
Phosphorus calibration	Decay rates
Nitrogen calibration	None
Error analysis	Model and Data
Availability factors	Ignored
Mass-balance tables	Use estimated concentrations

Global Variables

The global variables required by BATHTUB consist of:

- The averaging period for the analysis
- Precipitation, evaporation, and change in lake levels
- Atmospheric phosphorus loads

BATHTUB is a steady state model, whose predictions represent concentrations averaged over a period of time. A key decision in the application of BATHTUB is the selection of the length of time over which inputs and outputs should be modeled. The length of the appropriate averaging period for BATHTUB application depends upon the hydraulic and nutrient residence times, i.e. the average length of time that water and phosphorus spends in the lake before flushing out (or, in the case of phosphorus, settling). Guidance for the BATHTUB model recommends that the averaging period used for the analysis be at least twice as long as the nutrient residence time. The hydraulic residence time for Rice Lake was calculated as 3.9 years, while the nutrient residence time was calculated as approximately three months. Therefore, the averaging period used for this analysis was set at one year.

Precipitation and evaporation inputs were taken from the HSPF modelling of the Rice Lake Watershed, and correspond to a precipitation of 0.72 m/year and evaporation of 1.3 m/year. There was no assumed increase in storage during the modeling period for either lake, to represent steady state conditions. Atmospheric phosphorus loads were specified as 30 mg-P/m^2/yr.

Reservoir Segmentation and Geometry

BATHTUB provides the capability to divide the lake under study into a number of individual segments, allowing prediction of the change in phosphorus concentrations over the length of each reservoir. Given the presence of a single monitoring station, all of Rice Lake was simulated as a single model segment.

BATHTUB requires that the surface area and total water depth be specified for each segment. These values were calculated from available bathymetry data as 2.47 km^2 and 1.5 m, respectively.

Tributary Loads

Total tributary flow, and flow-weighted average total phosphorus (TP) were taken from the average HSPF model output for the two years for which observed lake water quality data existed 2008 and 2009, calculated as 2.4 (hm^3/yr), and 221.5 µg/L, respectively.

Model Calibration

Model calibration is the process of adjusting model input parameters (within reasonable range) to allow model predictions to best match the available observed data. This section describes the BATHTUB model calibration for Rice Lake. It begins with a discussion of the observed lake water quality data used to support model calibration, and concludes with a discussion of the model calibration process and outcome.

Lake Water Quality

The average June through September concentrations for TP, Chl-*a*, and Secchi depth were calculated from the available data are provided below in Table 25.

Table 25. Average lake water quality data used for BATHTUB calibration.

TP (µg/L)	Chl-*a* (µg/L)	Secchi depth (m)
290	148	0.229

Calibration Process and Result

The calibration process proceeded in a step-wise manner, starting with phosphorus then proceeding to internal loading. BATHTUB was initially applied with all of the inputs. The initial comparison between predicted and observed TP resulted in predicted phosphorus concentrations (84 µg/L) that were significantly less than observed (290 µg/L). This under-prediction was remedied by specifying an internal loading of 4.95 mg/m^2/day. Heiskary and Martin (2015) note (see 3.7.1) that *if external loads were calculated with a high degree of confidence, it might be reasonable to assign the "unaccounted for" portion of the estimated P budget to internal recycling.* As such, the loads of phosphorus added to the simulations should be considered "unaccounted for phosphorus" and not definitively described as solely representing internal loads. This model-data comparison for calibrated TP is shown below in Table 26.

Table 26. Calibration BATHTUB results for current conditions.

Total Phosphorus (µg/L)		Unaccounted for TP Load ($mg/m^2/day$)
Predicted	Observed	
290.1	290	4.95

Model Application

The calibrated BATHTUB model was applied to determine the maximum allowable phosphorus load that can be delivered to Rice Lake and maintain compliance with water quality standards, while including consideration of a MOS. An explicit MOS is being applied to this TMDL through the use of water quality target values that are 10% more stringent than the actual water quality standards. Initial BATHTUB simulations that reduced only the tributary phosphorus load demonstrated that, even with tributary loading set to zero, water quality targets would not be met due to the effect of the unaccounted for TP load. This indicates that the unaccounted load must be reduced in conjunction with the tributary load in order to meet objectives. An additional set of simulations were conducted where the unaccounted for load and tributary inflow concentrations were adjusted by equal amounts to match the water quality standard after applying the MOS. The maximum allowable load corresponded to a 90.1% reduction from current loads, necessary to meet the TP target. Target TMDL concentrations and predicted concentrations in response to a 90.1% load reduction are summarized in Table 27.

Table 27. Predicted concentrations in comparison to TMDL targets after load reductions.

Total Phosphorus (µg/L)	
Predicted	Target
81	81

4.2.2 Load Allocation Methodology

The LA is the portion of the TLC assigned to nonpoint and natural background sources of nutrient loading. These sources include the atmospheric loading and nearly all of the loading from watershed runoff, or in this case tributary inflow. The only portion of the watershed runoff not included in the LA is the small loading set aside for regulated stormwater runoff from construction and industrial sites. The LA includes nonpoint sources that are not subject to NPDES Permit requirements, as well as natural background sources. These include sources of phosphorus such as soil erosion or nutrient leaching from cropland, phosphorus-laden runoff from communities not covered by NPDES Permits, and streambed and streambank erosion resulting from human-induced hydrologic changes and disturbance of stream channels and riparian areas. In addition, some phosphorus may leach into the reservoir or its upstream tributaries from poorly functioning septic systems.

Natural background sources of phosphorus include atmospheric deposition, as well as the relatively low levels of soil erosion from both stream channels and upland areas that would occur under natural conditions. Given the demonstrated water quality improvement in Rice Lake that resulted from internal load management, it is unlikely that natural background is a major component of phosphorus loading. The LA is the loading capacity that remains after the WLA and MOS have been subtracted.

4.2.3 Watershed Allocation Methodology

Permitted Industrial and Municipal Wastewater Facilities

There are no permitted Industrial and Municipal WWTFs in the Rice Lake drainage area. This sector was not assigned a "0" WLA, but rather listed as NA (Not Applicable).

Regulated Construction and Industrial Stormwater

A permit is required for any construction activities disturbing: one acre or more of soil; less than one acre of soil if that activity is part of a "larger common plan of development or sale" that is greater than one acre; or less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources. A construction stormwater runoff WLA is needed to account for pollutant loading (phosphorus (nutrient eutrophication biological indicators), turbidity, DO, or biotic impairment (fish bioassessments, aquatic plant bioassessments and aquatic macroinvertebrate bioassessments) from ongoing construction activity in the watershed. Per the MPCA guidance website for setting WLAs for regulated stormwater, a construction stormwater WLAs is typically 0.05% to 0.15% of the TLC (https://stormwater.pca.state.mn.us/index.php?title=MPCA_guidance_for_setting_wasteload_allocations_for_regulated_stormwater). Thus, a generally appropriate estimate of the WLA for construction stormwater is 0.1% of the TLC, which was used in this TMDL report. (http://stormwater.pca.state.mn.us/index.php/Construction_activity_by_county).

There are no individual permitted industrial stormwater facilities in the ZRW that require an individual WLA. This sector was not assigned a "0" WLA, but rather listed as NA (Not Applicable).

Regulated MS4 Stormwater

The MS4 systems are designed to convey stormwater into a receiving waterbody and are permitted under the NPDES Permit. There are no MS4 communities in the Rice Lake Watershed. This sector was not assigned a "0" WLA, but rather listed as NA (Not Applicable).

4.2.4 Margin of Safety

The MOS was incorporated in the Rice Lake TMDL by assuming an explicit 10% MOS. This means that the water quality target used in the BATHTUB model was 90% of the actual in-lake phosphorus standard. For Rice Lake, which is a shallow lake, an in-lake phosphorus standard of 90 mg/L means that a target standard of 81 mg/L was used to account for the explicit MOS.

The BATHTUB model for Rice Lake provided the basis for a 10% MOS used in the TMDL. Additionally, the 10% explicit MOS was used to account for uncertainty in how well in-lake phosphorus concentration are being represented given the relatively small available water quality dataset (nine data points). This conservative approach will help achieve the in-lake water quality target required to meet state standards.

4.2.5 Seasonal Variation

In-lake water quality varies seasonally. In Minnesota lakes, the majority of the watershed phosphorus load often enters the lake during the spring. During the growing season months (June through September), phosphorus concentrations may not change drastically if major runoff events do not occur. However, Chl-*a* concentration may still increase throughout the growing season due to warmer temperatures fostering higher algal growth rates. In shallow lakes, the phosphorus concentration more frequently increases throughout the growing season due to the additional phosphorus load from internal sources. This can lead to even greater increases in Chl-*a* since not only is there more phosphorus but temperatures are also higher. This seasonal variation is taken into account in the TMDL by using the eutrophication standards (which are based on growing season averages) as the TMDL goals. The eutrophication standards were set with seasonal variability in mind. The load reductions are designed so that the lakes and streams will meet the water quality standards over the course of the growing season (June through September).

Critical conditions in these lakes occur during the growing season, which is when the lakes are used for aquatic recreation. Similar to the manner in which the standards take into account seasonal variation, since the TMDL is based on growing season averages, the critical condition is covered by the TMDL.

4.2.6 TMDL Summary

Table 28. Phosphorus TMDL for Rice Lake 74-0001-00.

Rice Lake 74-0001-00 TMDL Summary		Existing TP Load		Allowable TP Load		Estimated Load Reduction	
		kg/yr	kg/day	kg/yr	kg/day	kg/yr	%
Phosphorus Loading Capacity (TMDL)		5062.57	13.86	565.85	1.55	4496.72	88.82
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA	NA
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.57	0.002	0.57	0.002	NA	NA
	MS4***	NA	NA	NA	NA	NA	NA
	Total WLA	0.57	0.002	0.57	0.002	NA	NA
Load Allocation		5062.00	13.86	565.29	1.55	4496.72	88.83
10% Margin of Safety^		NA	NA	NA	NA	NA	NA

* No permitted wastewater facilities within lake drainage area
** No permitted individual stormwater facilities in the ZRW
*** No current MS4 communities within reach drainage area
^ 10% MOS was taken off of WQ target concentration

4.3 *E. coli*

4.3.1 Loading Capacity Methodology

A TLC was assigned to each impaired reach identified in Table 3 under the following flow regimes: Very High, High, Mid, Low, and Very Low. The LDC method is based on an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes virtually the full spectrum of allowable loading capacities is represented by the resulting curve. The flow data used to develop the flow and load duration curves (LDCs) for the *E. coli* TMDLs (and all subsequent stream TMDLs in this document) were simulated by a calibrated HSPF model. HSPF models combine land surface data, hydrographic boundaries, meteorological inputs, and water quality and quantity data to simulate watershed processes. For the ZRWHSPF model, these data were collected from federal, state, and local organizations and government entities. The primary hydrologic calibration point in the model is USGS Station 05372995 (South Fork Zumbro River at Rochester) as it is the only station that has a complete flow record for the entire simulation period. The ZRWHSPF model was initiated in 2012 and covered a simulation period from 1995 through 2009. The model was completed by LimnoTech, Inc. in 2014 and model output data are maintained by the MPCA modeling staff.

Data used to develop TMDLs were limited to 1996 through 2009 because the first simulated year allows model parameters to "normalize," or meet observed conditions. Based on strong calibration for hydrology and water quality parameters (such as TSS, total nitrogen, and TP), the model is well suited for both point source and nonpoint source nutrient reduction and hydrologic investigations. Datasets for the various parameters modeled in HSPF were selected based on what would be most representative of the 1996 through 2009 period.

In the TMDL equation tables of this report (Table 29 to Table 45), only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, it should be understood that the entire curve represents the TMDL and is what is ultimately approved by the EPA.

4.3.2 Load Allocation Methodology

As stated in the governing TMDL equation, the LA is comprised of the nonpoint source load that is allocated to an impaired AUID after the MOS and WLA are subtracted from the TLC for each flow regime. This residual load is meant to represent all non-regulated sources of *E. coli* upstream of the impaired reach, which are summarized in Section 3.7.3.

The relationship between bacterial sources and bacterial concentrations found in streams is complex, involving precipitation and flow, temperature, livestock management practices, wildlife activities, survival rates, land use practices, and other environmental factors. Section 3.7.3 discussed possible sources of bacteria found in streams and highlighted the observation that *E. coli* populations can be naturalized in the sediment and persist over an extended period of time. Sadowsky et al. (2010) concluded that approximately 36.5% of *E. coli* strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. The authors suggested that 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study period. While these results may not be transferable to other locations, they do suggest the presence of background *E. coli* and a fraction of *E. coli* may be present regardless of the control measures taken by traditional implementation strategies. The following *E. coli* LAs include natural background.

4.3.3 Wasteload Allocation Methodology

<u>Permitted Industrial and Municipal Wastewater Facilities</u>

Within the ZRW, there are 32 NPDES permitted Industrial and Municipal facilities. Each facility is permitted for specific water quality limits at their discharge. A list of facilities discharging to each AUID is provided in Appendix B. The WLA assigned to each permitted facility was calculated using the facility's design flow and permit limit for *E. coli*, which is 126 org/100 mL. Bacteria impaired AUIDs in this TMDL report are for *E. coli*, and as such, WLAs are based on an *E. coli* standard. However, permit limits continue to be expressed as fecal coliform bacteria, which is 200 organisms/100mL. Facilities receiving a bacteria WLA will need to comply with the fecal coliform standard as specified in their permit.

Regulated Construction and Industrial Stormwater

WLAs for regulated construction stormwater (MNR100001) were not developed, since *E. coli* is not a typical pollutant from construction sites. Industrial stormwater receives a WLA only if the pollutant is part of benchmark monitoring for an industrial site in the watershed of an impaired water body. There are no bacteria or *E. coli* benchmarks associated with any of the Industrial Stormwater Permits (MNR050000) in these watersheds and therefore no industrial stormwater *E. coli* WLAs were assigned. AUIDs impaired by bacteria were not assigned a "0" WLA, but rater are not applicable and therefore are not included in the following *E. coli* TMDL summary tables.

Regulated MS4 Stormwater

The MS4 systems are designed to convey stormwater into a receiving waterbody and are permitted under the NPDES Permit.

All MS4 communities are existing communities and are included in the WLA. Oronoco Township is planned as a future community and is included in the MS4 WLA as a future WLA.

MS4 allocations were calculated using the following equations:

$$\text{MS4 Allocation} = \%\text{MS4 Area} * (\text{TLC} - \text{MOS} - \text{Permitted WW Facility})$$

Where:

%MS4 Area: the ratio of the total MS4 area to the total drainage area for the given AUID. Areas were obtained using ArcMap.

Permitted WW Facilities: the total WLA for all permitted Industrial and Municipal WWTFs that discharge into the AUID's drainage area.

4.3.4 Margin of Safety

An explicit MOS equal to 10% of the loading capacity was use for the stream TMDLs based on the following considerations:

- Most of the uncertainty in flow is a result of extrapolating flows from the hydrologically-nearest stream gage. The explicit MOS, in part, accounts for this.
- The calibrated ZRWHSPF model does a "good" to "very good" job at predicting monthly, seasonal, and annual streamflow volumes and daily streamflows. However, uncertainties in predicting the timing and magnitude of flow as a result of spring snowmelt during both calibration and validation runs provides additional justification for a 10% MOS. Summary statistics comparing observed and predicted streamflows for both calibration and validation runs are provided in the ZRWHSPF model report (LimnoTech 2014).
- Allocations are a function of flow, which varies from very high to very low flows. This variability is accounted for through the development of a TMDL for each of the five flow regimes.

- With respect to the *E. coli* TMDLs, the load duration analysis does not address bacteria re-growth in sediments and die-off. The MOS helps to account for the variability associated with these conditions.

4.3.5 Seasonal Variation

Use of these water bodies for aquatic recreation occurs from April through October, which includes all or portions of the spring, summer and fall seasons. *E. coli* loading varies with the flow regime and season. Spring is associated with large flows from snowmelt, the summer is associated with the growing season as well as periodic storm events and receding streamflows, and the fall brings increasing precipitation and rapidly changing agricultural landscapes. The load–duration curve methodology addresses all flow regimes, and therefore takes into account the seasonal variation of *E. coli* loading described above.

4.3.6 TMDL Summary

With the exception of the *E. coli* impairments, the other impairments in this report were based on water quality data collected during the HSPF simulation period. However, the *E. coli* impairments were based on water quality data collected through 2014. Since the HSPF simulation period did not extend beyond 2009, stream flow data from USGS Station 05372995 was used to plot post-2009 water quality data on the load duration curves. For water quality data collected during the simulation period, HSPF flows were used to calculate loads. There are several HYDSTRA stream flow monitoring stations throughout the watershed, however a 1:1 plot of monitored flow vs. HSPF flow for West Indian Creek (07040004-542) showed a poor data fit (R^2=0.2), which is likely due to the fact the monitoring flow record had many poor/fair data quality flags. These data flags were observed in the other HYDSTRA flow records, therefore only USGS flows were used. The USGS station was also the primary station for the ZRW HSPF model calibration/validation.

To obtain an estimated HSPF flow for the post-2009 water quality sample dates, the water quality sample date was matched to the USGS flow on that same date and then to the flow duration curve percentile for that flow. That same percentile was identified on the impaired AUID's flow duration curve and matched to its corresponding flow. For example, the load duration curve for West Indian Creek 07040004-542 (Figure 27) has several monitoring data points post 2009. An *E. coli* sample was collected on July 6, 2010, which corresponds to a USGS flow of 220 cfs and a flow percentile of 26%. The 26th flow percentile for this AUID's corresponding HPSF flow is 17 cfs. The *E. coli* load on July 6, 2010 is therefore 17 cfs * *E. coli* concentration * unit conversion factor. Comparing actual HSPF flow to calculated flow using the USGS percentile match for this subbasin produced an R^2=0.71 over the entire 1996 through 2009 flow record.

Water quality data was collected as grab samples between April through October as part of the ZRW Intensive Watershed Monitoring program. This program covers a two-year period and includes site selection down to the HUC-14 scale. Additional sampling programs conducted by organizations such as Soil and Water Conservation Districts, Citizen Monitoring, and other TMDL studies was used to provide as complete a record as possible going back 10-years (2005 through 2014). The 10-year period is used to ensure data is collected over varying weather and flow conditions. Where data is available, loads are plotted along the load duration curve for each TMDL.

The *E. coli* LDCs indicate exceedances of the standard during all flow conditions, indicating a variety of sources. See Section 3.7.3 for additional discussion on *E. coli* sources and its persistence in stream sediments and algal mats.

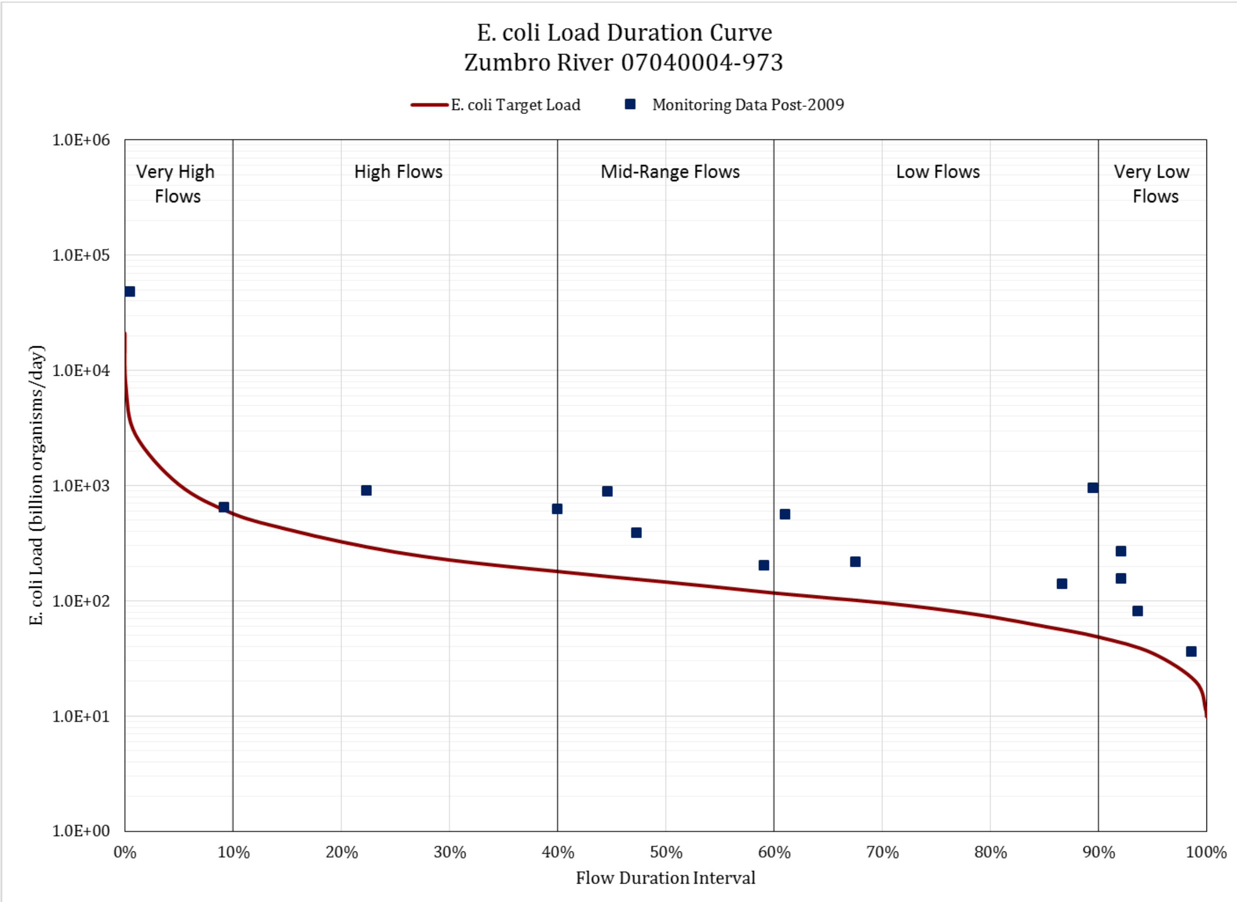

Figure 18. MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-973.

Table 29. MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-973.

Zumbro River 07040004-973 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		1023.54	265.45	145.94	85.25	35.19
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	2.26	2.26	2.26	2.26	2.26
	MS4**	NA	NA	NA	NA	NA
	Total WLA	2.26	2.26	2.26	2.26	2.26
Load Allocation		918.93	236.65	129.09	74.47	29.41
10% Margin of Safety		102.35	26.54	14.59	8.53	3.52

* See Table 54 in Appendix B for list of permitted facilities
** No current MS4 communities within reach drainage area

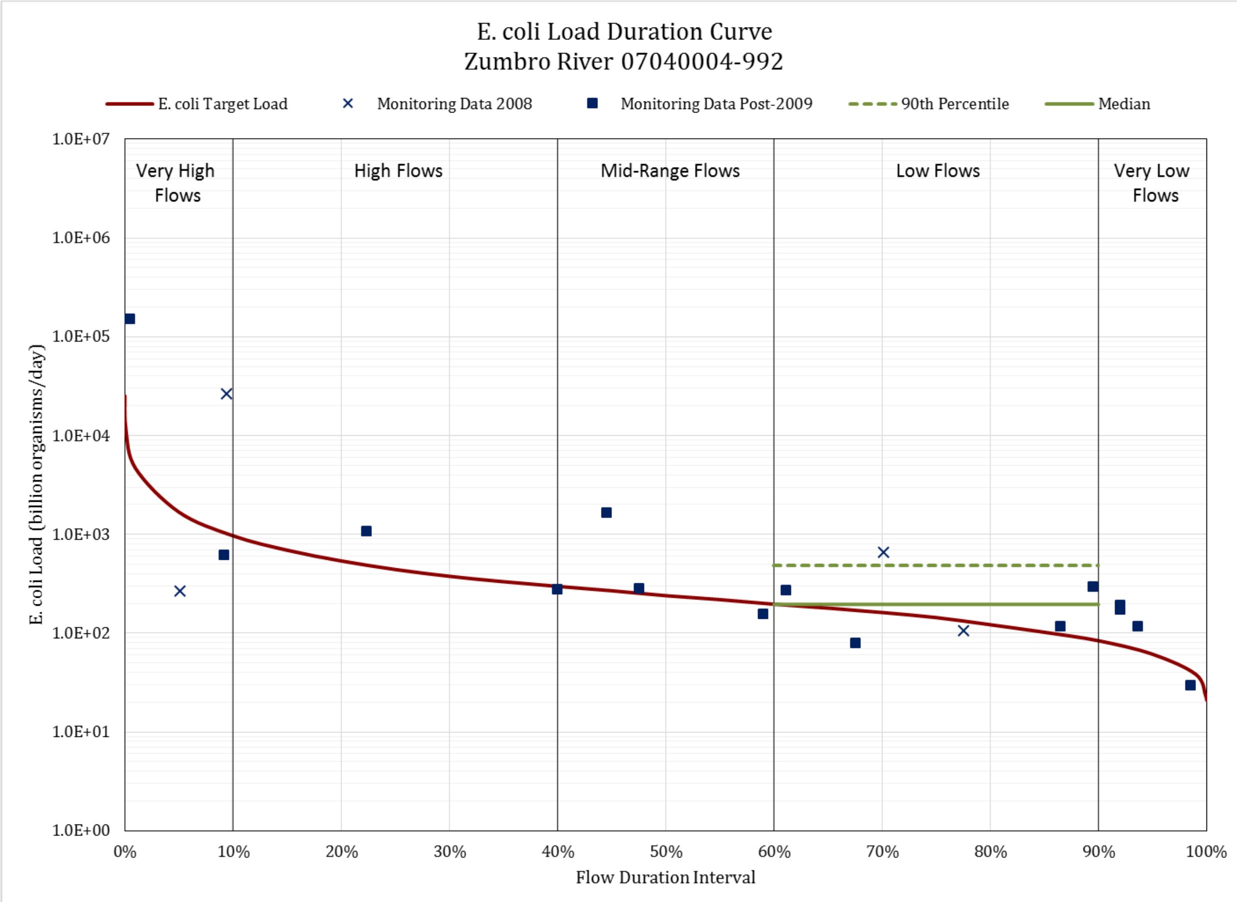

Figure 19. MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-992.

Table 30. MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-992.

<table>
<tr><th colspan="2" rowspan="3">Zumbro River 07040004-992 TMDL Summary</th><th colspan="5">Flow Regime</th></tr>
<tr><th>VHigh</th><th>High</th><th>Mid</th><th>Low</th><th>VLow</th></tr>
<tr><th colspan="5">Billions of Organisms/day</th></tr>
<tr><td colspan="2">E. coli Loading Capacity (TMDL)</td><td>1680.08</td><td>441.03</td><td>239.83</td><td>143.90</td><td>61.28</td></tr>
<tr><td rowspan="3">Wasteload Allocation (WLA) Components</td><td>Permitted Municipal and Industrial Wastewater Facilities*</td><td>5.62</td><td>5.62</td><td>5.62</td><td>5.62</td><td>5.62</td></tr>
<tr><td>MS4**</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Total WLA</td><td>5.62</td><td>5.62</td><td>5.62</td><td>5.62</td><td>5.62</td></tr>
<tr><td colspan="2">Load Allocation</td><td>1506.45</td><td>391.30</td><td>210.23</td><td>123.89</td><td>49.54</td></tr>
<tr><td colspan="2">10% Margin of Safety</td><td>168.01</td><td>44.10</td><td>23.98</td><td>14.39</td><td>6.13</td></tr>
</table>

* See Table 55 in Appendix B for list of permitted facilities
** No current MS4 communities within reach drainage area

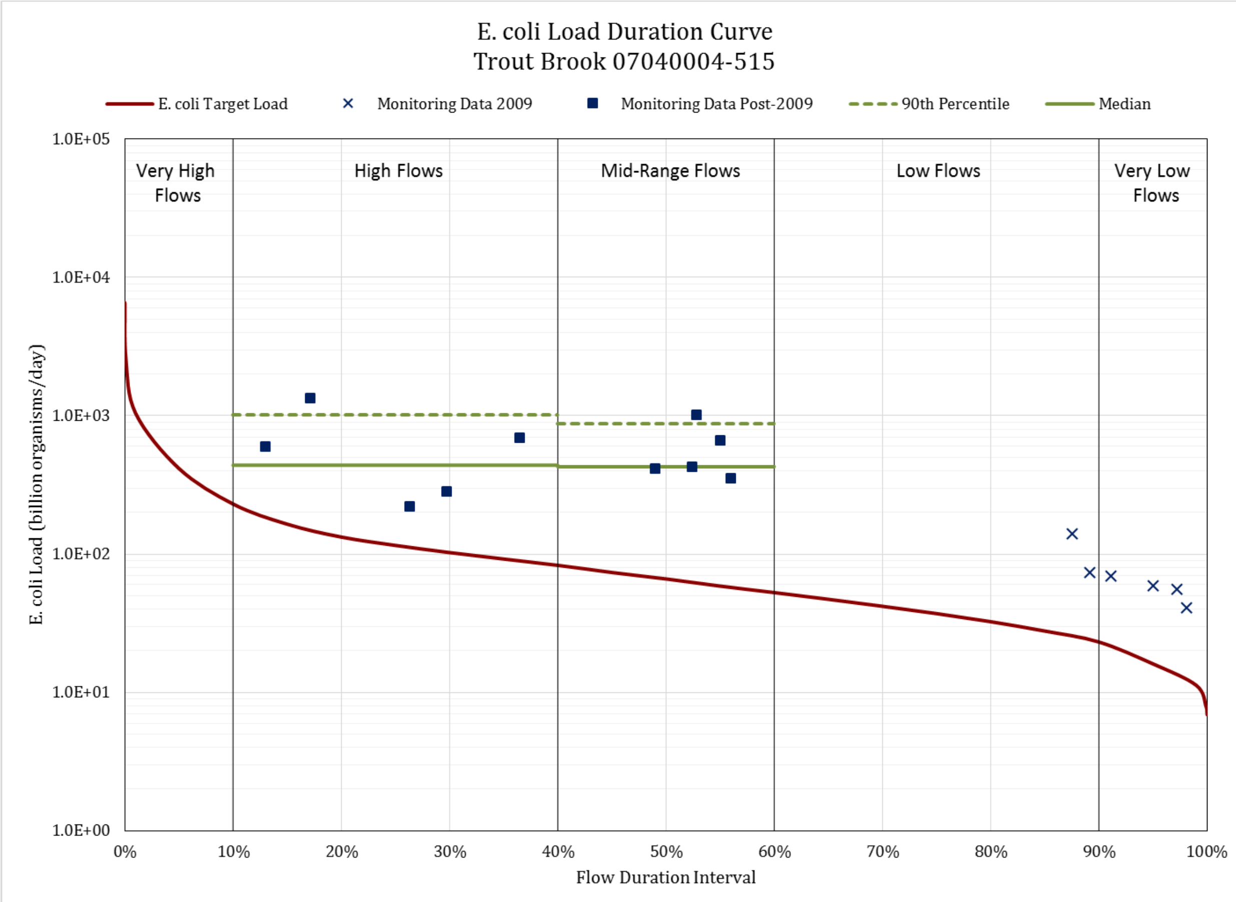

Figure 20. NORTH FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Trout Brook – 07040004-515.

Table 31. NORTH FORK ZUMBRO RIVER HUC-10: TMDL Summary for Trout Brook – 07040004-515.

Trout Brook 07040004-515 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		415.95	115.62	66.17	37.16	16.08
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	0.47	0.47	0.47	0.47	0.47
	MS4**	NA	NA	NA	NA	NA
	Total WLA	0.47	0.47	0.47	0.47	0.47
Load Allocation		373.88	103.59	59.08	32.97	14.00
10% Margin of Safety		41.59	11.56	6.62	3.72	1.61

* See Table 56 in Appendix B for list of permitted facilities

** No current MS4 communities within reach drainage area

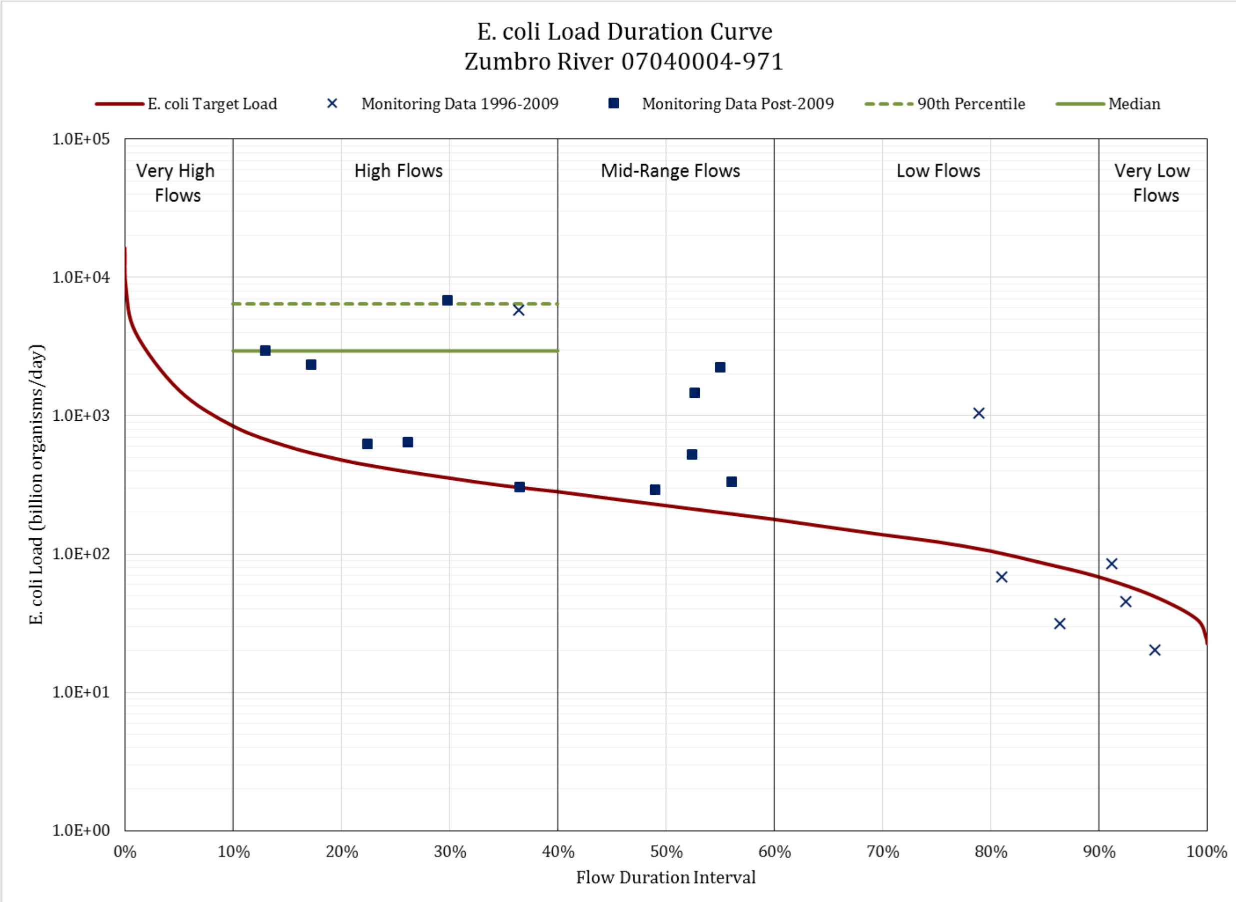

Figure 21. NORTH FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-971.

Table 32. NORTH FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-971.

Zumbro River 07040004-971 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		1531.24	406.51	224.19	122.85	49.97
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	9.53	9.53	9.53	9.53	9.53
	MS4**	NA	NA	NA	NA	NA
	Total WLA	9.53	9.53	9.53	9.53	9.53
Load Allocation		1368.59	356.33	192.25	101.04	35.45
10% Margin of Safety		153.12	40.65	22.42	12.29	5.00

* See Table 57 in Appendix B for list of permitted facilities

** No current MS4 communities within reach drainage area

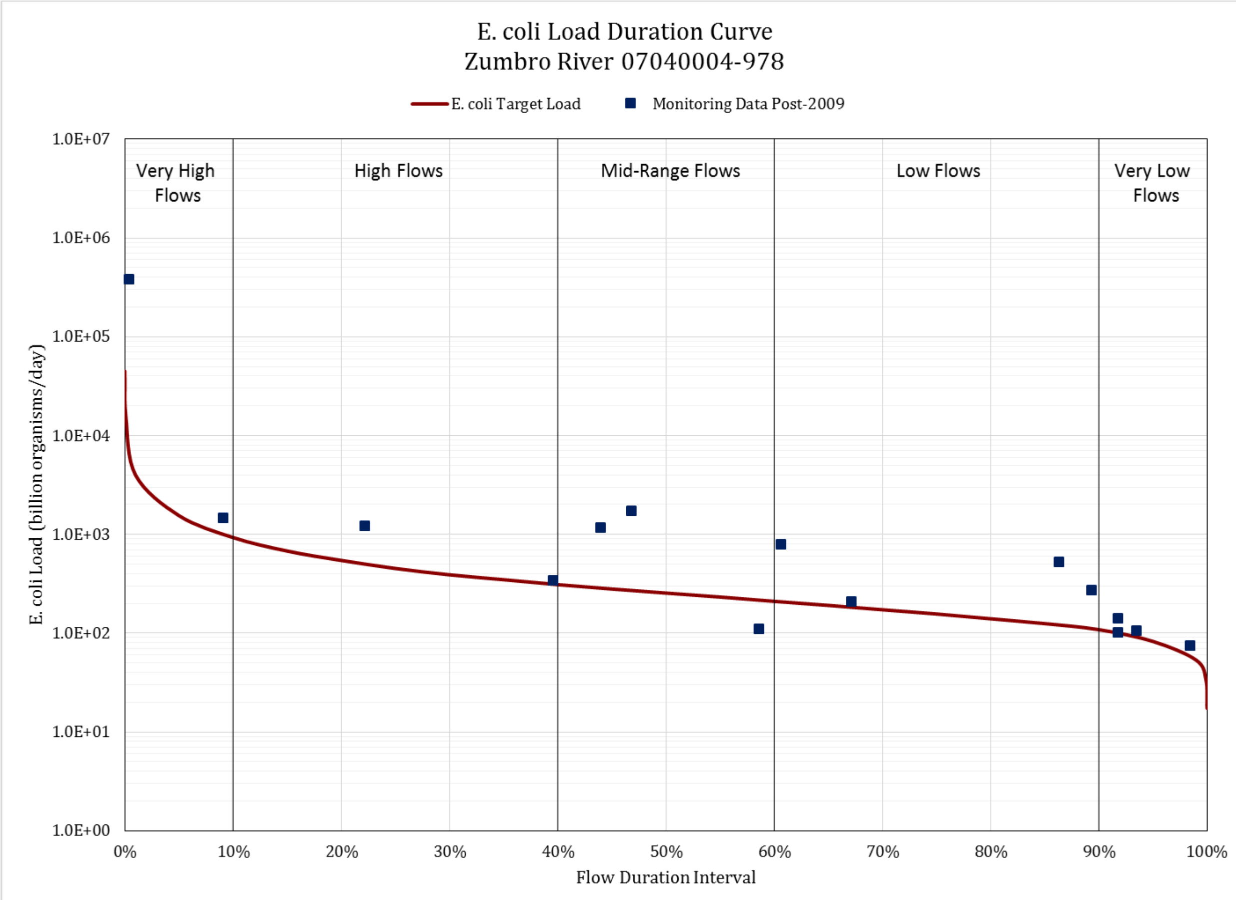

Figure 22. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-978.

Table 33. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-978.

Zumbro River 07040004-978 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		1548.67	452.10	254.60	156.48	82.46
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	27.00	27.00	27.00	27.00	27.00
	Oronoco Township MS4 (0.53% - FUTURE)	7.34	2.14	1.21	0.74	0.39
	Total WLA	34.34	29.14	28.21	27.74	27.39
Load Allocation		1359.47	377.74	200.93	113.09	46.82
10% Margin of Safety		154.87	45.21	25.46	15.65	8.25

* See Table 59 in Appendix B for list of permitted facilities

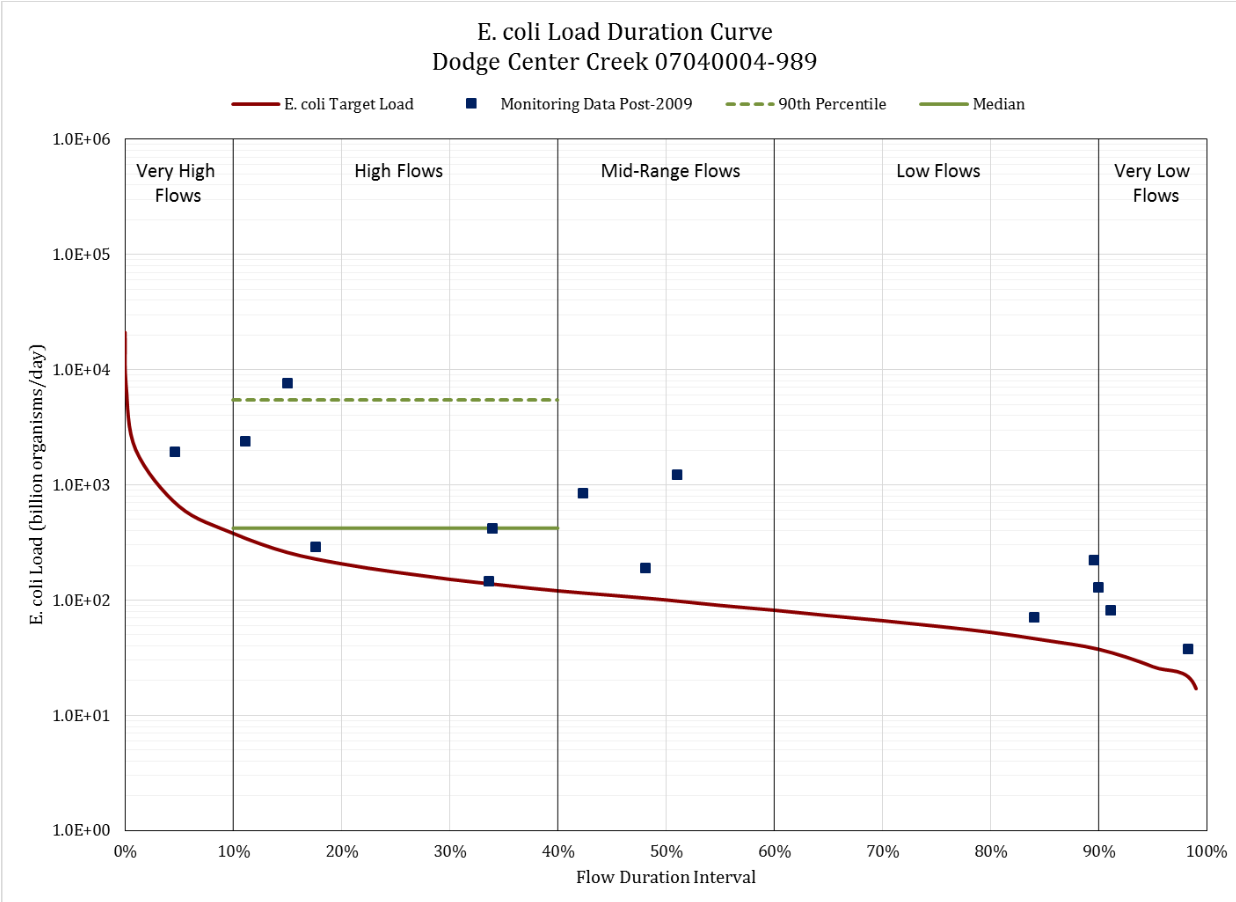

Figure 23. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Dodge Center Creek – 07040004-989.

Table 34. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Dodge Center Creek – 07040004-989.

Dodge Center Creek 07040004-989 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		651.14	175.13	100.52	59.50	26.46
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	9.34	9.34	9.34	9.34	9.34
	MS4**	NA	NA	NA	NA	NA
	Total WLA	9.34	9.34	9.34	9.34	9.34
Load Allocation		576.68	148.28	81.13	44.21	14.47
10% Margin of Safety		65.11	17.51	10.05	5.95	2.65

* See Table 60 in Appendix B for list of permitted facilities

** No current MS4 communities within reach drainage area

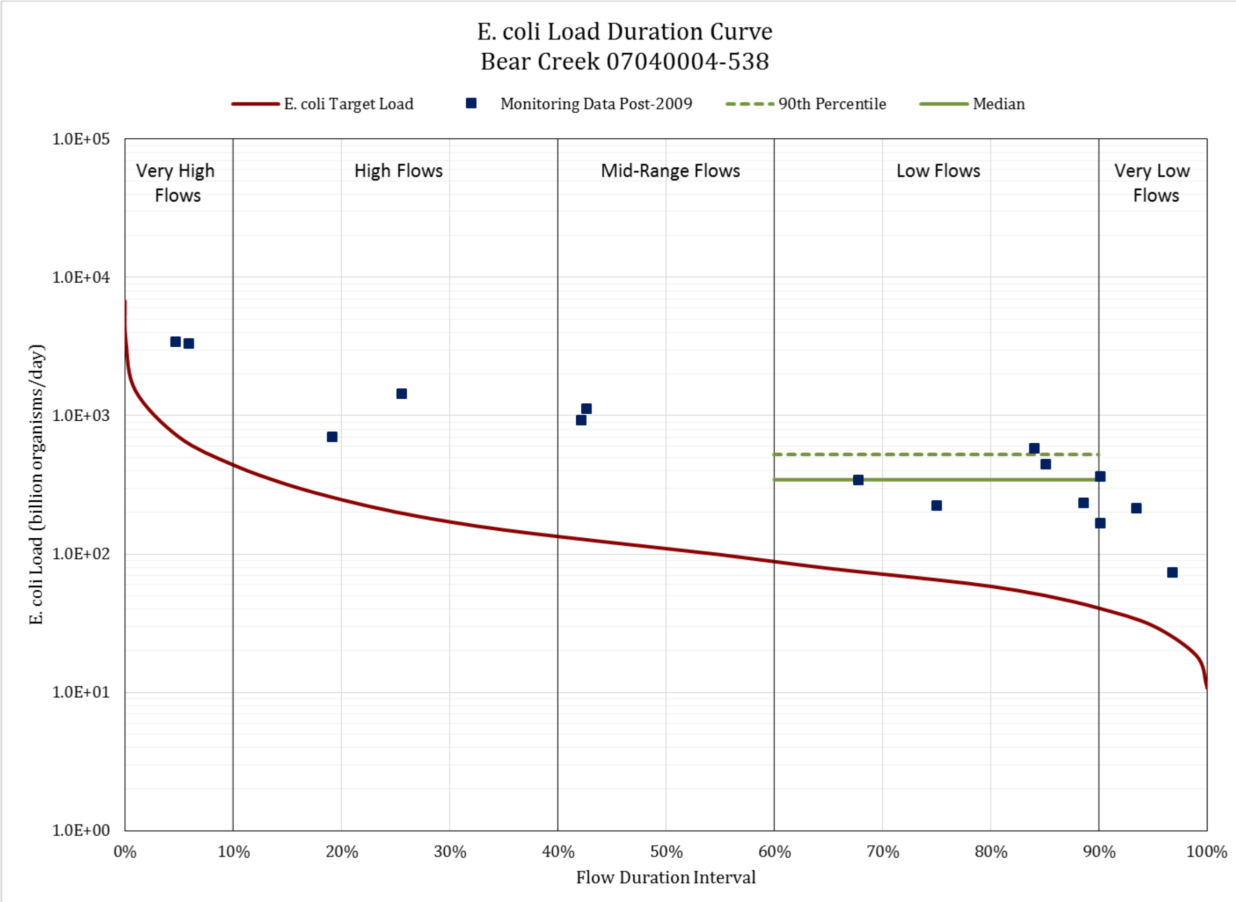

Figure 24. SOUTH FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Bear Creek – 07040004-538.

Table 35. SOUTH FORK ZUMBRO RIVER HUC-10: TMDL Summary for Bear Creek – 07040004-538.

Bear Creek 07040004-538 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		701.56	201.69	109.68	65.17	30.32
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Federal Medical Center MS4 (0.03%)	0.21	0.06	0.03	0.02	0.01
	Haverhill Township MS4 (0.004%)	0.02	0.01	0.004	0.002	0.001
	Marion Township MS4 (3.9%)	24.58	7.07	3.84	2.28	1.06
	MnDOT Outstate MS4 (1.7%)	10.42	3.00	1.63	0.97	0.45
	Olmsted County MS4 (0.4%)	2.61	0.75	0.41	0.24	0.11
	City of Rochester MS4 (13.0%)	82.30	23.66	12.87	7.65	3.56
	Rochester Community & Tech College MS4 (0.2%)	1.23	0.35	0.19	0.11	0.05
	Rochester Township MS4 (1.8%)	11.25	3.23	1.76	1.04	0.49
	Total WLA	132.61	38.12	20.73	12.32	5.73
Load Allocation		498.79	143.40	77.98	46.34	21.56
10% Margin of Safety		70.16	20.17	10.97	6.52	3.03

* No permitted wastewater facilities within reach drainage area

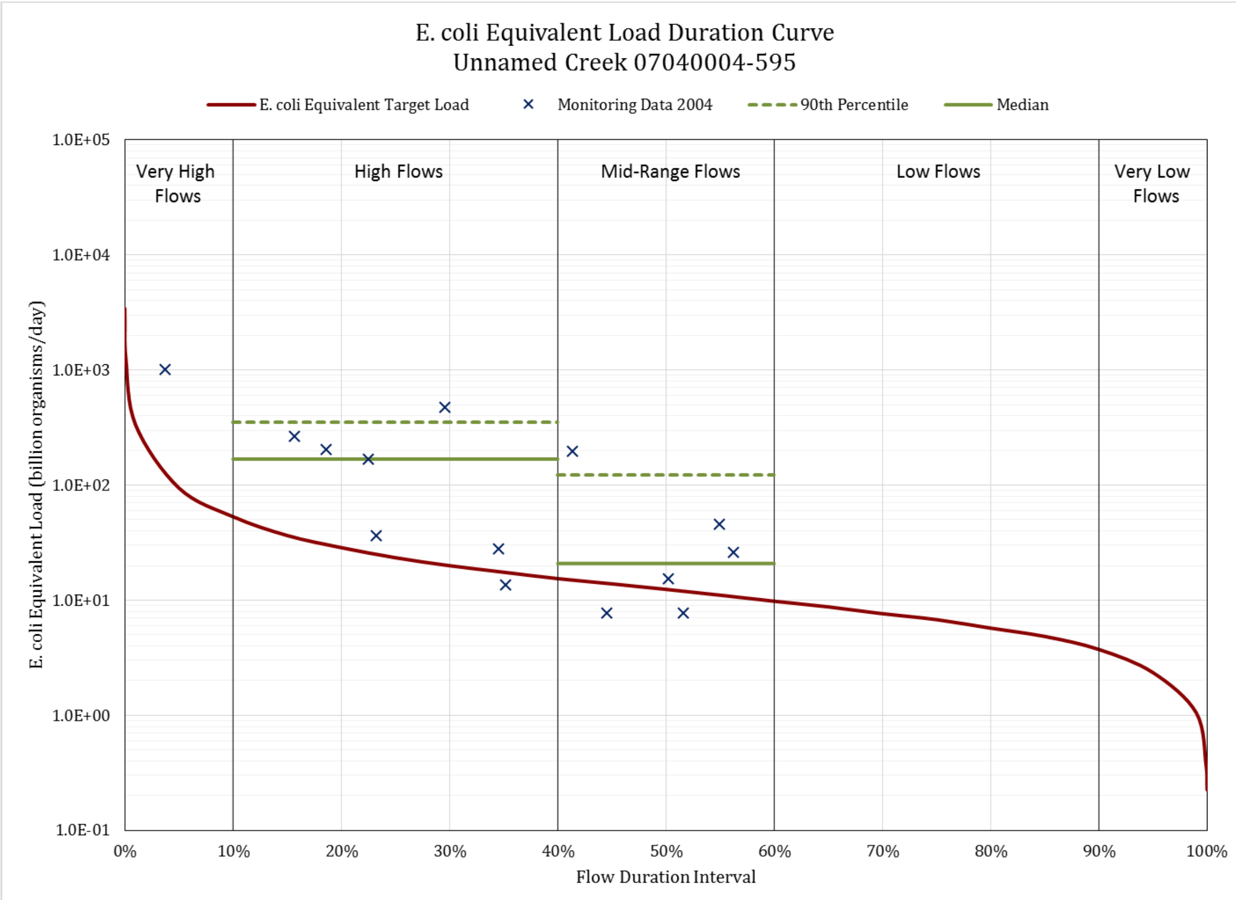

Figure 25. SOUTH FORK ZUMBRO RIVER HUC-10: *E. coli* Equivalent Load Duration Curve for Unnamed Creek – 07040004-595.

Table 36. SOUTH FORK ZUMBRO RIVER HUC-10: *E. coli* Equivalent TMDL Summary for Unnamed Creek – 07040004-595.

Unnamed Creek 07040004-595 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Equivalent Loading Capacity (TMDL)		94.37	23.42	12.43	6.79	2.35
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		84.93	21.08	11.19	6.11	2.11
10% Margin of Safety		9.44	2.34	1.24	0.68	0.23

* No permitted wastewater facilities within reach drainage area

** No current MS4 communities within reach drainage area

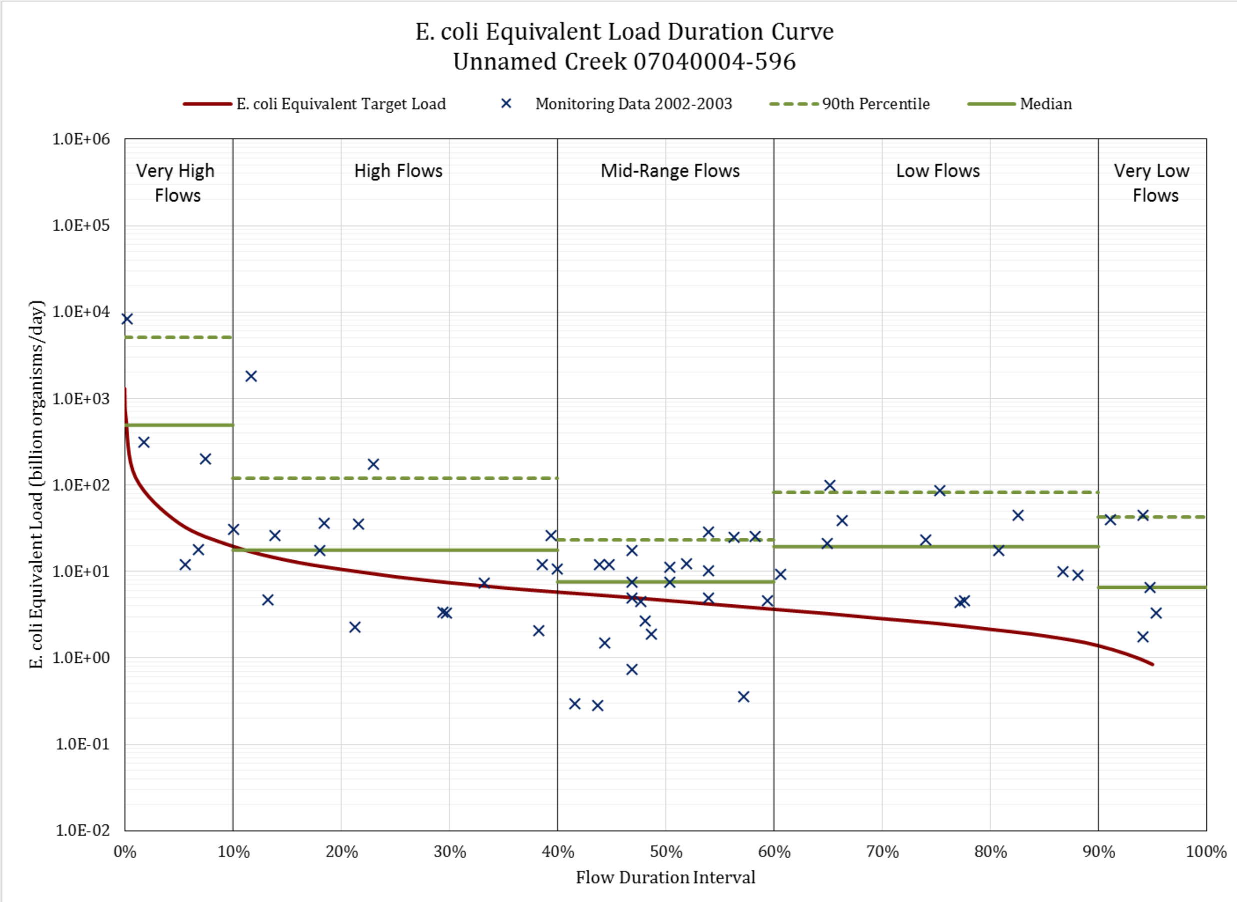

Figure 26. SOUTH FORK ZUMBRO RIVER HUC-10: *E. coli* Equivalent Load Duration Curve for Unnamed Creek – 07040004-596.

Table 37. SOUTH FORK ZUMBRO RIVER HUC-10: *E. coli* Equivalent TMDL Summary for Unnamed Creek – 07040004-596.

Unnamed Creek 07040004-596 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Equivalent Loading Capacity (TMDL)		36.16	8.68	4.63	2.51	0.84
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		32.54	7.81	4.16	2.26	0.75
10% Margin of Safety		3.62	0.87	0.46	0.25	0.08

* No permitted wastewater facilities within reach drainage area
** No current MS4 communities within reach drainage area

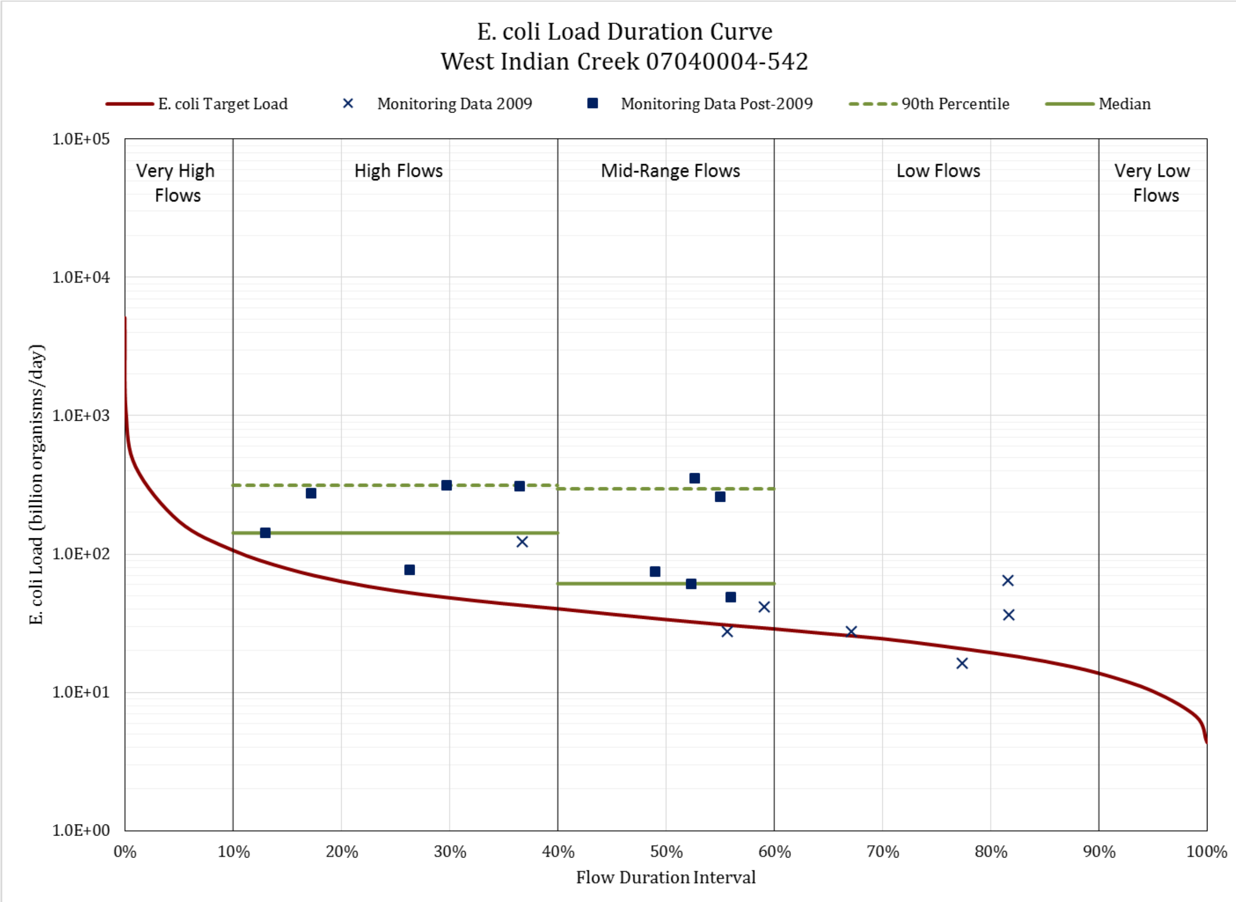

Figure 27. ZUMBRO RIVER HUC-10: Load Duration Curve for West Indian Creek – 07040004-542.

Table 38. ZUMBRO RIVER HUC-10: TMDL Summary for West Indian Creek – 07040004-542.

West Indian Creek 07040004-542 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		172.67	54.29	33.67	21.92	10.19
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		155.40	48.86	30.30	19.73	9.17
10% Margin of Safety		17.27	5.43	3.37	2.19	1.02

* No permitted wastewater facilities within reach drainage area

** No current MS4 communities within reach drainage area

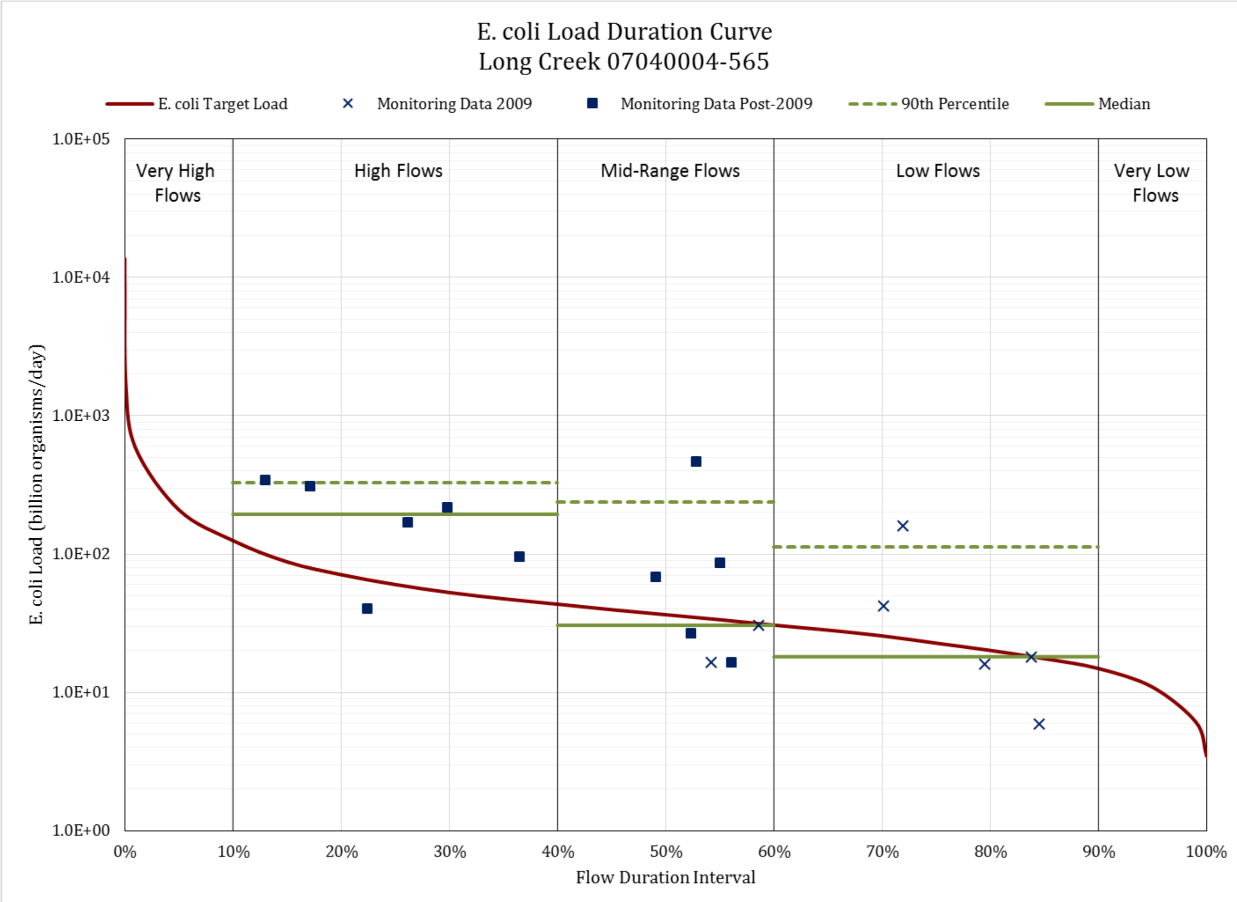

Figure 28. ZUMBRO RIVER HUC-10: Load Duration Curve for Long Creek – 07040004-565.

Table 39. ZUMBRO RIVER HUC-10: TMDL Summary for Long Creek – 07040004-565.

Long Creek 07040004-565 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		209.08	60.31	36.49	22.73	10.93
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		188.17	54.28	32.84	20.46	9.84
10% Margin of Safety		20.91	6.03	3.65	2.27	1.09

* No permitted wastewater facilities within reach drainage area

** No current MS4 communities within reach drainage area

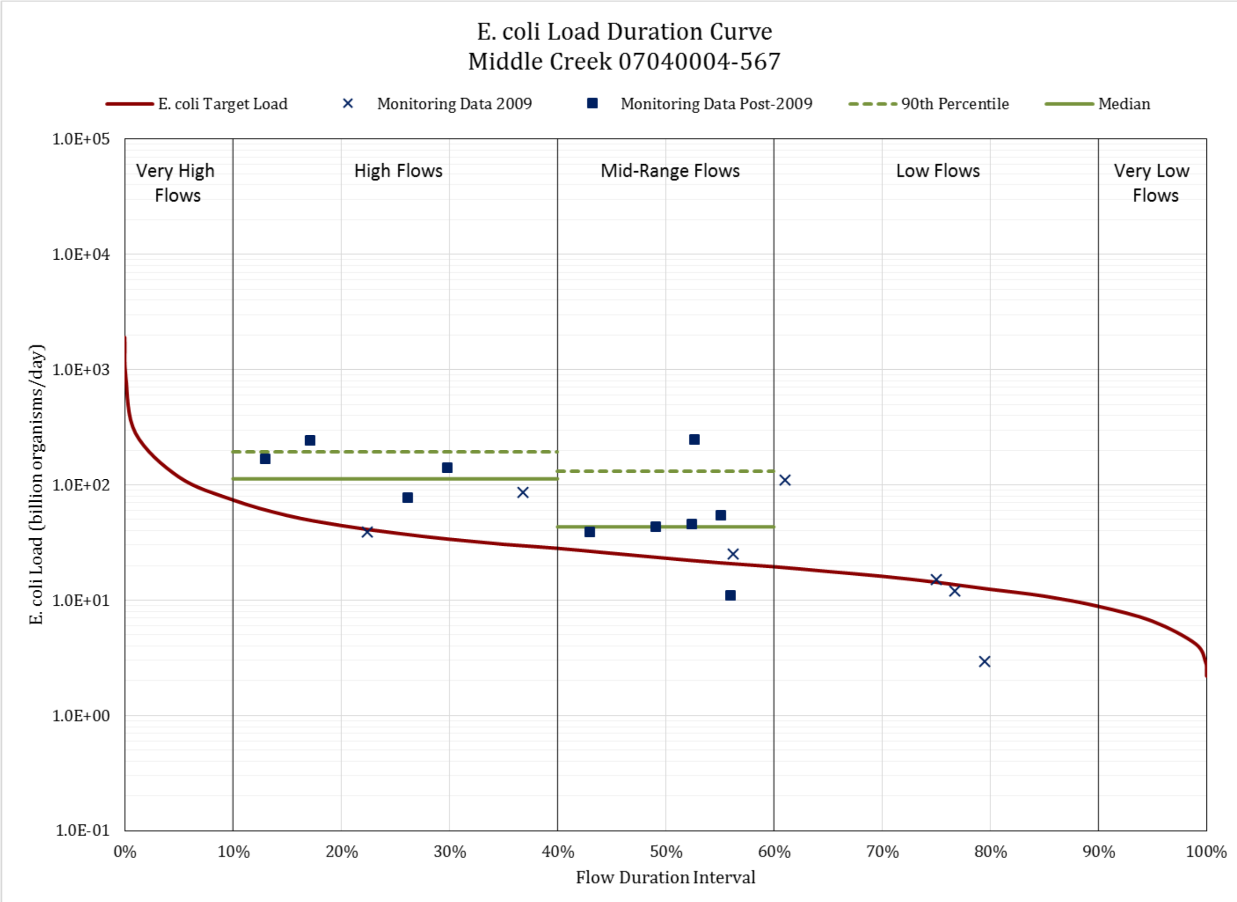

Figure 29. ZUMBRO RIVER HUC-10: Load Duration Curve for Middle Creek – 07040004-567.

Table 40. ZUMBRO RIVER HUC-10: TMDL Summary for Middle Creek – 07040004-567.

Middle Creek 07040004-567 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		117.30	38.29	23.17	14.33	6.57
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		105.57	34.46	20.85	12.90	5.92
10% Margin of Safety		11.73	3.83	2.32	1.43	0.66

* No permitted wastewater facilities within reach drainage area

** No current MS4 communities within reach drainage area

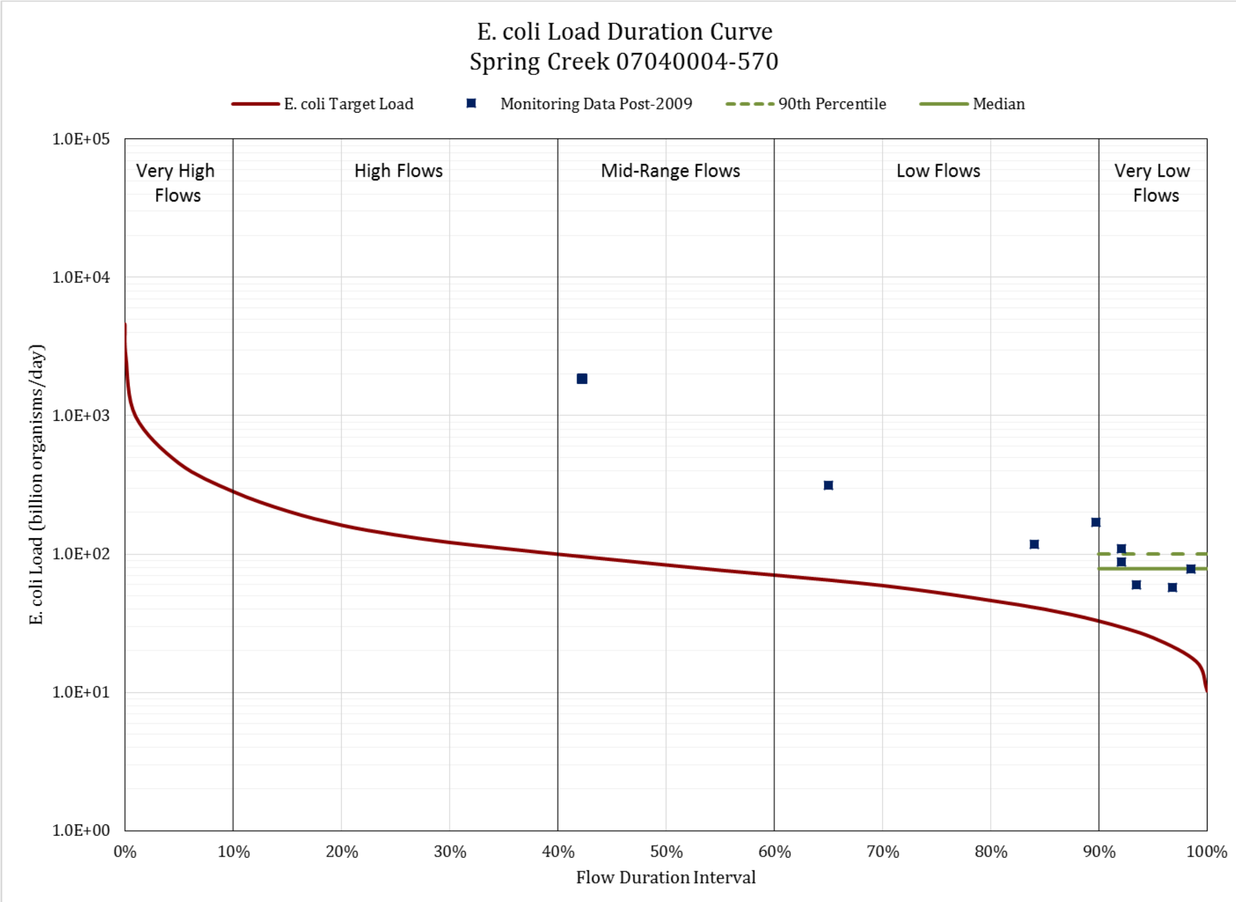

Figure 30. ZUMBRO RIVER HUC-10: Load Duration Curve for Spring Creek – 07040004-570.

Table 41. ZUMBRO RIVER HUC-10: TMDL Summary for Spring Creek – 07040004-570.

Spring Creek 07040004-570 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		453.84	137.76	83.57	52.85	24.88
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		408.46	123.99	75.21	47.57	22.39
10% Margin of Safety		45.38	13.78	8.36	5.29	2.49

* No permitted wastewater facilities within reach drainage area
** No current MS4 communities within reach drainage area

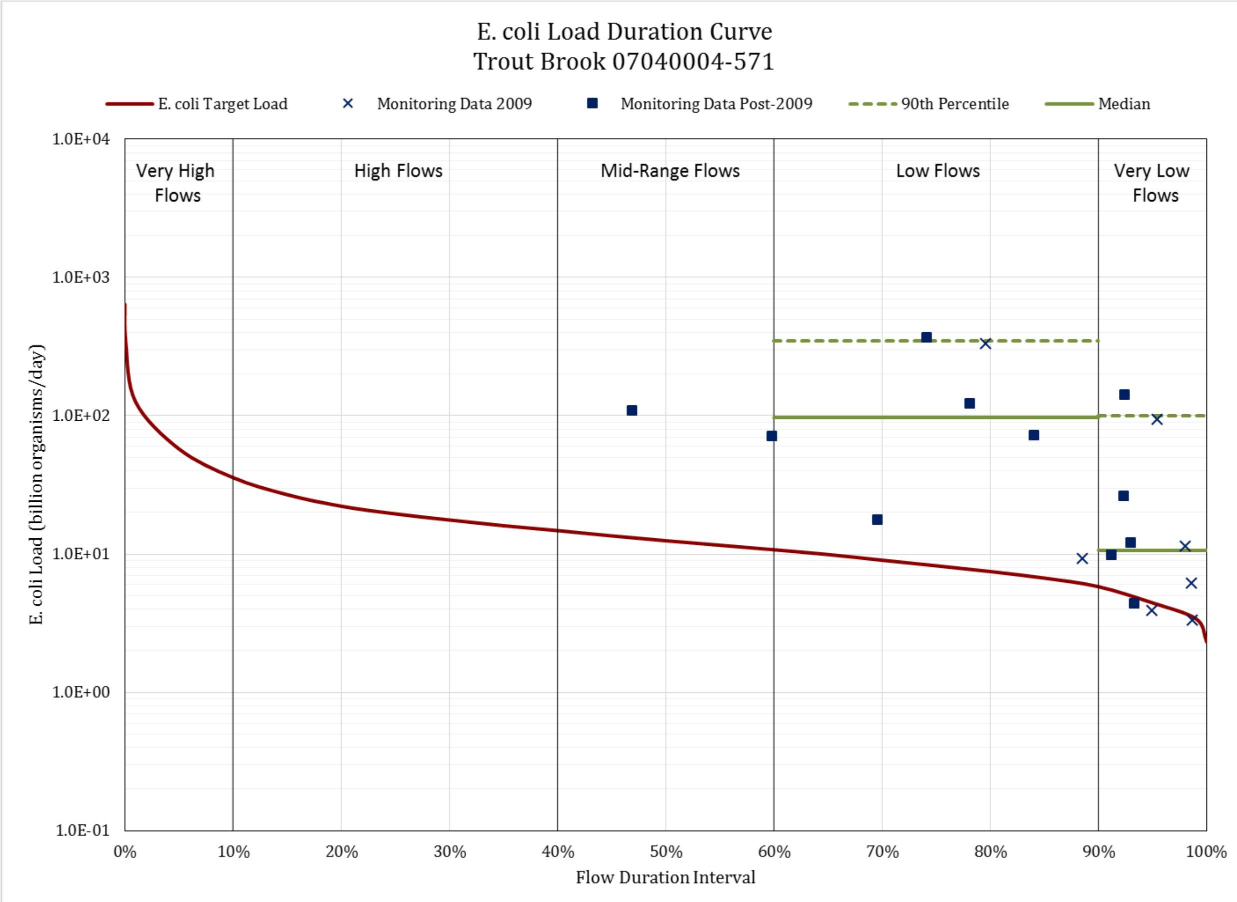

Figure 31. ZUMBRO RIVER HUC-10: Load Duration Curve for Trout Brook – 07040004-571.

Table 42. ZUMBRO RIVER HUC-10: TMDL Summary for Trout Brook – 07040004-571.

Trout Brook 07040004-571 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		57.64	19.54	12.50	8.24	4.44
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		51.88	17.59	11.25	7.41	4.00
10% Margin of Safety		5.76	1.95	1.25	0.82	0.44

* No permitted wastewater facilities within reach drainage area

** No current MS4 communities within reach drainage area

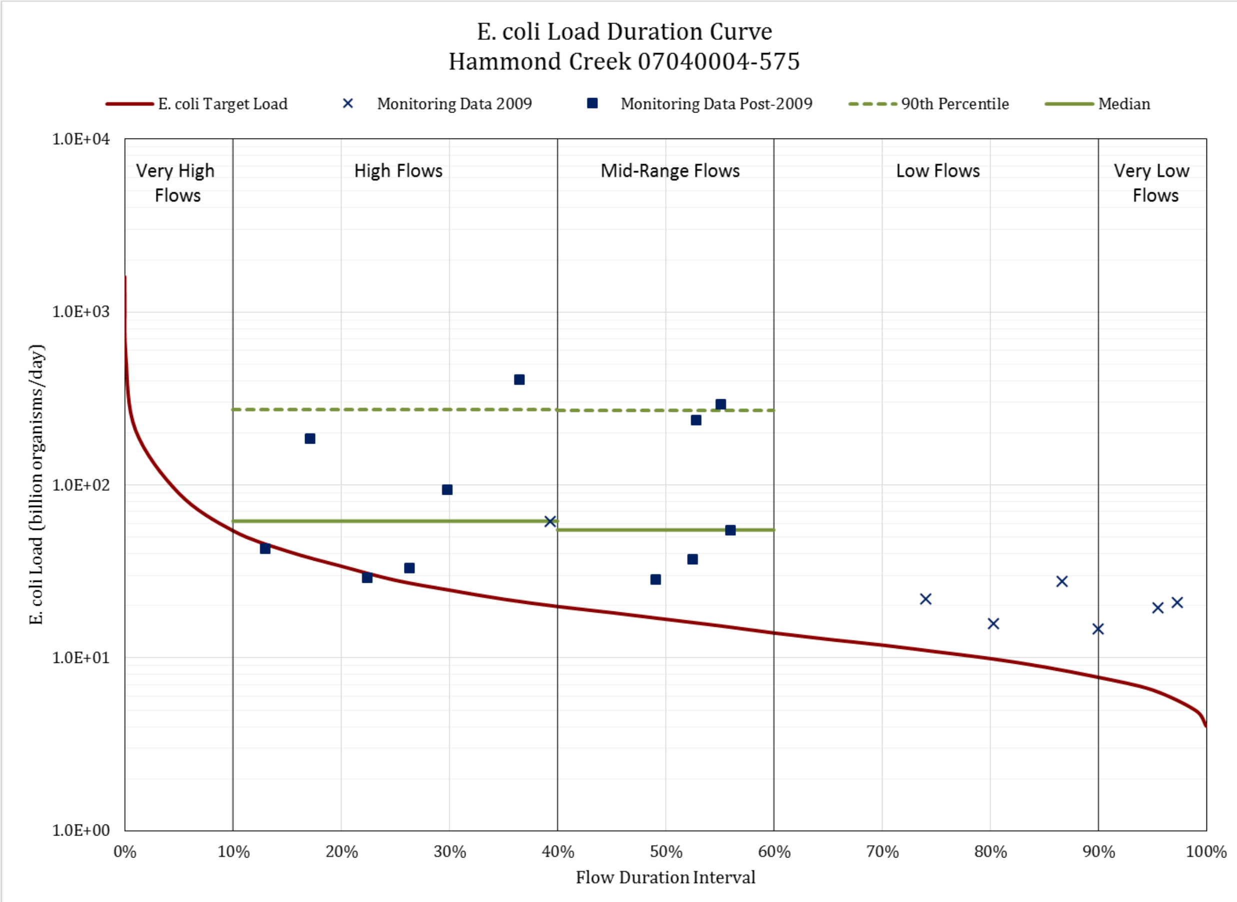

Figure 32. ZUMBRO RIVER HUC-10: Load Duration Curve for Hammond Creek – 07040004-575.

Table 43. ZUMBRO RIVER HUC-10: TMDL Summary for Hammond Creek – 07040004-575.

Hammond Creek 07040004-575 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		89.48	28.13	16.73	10.85	6.52
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		80.53	25.32	15.06	9.77	5.87
10% Margin of Safety		8.95	2.81	1.67	1.09	0.65

* No permitted wastewater facilities within reach drainage area
** No current MS4 communities within reach drainage area

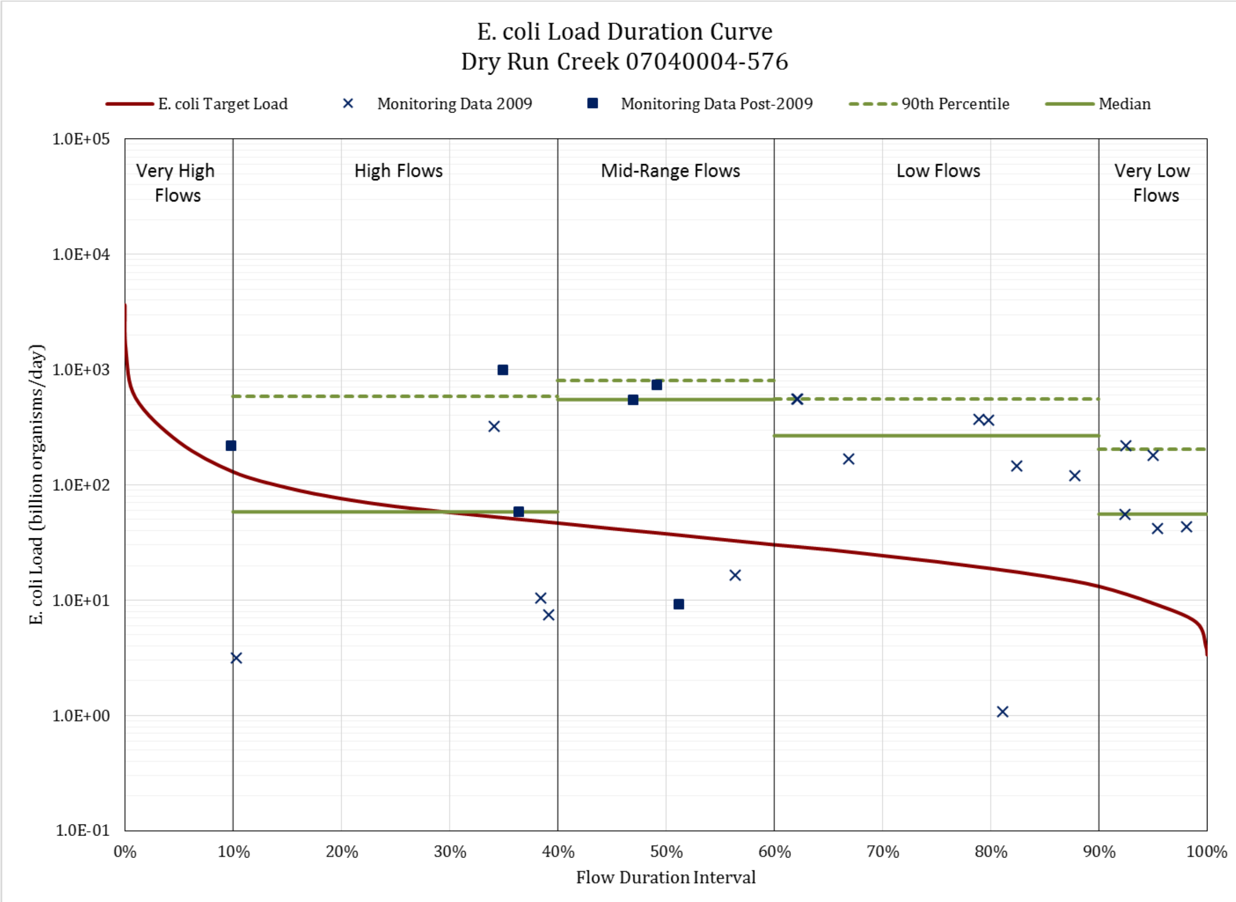

Figure 33. ZUMBRO RIVER HUC-10: Load Duration Curve for Dry Run Creek – 07040004-576.

Table 44. ZUMBRO RIVER HUC-10: TMDL Summary for Dry Run Creek – 07040004-576.

Dry Run Creek 07040004-576 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		235.84	65.10	37.70	21.59	9.40
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Oronoco Township MS4 (8.14% - FUTURE)	17.28	4.77	2.76	1.58	0.69
	Total WLA	17.28	4.77	2.76	1.58	0.69
Load Allocation		194.98	53.82	31.17	17.85	7.77
10% Margin of Safety		23.58	6.51	3.77	2.16	0.94

* No permitted wastewater facilities within reach drainage area

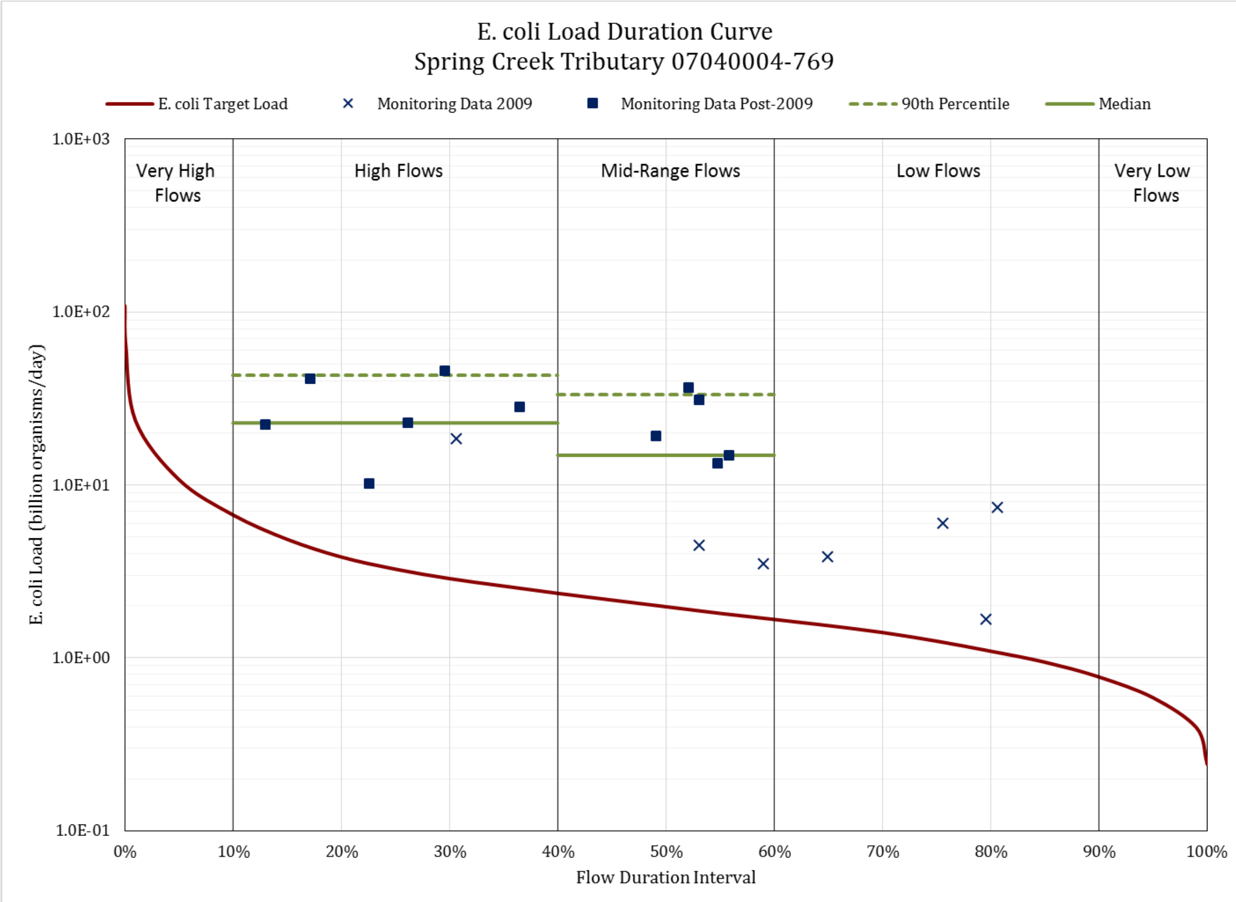

Figure 34. ZUMBRO RIVER HUC-10: Load Duration Curve for Spring Creek Tributary – 07040004-769.

Table 45. ZUMBRO RIVER HUC-10: TMDL Summary for Spring Creek Tributary – 07040004-769.

Spring Creek Tributary 07040004-769 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		Billions of Organisms/day				
E. coli Loading Capacity (TMDL)		10.73	3.26	1.98	1.25	0.59
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	MS4**	NA	NA	NA	NA	NA
	Total WLA	NA	NA	NA	NA	NA
Load Allocation		9.66	2.93	1.78	1.12	0.53
10% Margin of Safety		1.07	0.33	0.20	0.12	0.06

* No permitted wastewater facilities within reach drainage area
** No current MS4 communities within reach drainage area

4.4 Total Suspended Solids

4.4.1 Loading Capacity Methodology

In 2014, LimnoTech developed a calibrated HSPF model for the simulation period covering 1996 through 2009, which was used as the baseline flow for all TMDLs. From these results, a TLC was assigned for each flow regime – Very High, High, Mid, Low, and Very Low – by multiplying the median flow of each regime by the Minnesota water quality standard for TSS. There are two standards in the ZRW: 10 mg/L for coldwater streams (2A class) and 65 mg/L for warmwater streams (2B class).

The load duration curve method is based on an analysis that encompasses the cumulative frequency of historic flow data over a specified period. Because this method uses a long-term record of daily flow volumes virtually the full spectrum of allowable loading capacities is represented by the resulting curve. In the TMDL equation tables of this report (Table 46 through Table 52), only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, it should be understood that the entire curve represents the TMDL and is what is ultimately approved by the EPA.

When water quality data was not available for a specific AUID, the HSPF predicted TSS loads were plotted on the load duration curve.

4.4.2 Load Allocation Methodology

As stated in the governing TMDL equation, the LA is comprised of the nonpoint source load that is allocated to an impaired AUID after the MOS and WLA are subtracted from the TLC for each flow regime. This residual load is meant to represent all non-regulated sources of TSS upstream of the impaired reach (summarized in Section 3.7.2.2). Given the complexity of sediment dynamics and a lack of sufficient historical data in the ZRW, attempting to allocate a specific natural background load to any river or stream reach would result in a margin of error that in itself may be more than the estimated allocation. As such, the LA includes natural background. Schottler et al (2010) and other sources tabulated in Section 3.7.2.2 discuss this matter further.

4.4.3 Wasteload Allocation Methodology

Permitted Industrial and Municipal Wastewater Facilities

Within the ZRW, there are 32 NPDES permitted Industrial and Municipal facilities. Each facility is permitted for specific water quality limits at their discharge. A list of facilities discharging to each AUID is included in Appendix B. The WLA assigned to each permitted facility was calculated using the facility's design flow and permit limit for TSS, which varied from facility to facility, but was either 20 mg/L, 30 mg/L, or 45 mg/L. The 20 mg/L permit limit applies to Milestone Materials – North Quarry when Zumbro River flow at the 37th Street Bridge gauge is equal to or less than 161 cfs. At flows greater than 161 cfs, a 30 m/L permit limit applies. Any discrepancies observed in the tables between permit limit and WLA are due to rounding.

Regulated Construction and Industrial Stormwater

A permit is required for any construction activities disturbing: one acre or more of soil; less than one acre of soil if that activity is part of a "larger common plan of development or sale" that is greater than one acre; or less than one acre of soil, but the MPCA determines that the activity poses a risk to water resources. A construction stormwater runoff WLA is needed to account for pollutant loading (nutrient eutrophication biological indicators), turbidity, DO, or biotic impairment (fish bioassessments, aquatic plant bioassessments and aquatic macroinvertebrate bioassessments) from ongoing construction activity in the watershed. Per the MPCA guidance website for setting WLAs for regulated stormwater, a construction stormwater WLA is typically 0.05% - 0.15% of the TLC (https://stormwater.pca.state.mn.us/index.php?title=MPCA_guidance_for_setting_wasteload_allocations_for_regulated_stormwater). Thus, a generally appropriate estimate of the WLA for construction stormwater is 0.1% of the TLC, which was used in this TMDL report. (http://stormwater.pca.state.mn.us/index.php/Construction_activity_by_county). There are no individual permitted Industrial Stormwater Facilities in the ZRW that require an individual WLA. This sector was not assigned a "0" WLA, but rather listed as NA (Not Applicable).

Regulated MS4 Stormwater

The MS4 systems are designed to convey stormwater into a receiving waterbody and are permitted under the NPDES Permit.

All MS4 communities are existing communities and are included in the WLA. Oronoco Township is planned as a future community and is included in the MS4 WLA as a future WLA.

MS4 allocations were calculated using the following equations:

$$\text{MS4 Allocation} = \%\text{MS4 Area} * (\text{TLC} - \text{MOS} - \text{Permitted WW Facility})$$

Where:

%MS4 Area: the ration of the total MS4 area to the total drainage area for the given AUID. Areas were obtained using ArcMap.

Permitted WW Facilities: the total WLA for all permitted Industrial and Municipal WWTFs that discharge into the AUID's drainage area.

4.4.4 Margin of Safety

An explicit MOS equal to 10% of the loading capacity was use for the stream TMDLs based on the following considerations:

- Most of the uncertainty in flow is a result of extrapolating flows from the hydrologically-nearest stream gage. The explicit MOS, in part, accounts for this.
- The calibrated ZRWHSPF model does a "good" to "very good" job at predicting monthly, seasonal, and annual streamflow volumes and daily streamflows. However, uncertainties in predicting the timing and magnitude of flow as a result of spring snowmelt during both calibration and validation runs provides additional justification for a 10% MOS. Summary statistics comparing observed and predicted streamflows for both calibration and validation runs are provided in the ZRWHSPF model report (LimnoTech 2014).

- Allocations are a function of flow, which varies from very high to very low flows. This variability is accounted for through the development of a TMDL for each of the five flow regimes.

4.4.5 Season Variation

The TSS water quality standard applies for the period April through September, which corresponds to the open water season when aquatic organisms are most active and when high stream TSS concentrations generally occur. TSS loading varies with the flow regime and season. Spring is associated with large flows from snowmelt, the summer is associated with the growing season as well as periodic storm events and receding streamflows, and the fall brings increasing precipitation and rapidly changing agricultural landscapes.

Critical conditions and seasonal variation are addressed in this TMDL through several mechanisms. The TSS standard applies during the open water months, and data was collected throughout this period. The water quality analysis conducted on these data evaluated variability in flow through the use of five flow regimes: from high flows, such as flood events, to low flows, such as baseflow. Through the use of LDCs, TSS loading was evaluated at actual flow conditions at the time of sampling.

4.4.6 TMDL Summary

The same method described in Section 4.3.6 to estimate HSPF flow for water quality samples collected after the simulation period (post-2009) was applied to the two AUIDs that had monitoring data after 2009 (Dodge Center Creek – 07040004-989 and Spring Creek – 07040004-570). In cases of little or no available monitoring data, the HSPF predicted TSS loads were plotted for the entire simulation period. For some AUIDs, for illustrative purposes duration curves were built using both loads based on actual water quality and modeled water quality data. In such cases, the TMDLs (the loading capacity lines based on the respective water quality standard) are the same in both figures. Water quality data was collected as grab samples between April through October as part of the ZRW Intensive Watershed Monitoring program. This program covers a two-year period and includes site selection down to the HUC-14 scale. Additional sampling programs conducted by organizations such as Soil and Water Conservation Districts, Citizen Monitoring, and other TMDL studies was used to provide as complete a record as possible going back 10-years (2005 through 2014). The 10-year period is used to ensure data is collected over varying weather and flow conditions. The HSPF model predicted loads plotted on the load duration curves are representative of all hydrologic conditions simulated in the model.

The TSS LDCs document exceedances during higher flows, confirming the nonpoint source contributions and the significant loads that come during large rain events. Of this load, the near-channel sources are an important component (see Section 3.7.4, which discusses the approximate split between near-channel and upland sediment sources (Figure 16).

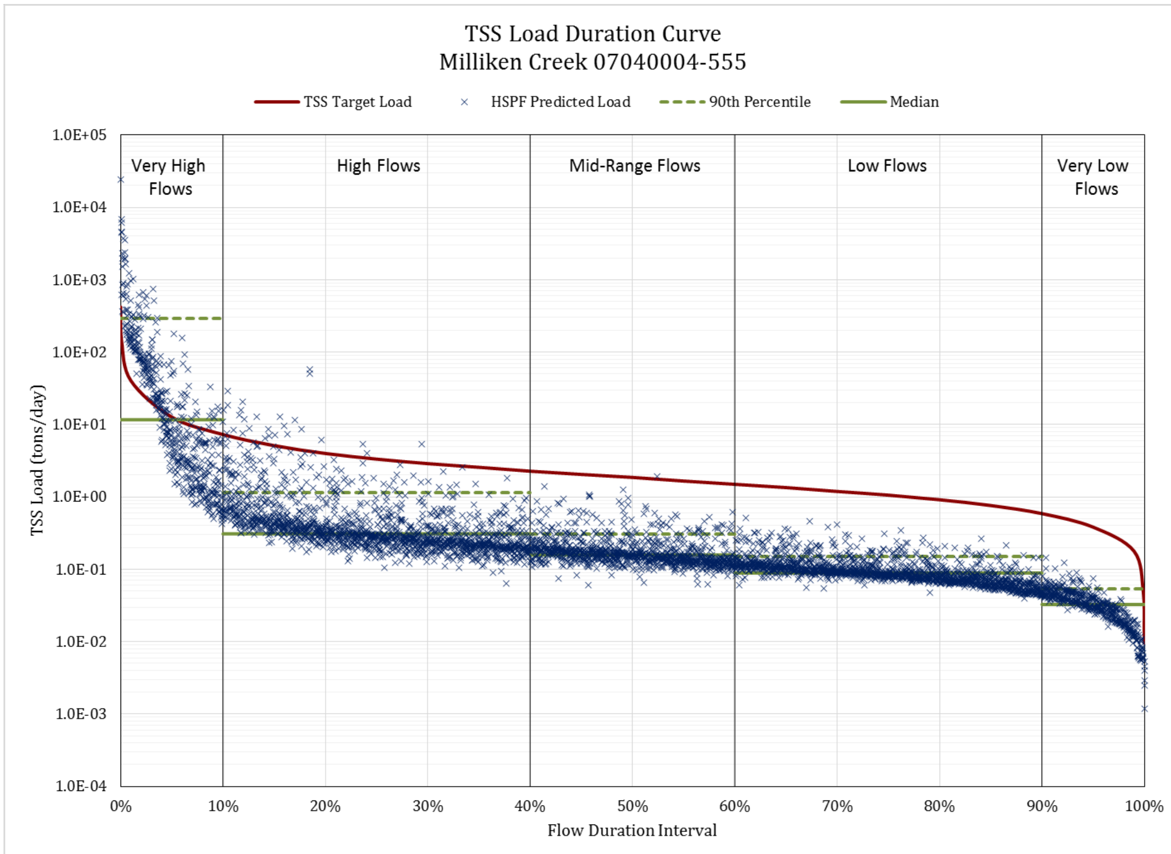

Figure 35. MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Milliken Creek – 07040004-555. WQ Standard is 65 mg/L.

Table 46. MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Milliken Creek – 07040004-555.

Milliken Creek 07040004-555 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		12.69	3.33	1.86	1.06	0.38
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.01	0.003	0.002	0.001	0.0003
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.01	0.003	0.002	0.001	0.0003
Load Allocation		11.41	3.00	1.67	0.95	0.34
10% Margin of Safety		1.27	0.33	0.19	0.11	0.04

* No permitted wastewater facilities within reach drainage area

** No permitted individual stormwater facilities within reach drainage area

*** No current MS4 communities within reach drainage area

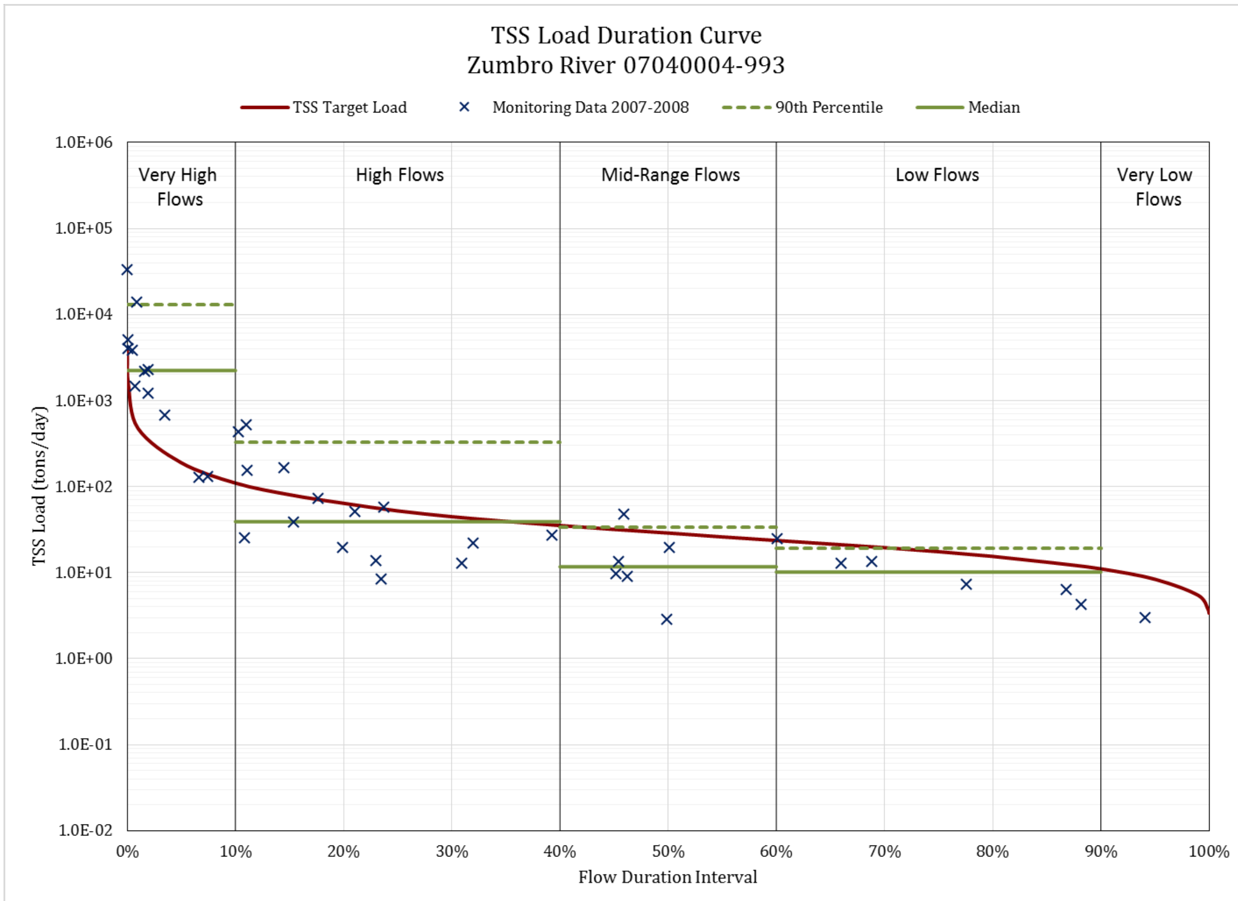

Figure 36. MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-993. WQ Standard is 65 mg/L.

Table 47. MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-993.

Zumbro River 07040004-993 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		189.00	52.16	28.83	17.50	8.36
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	0.92	0.92	0.92	0.92	0.92
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.17	0.05	0.03	0.02	0.01
	Oronoco Township MS4 (2.06% - FUTURE)	3.49	0.95	0.52	0.31	0.14
	Total WLA	4.58	1.92	1.47	1.24	1.07
Load Allocation		165.52	45.02	24.49	14.50	6.46
10% Margin of Safety		18.90	5.22	2.88	1.75	0.84

* See Table 58 in Appendix B for list of permitted facilities

** No permitted individual stormwater facilities within reach drainage area

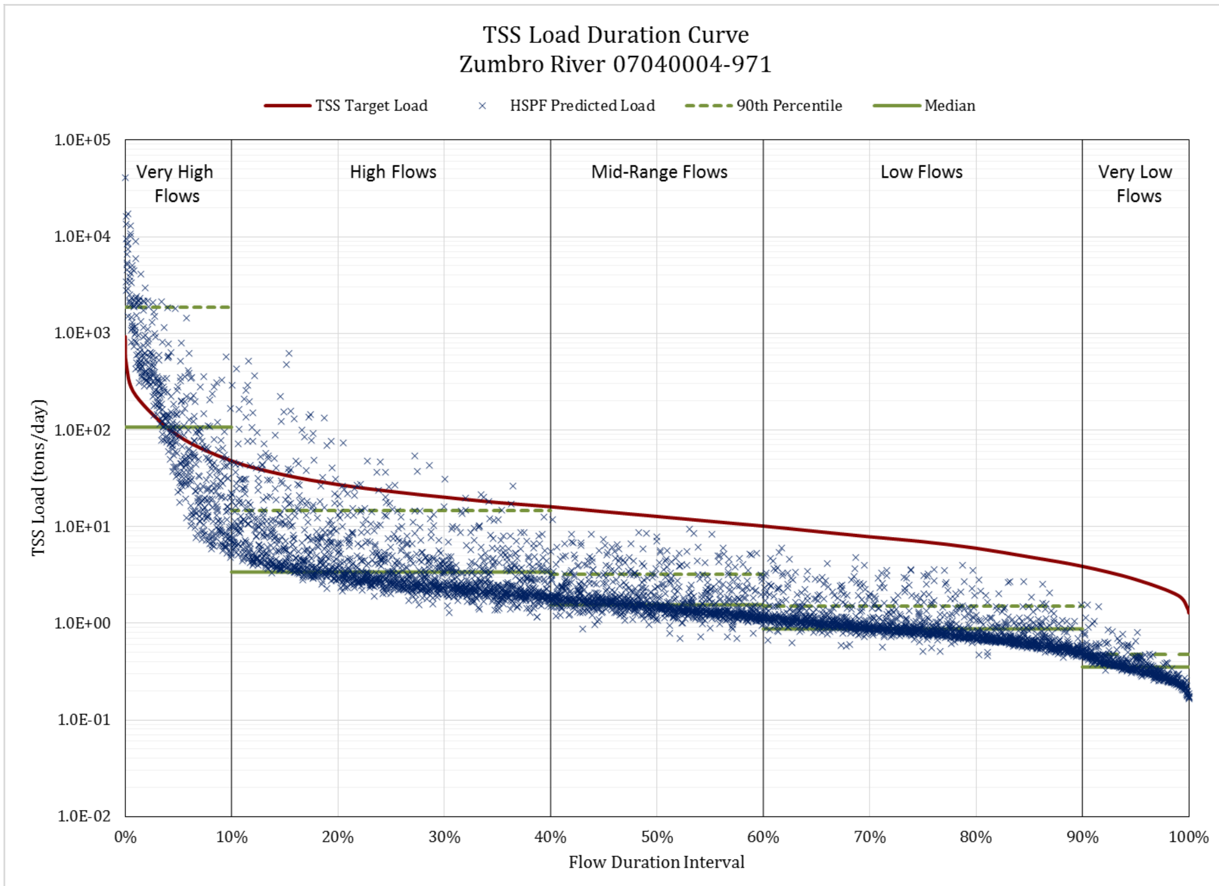

Figure 37. NORTH FORK ZUMBRO RIVER HUC-10: Load Duration Curve for Zumbro River – 07040004-971. WQ Standard is 65 mg/L.

Table 48. NORTH FORK ZUMBRO RIVER HUC-10: TMDL Summary for Zumbro River – 07040004-971.

Zumbro River 07040004-971 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		87.07	23.12	12.75	6.99	2.84
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	0.25	0.25	0.25	0.25	0.25
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.08	0.02	0.01	0.01	0.003
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.33	0.27	0.26	0.26	0.25
Load Allocation		78.04	20.53	11.21	6.03	2.31
10% Margin of Safety		8.71	2.31	1.27	0.70	0.28

* See Table 57 in Appendix B for list of permitted facilities
** No permitted individual stormwater facilities within reach drainage area
*** No current MS4 communities within reach drainage area

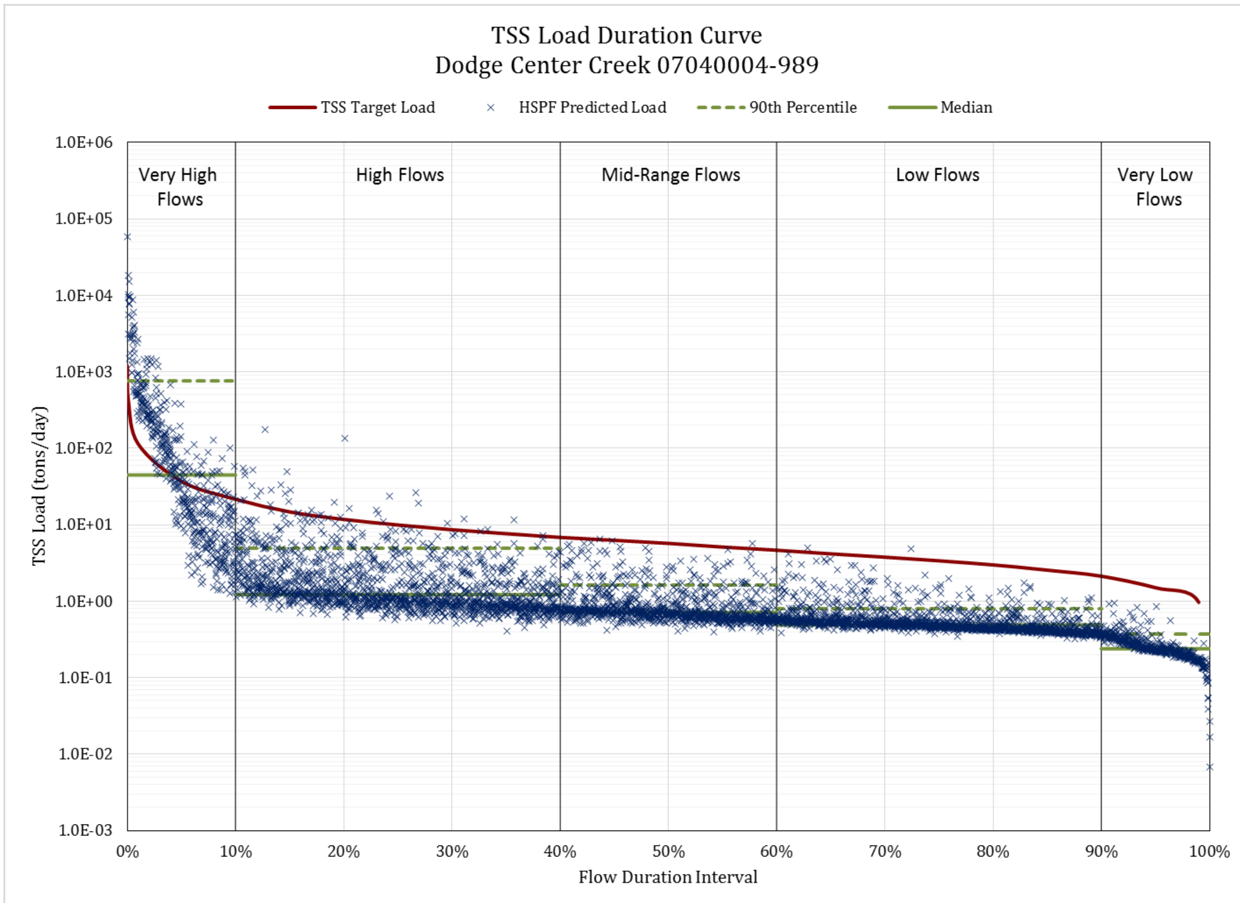

Figure 38. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve with HSPF model predicted TSS loads for Dodge Center Creek – 07040004-989. WQ Standard is 65 mg/L.

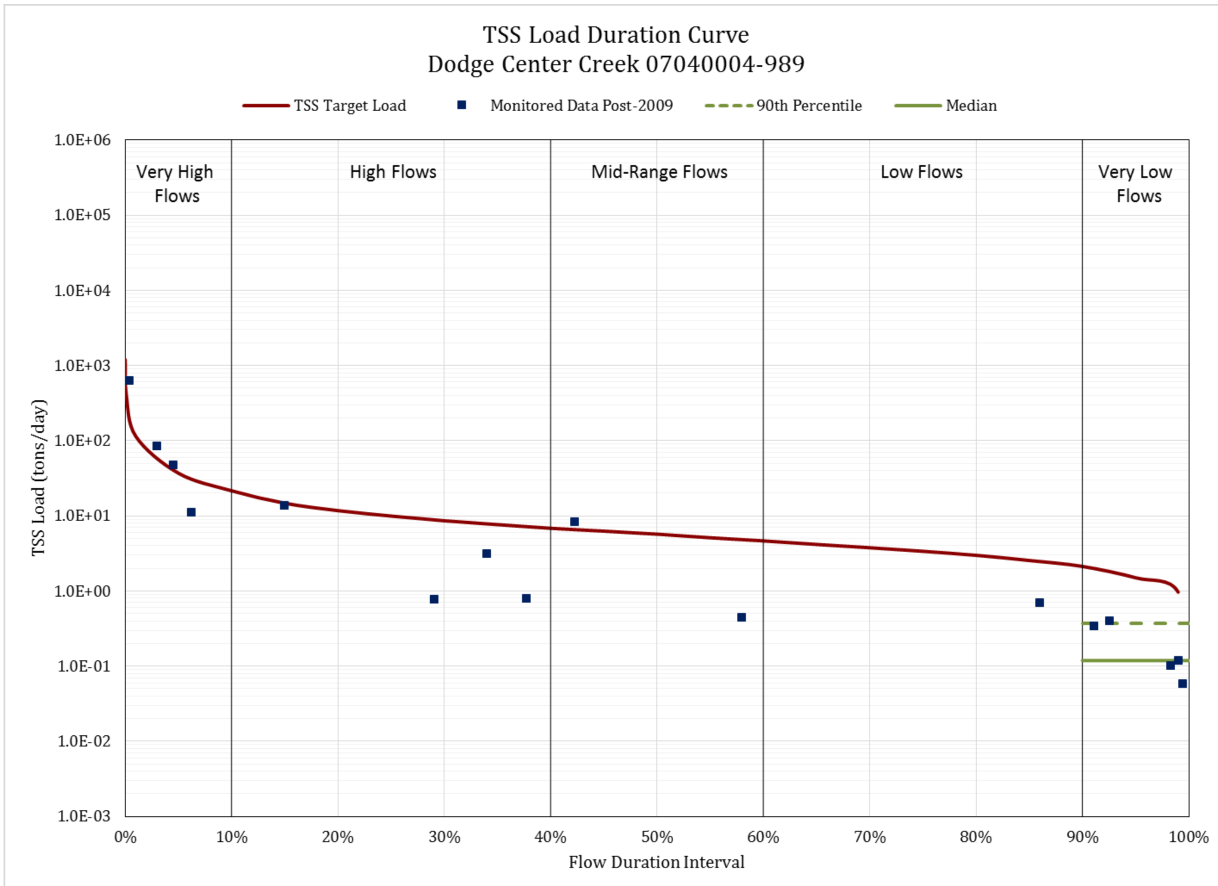

Figure 39. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: Load Duration Curve with water quality data TSS loads for Dodge Center Creek – 07040004-989. WQ Standard is 65 mg/L.

Table 49. SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER HUC-10: TMDL Summary for Dodge Center Creek – 07040004-989.

Dodge Center Creek 07040004-989 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		37.03	9.96	5.72	3.38	1.50
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	0.25	0.25	0.25	0.25	0.25
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.03	0.01	0.01	0.003	0.001
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.28	0.25	0.25	0.25	0.25
Load Allocation		33.05	8.71	4.89	2.80	1.11
10% Margin of Safety		3.70	1.00	0.57	0.34	0.15

* See Table 60 in Appendix B for list of permitted facilities
** No permitted individual stormwater facilities within reach drainage area
*** No current MS4 communities within reach drainage area

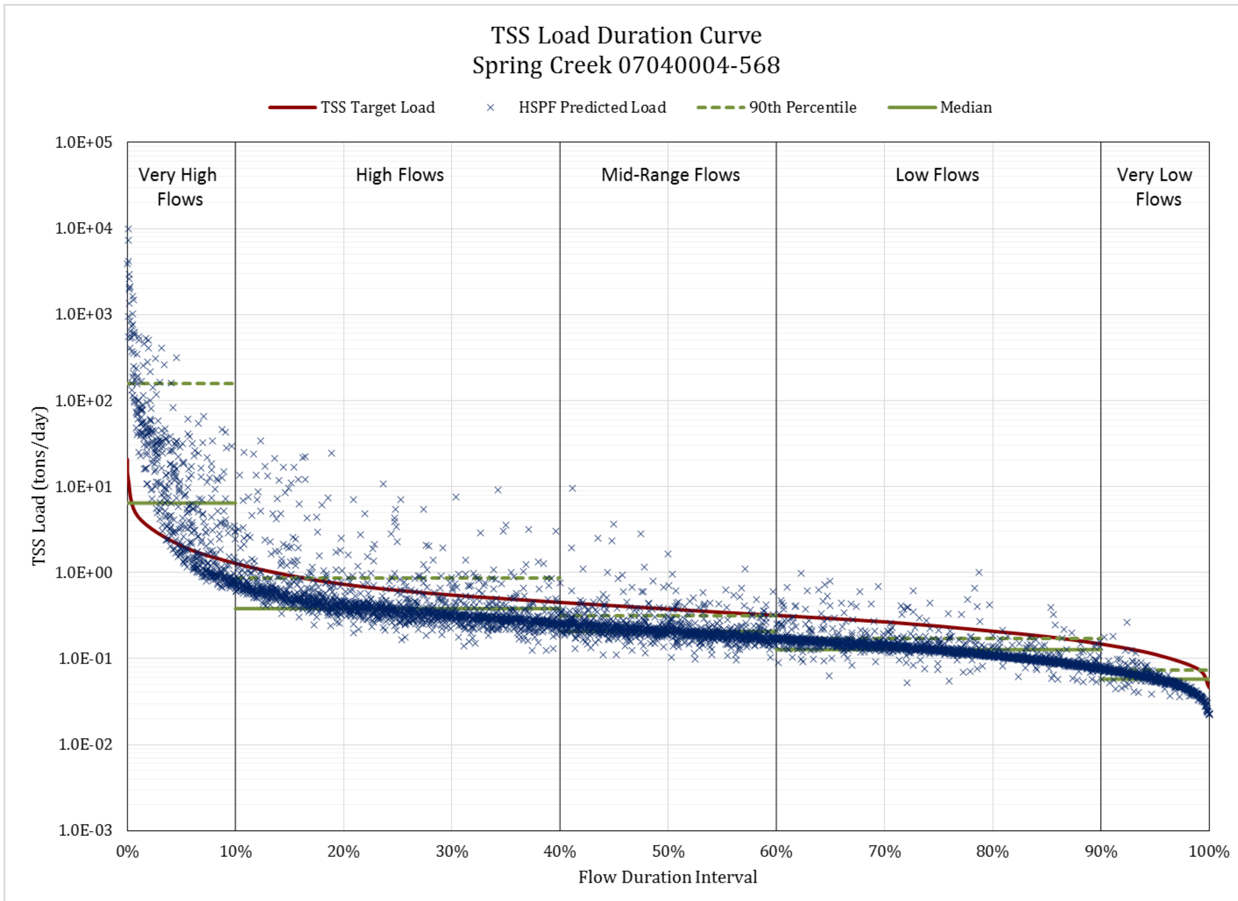

Figure 40. ZUMBRO RIVER HUC-10: Load Duration Curve for Spring Creek – 07040004-568. WQ Standard is 10 mg/L.

Table 50. ZUMBRO RIVER HUC-10: TMDL Summary for Spring Creek – 07040004-568.

Spring Creek 07040004-568 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		2.05	0.62	0.38	0.24	0.11
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.002	0.001	0.0003	0.0002	0.0001
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.002	0.001	0.0003	0.0002	0.0001
Load Allocation		1.84	0.56	0.34	0.21	0.10
10% Margin of Safety		0.20	0.06	0.04	0.02	0.01

* No permitted wastewater facilities within reach drainage area

** No permitted individual stormwater facilities within reach drainage area

*** No current MS4 communities within reach drainage area

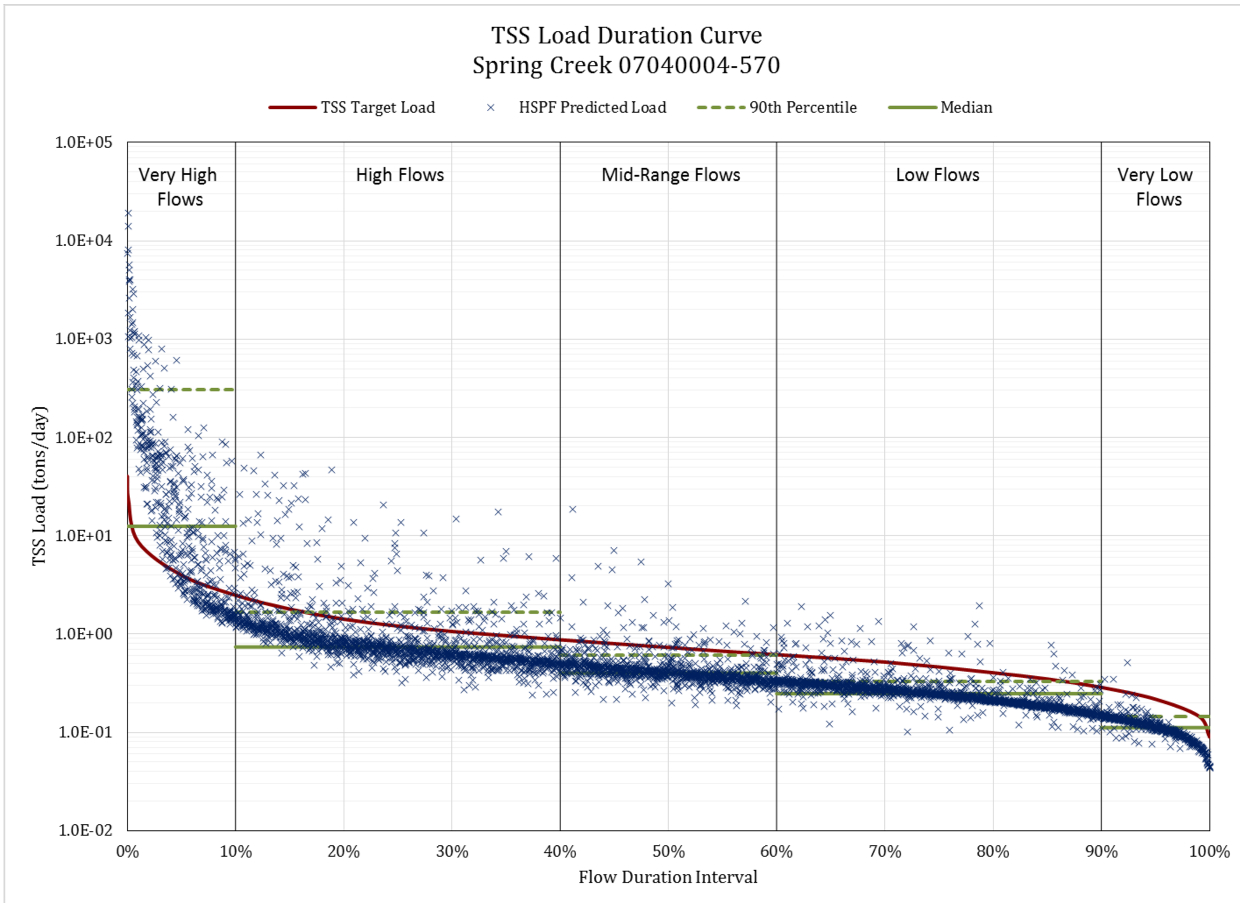

Figure 41. ZUMBRO RIVER HUC-10: Load Duration Curve with HSPF model predicted TSS loads for Spring Creek – 07040004-570. WQ Standard is 10 mg/L

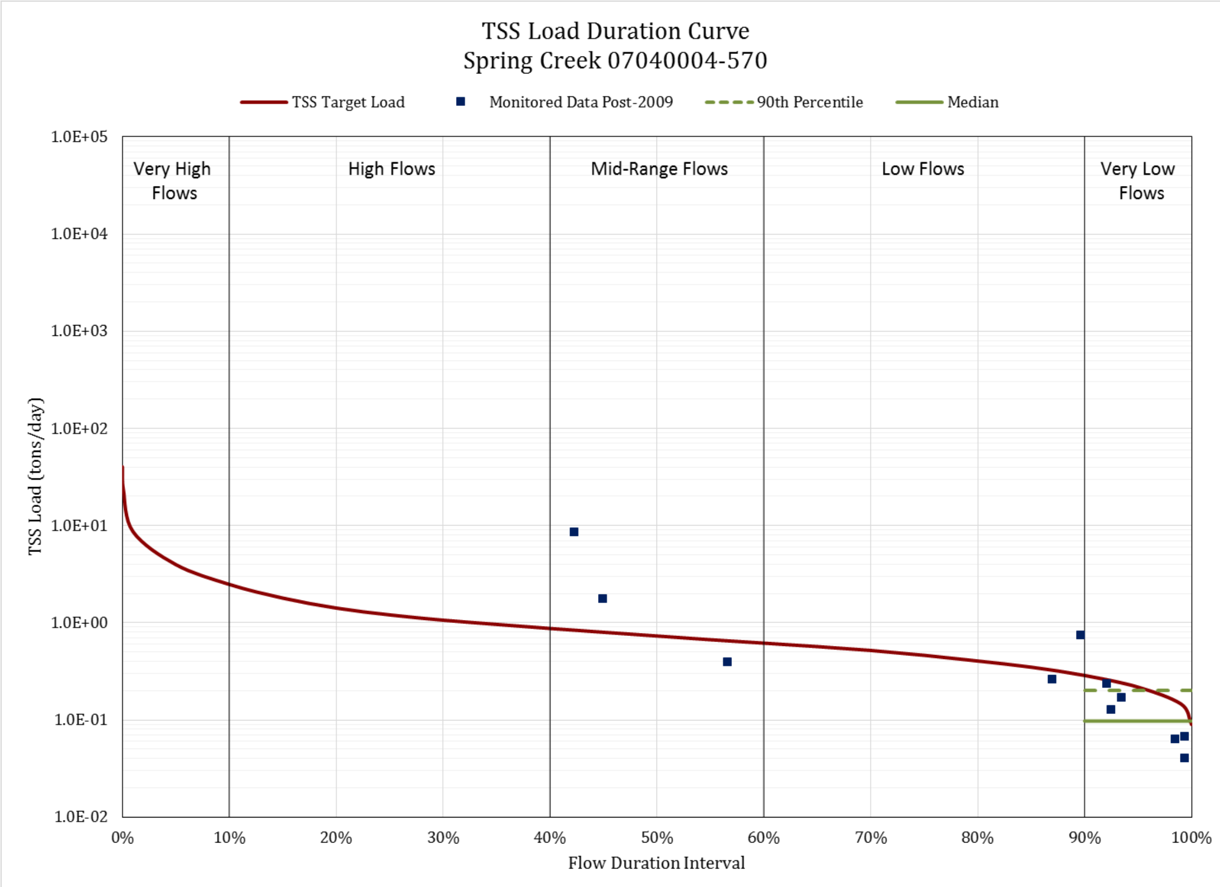

Figure 42. ZUMBRO RIVER HUC-10: Load Duration Curve with water quality data TSS loads for Spring Creek – 07040004-570. WQ Standard is 10 mg/L.

Table 51. ZUMBRO RIVER HUC-10: TMDL Summary for Spring Creek – 07040004-570.

Spring Creek 07040004-570 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		3.97	1.21	0.73	0.46	0.22
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.004	0.001	0.001	0.0004	0.0002
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.004	0.001	0.001	0.0004	0.0002
Load Allocation		3.57	1.08	0.66	0.42	0.20
10% Margin of Safety		0.40	0.12	0.07	0.05	0.02

* No permitted wastewater facilities within reach drainage area

** No permitted individual stormwater facilities within reach drainage area

*** No current MS4 communities within reach drainage area

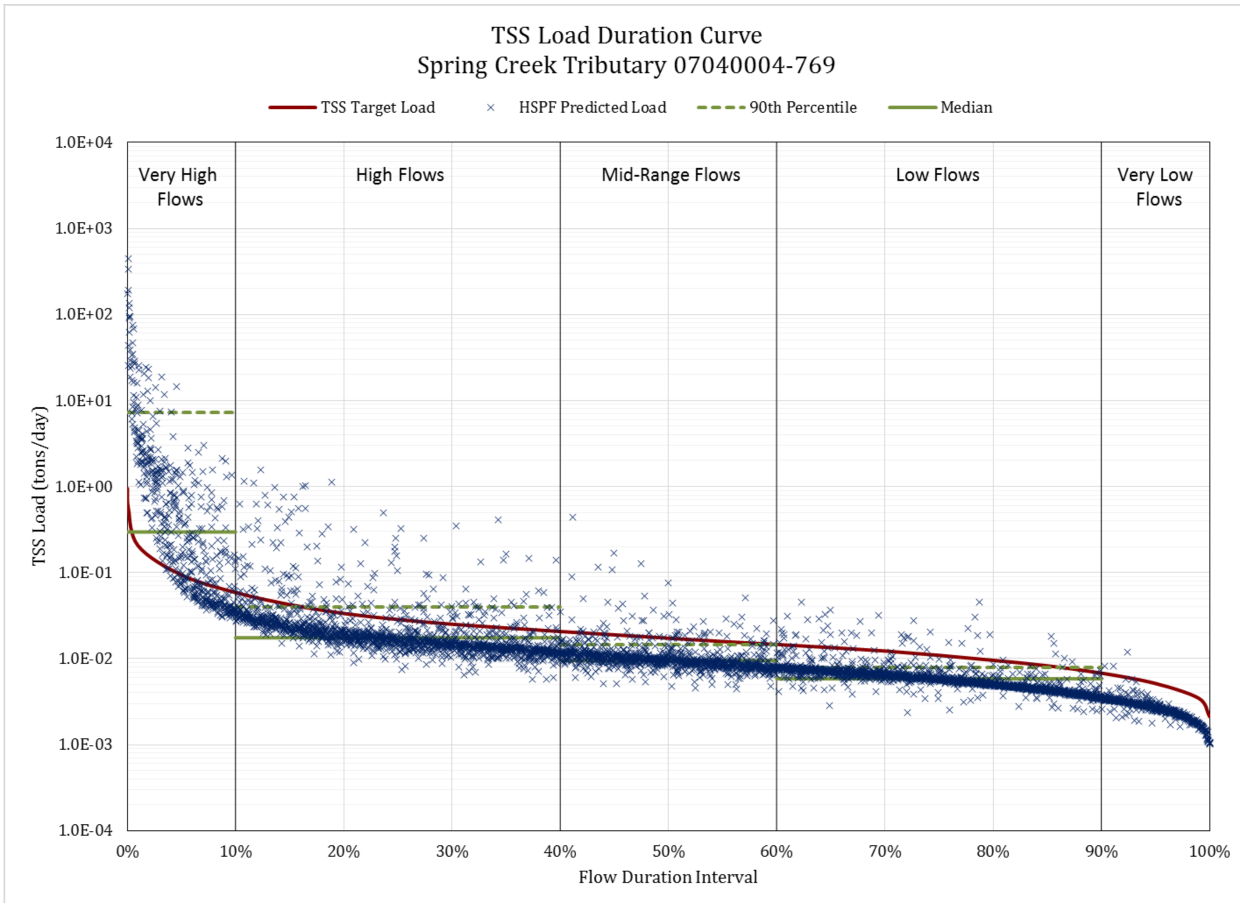

Figure 43. ZUMBRO RIVER HUC-10: Load Duration Curve for Spring Creek Tributary – 07040004-769. WQ Standard is 10 mg/L.

Table 52. ZUMBRO RIVER HUC-10: TMDL Summary for Spring Creek Tributary – 07040004-769.

Spring Creek Tributary 07040004-769 TMDL Summary		Flow Regime				
		VHigh	High	Mid	Low	VLow
		tons/day				
TSS Loading Capacity (TMDL)		0.09	0.03	0.02	0.01	0.01
Wasteload Allocation (WLA) Components	Permitted Municipal and Industrial Wastewater Facilities*	NA	NA	NA	NA	NA
	Permitted Industrial Stormwater Facilities**	NA	NA	NA	NA	NA
	Construction and Industrial Stormwater	0.0001	0.00003	0.00002	0.00001	0.000005
	MS4***	NA	NA	NA	NA	NA
	Total WLA	0.0001	0.00003	0.00002	0.00001	0.000005
Load Allocation		0.08	0.03	0.02	0.01	0.005
10% Margin of Safety		0.01	0.003	0.002	0.001	0.001

* No permitted wastewater facilities within reach drainage area

** No permitted individual stormwater facilities within reach drainage area

*** No current MS4 communities within reach drainage area

5 Future Growth Considerations

5.1 New or Expanding Permitted MS4 WLA Transfer Process

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

1. New development occurs within a regulated MS4. Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.
2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.
3. One or more non-regulated MS4s become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.
4. Expansion of a U.S. Census Bureau Urban Area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an Urban Area at the time the TMDL was completed, but are now inside a newly expanded Urban Area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related point source is identified and is covered under a NPDES Permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

5.2 New or Expanding Wastewater (TSS and *E. coli* TMDLs only)

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

For more information on the overall process, visit the MPCA's TMDL Policy and Guidance webpage.

6 Reasonable Assurance

Reasonable assurance that water quality in the ZRW will be improved is formulated on the following points:

1. Availability of reliable means of addressing pollutant loads (i.e. best management practices (BMPs), NPDES Permits);
2. A means of prioritizing and focusing management;
3. Development of a strategy for implementation;
4. Availability of funding to execute projects;
5. A system of tracking progress and monitoring water quality response.
6. Nonpoint source pollution reduction examples at multiple scales.

Accordingly, the following summary provides reasonable assurance that implementation will occur and result in pollutant load reductions in the ZRW.

- **Availability of reliable means of addressing pollutant loads:** Reliable means of addressing nonpoint source pollutant loads are fully addressed in the ZRW WRAPS Report, a document that is written to be companion to the TMDLs. As described in the WRAPS text, the BMPs (for both phosphorus and nitrogen reduction) included there have all been demonstrated to be effective in reducing transport of pollutants to surface water. The combinations of BMPs discussed throughout the WRAPS process were derived from Minnesota's NRS and related tools. As such, they were vetted by a statewide engagement process prior to being applied in the ZRW. They are practices that are supported by the basic programs administered by the SWCDs and the NRCS. Local resource managers are well-trained in promoting, placing and installing these BMPs. Some watershed counties have shown significant levels of adoption of these practices. Throughout the course of WRAPS and TMDL meetings local stakeholders endorsed these BMPs which constitute the standard means of addressing reductions in both runoff pollutant loads (i.e. phosphorus, sediment and even pathogens, which all share many sources and transport mechanisms) and pollutant loads delivered via vertical leaching to tiles or groundwater (e.g. nitrates). The WRAPS also takes great care in describing example scales of adoption that will attain pollutant reduction goals and entities with primary responsibility for implementation of strategies and programs.

  All municipal and industrial NPDES Wastewater Permits in the watershed will reflect limits derived from WLAs described herein. The MPCA's MS4 General Permit requires MS4 permittees to provide reasonable assurances that progress is being made toward achieving all WLAs in TMDLs approved by the EPA prior to the effective date of the permit. In doing so, they must determine if they are currently meeting their WLA(s). If the WLA is not being achieved at the time of application, a compliance schedule is required that includes interim milestones, expressed as BMPs, that will be implemented over the current five-year permit term to reduce loading of the pollutant of concern in the TMDL. Additionally, a long-term implementation strategy and target date for fully meeting the WLA must be included.

  Water Quality Trends for Minnesota Rivers and Streams at Milestone Sites notes that sites across Minnesota, including the Zumbro River, show significant reductions over the period of record for TSS, phosphorus, ammonia and biochemical oxygen demand (MPCA 2014d). *The Minnesota NRS* documented a 33% reduction of the phosphorus load leaving the state via the Mississippi River from the pre-2000 baseline to current (MPCA 2014e). These reports generally agree that while further reductions are needed, municipal and industrial phosphorus loads as well as loads of runoff-driven pollutants (i.e. TSS and TP) are decreasing; a conclusion that lends assurance that the ZRW WRAPS and TMDL phosphorus goals and strategies are reasonable and that long-term, enduring efforts to decrease erosion and nutrient loading to surface waters have the potential for positive impacts.

- **Means of prioritizing and focusing management:** The WRAPS details a number of tools that provide means for identifying priority pollutant sources and focusing implementation work in the watershed. These include but are not limited to the HSPF model, a detailed inventory of existing BMPs and the "fifty sites" project in the Middle Fork ZRW. Prioritization improves the likelihood that water quality improvements will occur. Further, LGUs in the ZRW often employ their own local analysis for determining priorities for work:
    - The state of Minnesota has provided tools to further the buffer initiative; they are being used in the implementation planning process to examine riparian land use in the ZRW, and prioritize potential buffer installation.
    - Light Detection and Ranging (LIDAR) data are available for all of southeast Minnesota, and being increasingly used by LGUs to examine landscapes, understand water flow and dynamics, and accordingly prioritize BMP targeting.
- **Strategy for implementation**: the WRAPS, TMDLs and all supporting work provides a foundation for local water planning in the ZRW. Subsequent planning (e.g. local water planning or development of a "One Water-One Plan" for the ZRW) will draw on the goals, strategies, technical information, and built tools to determine more detailed strategies and more specific actions for implementation. For the purposes of TMDL reasonable assurance, the WRAPS document is sufficient in that it provides strategies that in combination show examples of pollutant reduction goal attainment.
- **Availability of funding to execute projects**: On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the constitution to:
    - protect drinking water sources;
    - protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat;
    - preserve arts and cultural heritage;
    - support parks and trails; and
    - protect, enhance, and restore lakes, rivers, streams, and GW.

  This is a secure funding mechanism with the explicit purpose of supporting water quality improvement projects. Additionally, there are many other funding sources for nonpoint pollutant reduction work; they include but are not limited to EPA Clean Water Act Section 319 and the various NRCS programs.
- **System of tracking progress and monitoring water quality response**: Monitoring components in the CRW are diverse and constitute a sufficient means for tracking progress and supporting adaptive management. See Chapter 7.

- **Additional nonpoint source pollution reduction examples at multiple scales:**

Statewide implementation, including the ZRW: The Buffer Initiative was signed into law by Governor Dayton in June 2015 (amended by the Legislature and signed into law by Governor Dayton on April 25, 2016). It provides clarification regarding which waters need buffers, a timeline for implementing them, and tools for local government units to use in tracking and reporting compliance. http://www.bwsr.state.mn.us/buffers/

Statewide implementation, including the ZRW: Minnesota was awarded a $500 million Conservation Reserve Enhancement Program (CREP) funding that when implemented will convert approximately 60,000 acres of land to perennial cover (perpetual easements). The proposal indicates that "riparian areas and marginal agricultural land" will be targeted. This aligns precisely with statewide and ZRW strategies focused on converting marginal lands to perennials to reduce pollutant loading to surface and groundwater.

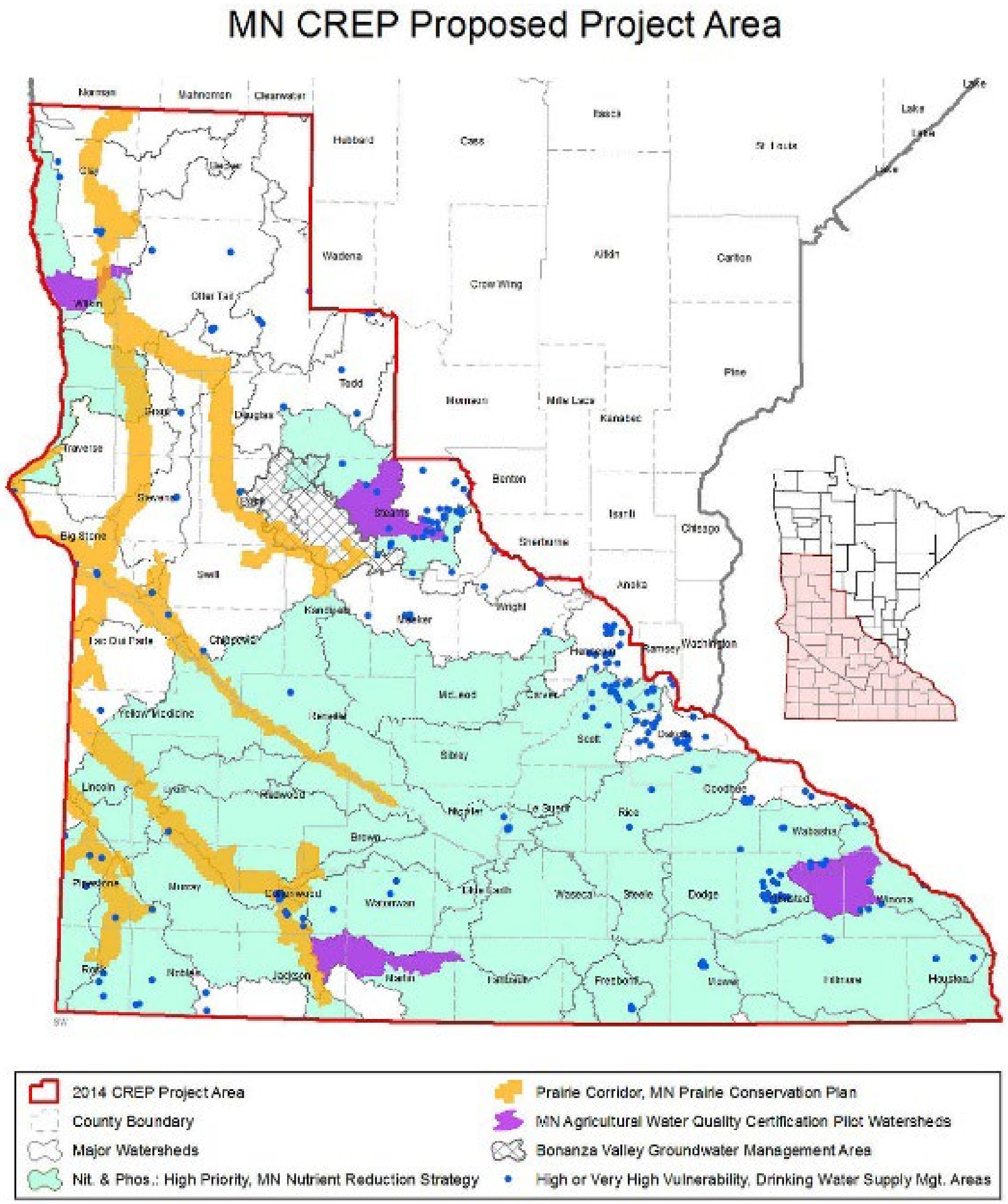

Figure 44. Minnesota CREP map (from BWSR website).

Regional implementation, including the ZRW: The Southeast Minnesota Water Resources Board has coordinated acquisition of EPA Section 319 funding to fix small (non-permitted) feedlots in southeast Minnesota. In 2001, LGUs estimated that 3,357 feedlots less than 300 AUs were likely to pose pollution hazards. After multiple grant cycles and focused effort by LGUs, the 2017 estimate was that less than 400 such feedlots pose pollution hazards. Of the 3,000 feedlots that no longer pose pollution hazards, approximately half went out of business and half were improved to mitigate pollution hazard (Linda Dahl, personal communication 2017).

Regional implementation, including the ZRW: Southeast Minnesota has proven to be a leader in addressing unsewered communities, which can be sources of nutrients and pathogens to surface waters. The Southeast Minnesota Wastewater Initiative (SEMWI, http://crwp.net/sewersquad/) has helped 25 small communities upgrade their sewer systems, eliminating 355,090 gallons of untreated sewage per day (129 million gallons per year) from entering the lakes, streams, and rivers of Southeast Minnesota (Aaron Wills, personal communication 2017). This work was recognized by an award from the Bush Foundation in 2014.

Local tool development in ZRW: The SWCDs in the ZRW have mapped structural BMPs and delineated the drainage areas treated by each. This planning tool serves to confirm the work completed to date and provide guidance regarding focus areas for new BMPs, as well as potential BMP maintenance/cleanout needs.

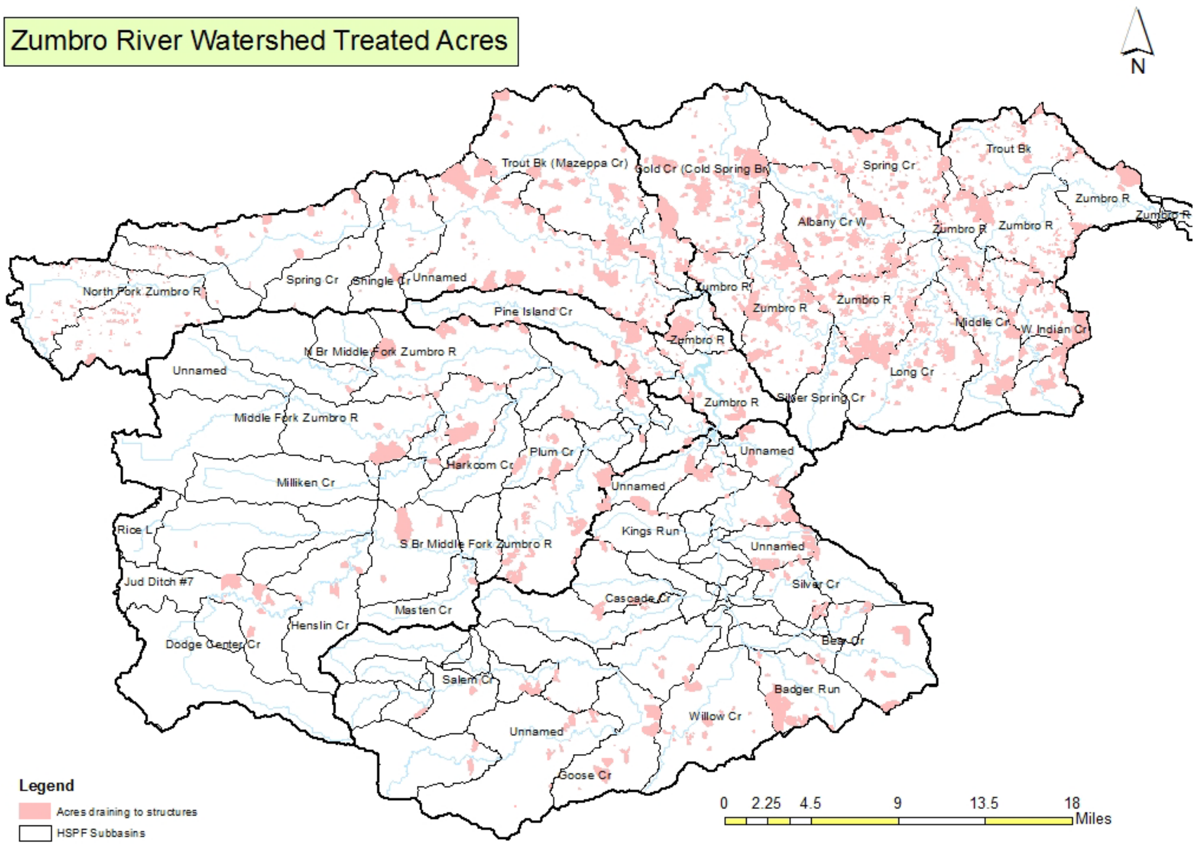

Figure 45. ZRW BMP inventory.

Local tool development and implementation in ZRW: The *Identifying Priority Erosion Sites* (IPES) project, funded by a grant from the Legislative Citizen Commission on Minnesota Resources (LCCMR) and managed by the Zumbro Watershed Partnership, provided a tool for local SWCDs to identify and prioritize erosion sites in their counties. Barr Engineering and University of Minnesota's Dr. David Mulla implemented the technical components of the project using high-resolution GIS mapping data to identify which parts of the ZRW could have the biggest erosion problems. The project was completed on July 31, 2014, with the publishing of a final report and operations manual that local SWCDs can use to address erosion problems in their counties. Documents, maps and lists of priority erosion sites in the ZRW were forwarded to SWCDs. This tool has already been used to secure project funding (Dodge County) to reduce sediment and nutrient loading in the ZRW.

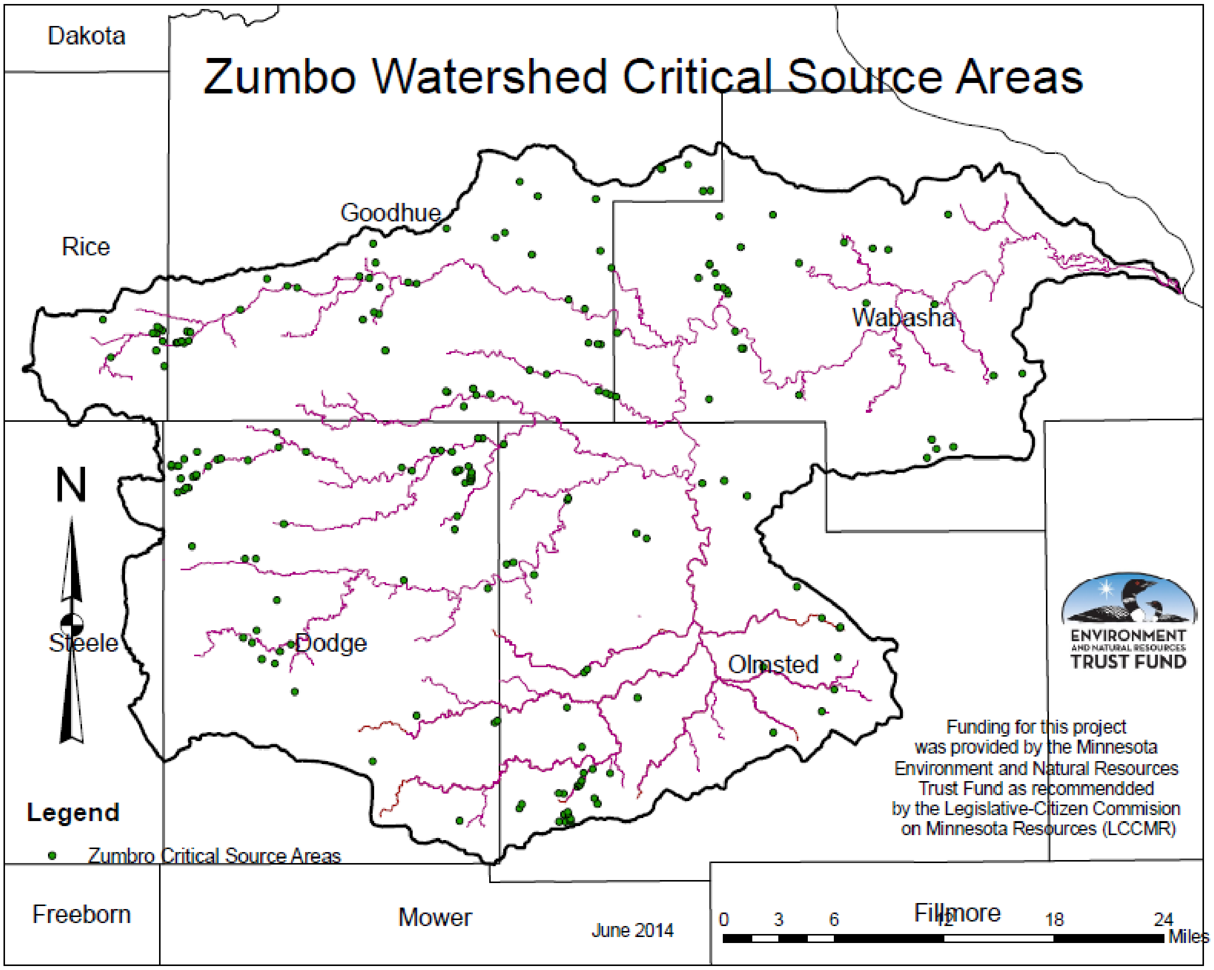

Figure 46. Critical source areas for sediment reduction.

Local implementation in the ZRW: LGUs and DNR have initiated a stream restoration on Cascade Creek 07040004-991 that aims to provide floodplain reconnection and improve habitat and channel stability.

Figure 47. Cascade Creek stream restoration project photo (photo from DNR).

Local implementation in the ZRW: The city of Rochester is using EPA Section 319 funds to implement a "volume, TSS and fecal coliform Reduction" project, focused on reducing pollutant loads to the receiving waters for downtown Rochester by identifying feasible volume control locations, and demonstrating green infrastructure designs, benefits, and maintenance practices before redevelopment opportunities arise.

Figure 48. Impaired waters in Rochester.

In summary, significant time and resources have been devoted to identifying the best BMPs, providing means of focusing them in southeast Minnesota and in the ZRW, and supporting their implementation via state initiatives and dedicated funding. The ZRW WRAPS and TMDLs process engaged partners to arrive at reasonable examples of BMP combinations that attain pollutant reduction goals. Minnesota is a leader in watershed planning as well as monitoring and tracking progress toward water quality goals and pollutant load reductions. Finally, examples cited herein confirm that BMPs and restoration projects have proven to be effective over time and as stated by the State of Minnesota Court of Appeals in A15-1622 MCEA vs MPCA and MCES:

- *We conclude that substantial evidence exists to conclude that voluntary reductions from nonpoint sources have occurred in the past and can be reasonably expected to occur in the future. The Nutrient Reduction Strategy (NRS) [...] provides substantial evidence of existing state programs designed to achieve reductions in nonpoint source pollution as evidence that reductions in nonpoint pollution have been achieved and can reasonably be expected to continue to occur.*

7 Monitoring Plan

Future monitoring in the ZRW will be according to the watershed approach framework. The IWM strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse scale to a fine scale. The foundation of this comprehensive approach is the 80 major watersheds within Minnesota. IWM occurs in each major watershed once every 10 years (MPCA 2012). The ZRW Monitoring and Assessment Report provides detailed discussion of IWM and how it will be applied going forward (it will be repeated in ZRW in 2022).

Load monitoring at State Highway 61 at Kellogg (S004-384) and at the pour points of each fork is on-going, and will be used to track reductions in pollutant loads in the ZRW; these sites are instrumented and gauged to track flow volumes, and are intensively monitored by the MPCA staff and partners. Site locations and loading data can be viewed at the MPCA web site: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network

Further, the *Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota* includes a monitoring section that describes activities and responsibilities pertaining to the greater regional examination of pathogens in surface water, of which ZRW is a part.

The Lake Zumbro Improvement Association monitors water clarity in the reservoir (i.e. Citizen Lake Monitoring and Citizen Stream Monitoring Programs); the DNR monitors water clarity in Rice Lake; these are important on-going records useful in trend analysis (see WRAPS document).

Focused Monitoring and Research Needs

In addition to monitoring for both assessment and effectiveness purposes, there are research needs to better understand pollutant loads and dynamics in the ZRW. Streamflow monitoring, GW level monitoring, and aquifer tests in the trout stream watersheds may further form the basis for protection strategies for these waters. Regarding pathogens, the *Revised Regional TMDL Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota Implementation Plan* notes that research needs include, but are not limited to:

- Study of sources of pathogens in cities and urban areas;
- Better understanding of load reduction capabilities for applicable structural and non-structural BMPs;
- Models to evaluate loading sources and track load reductions;
- Methods to evaluate pollutant migration pathways and delivery mechanisms from pathogen sources to surface waters, both generally and in karsted landscapes; DNA "fingerprinting" to identify pathogen sources.

The Sediment Reduction Component of the Zumbro Watershed Comprehensive Management Plan includes substantial discussion regarding research needs (https://www.pca.state.mn.us/sites/default/files/wq-iw9-13c.pdf).

8 Implementation Strategy Summary

8.1 Permitted Sources

8.1.1 Construction Stormwater

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

8.1.2 Industrial Stormwater

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

8.1.3 MS4

The MPCA oversees all regulated MS4 entities in stormwater management accounting activities. All regulated MS4s in the watershed fall under the category of Phase II. The MS4 NPDES/SDS Permits require regulated municipalities to implement BMPs to reduce pollutants in stormwater runoff to the maximum extent practicable.

All owners or operators of regulated MS4s (also referred to as "permittees") are required to satisfy the requirements of the MS4 General Permit. The MS4 General Permit requires the permittee to develop a Stormwater Pollution Prevention Program (SWPPP) that addresses all permit requirements, including the following six minimum control measures:

- Public education and outreach
- Public participation

- Illicit Discharge Detection and Elimination (IDDE) Program
- Construction-site runoff controls
- Post-construction runoff controls
- Pollution prevention and municipal good housekeeping measures

A SWPPP is a management plan that describes the MS4 permittee's activities for managing stormwater within their jurisdiction or regulated area. In the event a TMDL study has been completed, approved by the EPA prior to the effective date of the general permit, and assigns a WLA to an MS4 permittee, that permittee must document the WLA in their application and provide an outline of the BMPs to be implemented in the current permit term to address any needed reduction in loading from the MS4.

The MPCA requires applicants submit their application materials and SWPPP document to the MPCA for review. Prior to extension of coverage under the general permit, all application materials are placed on 30-day public notice by the MPCA, to ensure adequate opportunity for the public to comment on each permittee's stormwater management program. Upon extension of coverage by the MPCA, the permittees are to implement the activities described within their SWPPP, and submit annual reports to the MPCA by June 30 of each year. These reports document the implementation activities, which have been completed within the previous year, analyze implementation activities already installed, and outline any changes within the SWPPP from the previous year.

8.1.4 Wastewater

The MPCA issues permits for WWTFs that discharge into waters of the state. The permits have site specific limits that are based on water quality standards. Permits regulate discharges with the goals of 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. In addition, SDS Permits set limits and establish controls for land application of sewage.

8.2 Non-Permitted Sources

8.2.1 Adaptive Management

The response of the lakes and streams will be evaluated as management practices are implemented. The management approach to achieving the goals should be adapted as new information is collected and evaluated. This list of implementation elements and the more detailed WRAPS report that is being prepared concurrent to this TMDL assessment focuses on adaptive management Figure 49. Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL. Management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired water bodies.

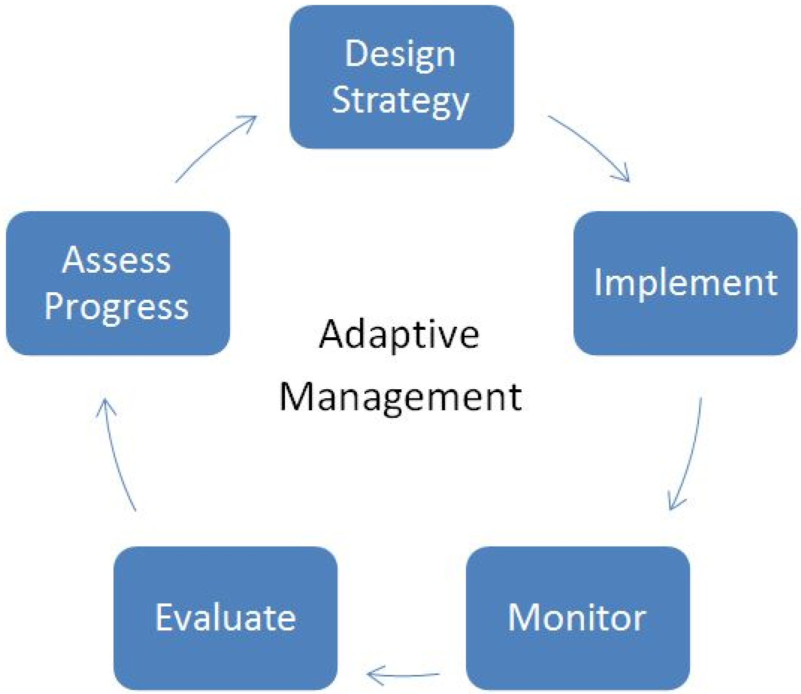

Figure 49. Adaptive Management

8.2.2 Best Management Practices

A variety of BMPs to restore and protect the lakes and streams within the ZRW are outlined in the WRAPS report.

8.2.3 Education and Outreach

A crucial part in the success of the WRAPS report, that is designed to clean up the impaired lakes and streams and protect the non-impaired water bodies, will be participation from local citizens. In order to gain support from these citizens, education and civic engagement opportunities will be necessary. A variety of educational avenues can and will be used throughout the watershed (see Public Participation section). These include, but are not limited to, press releases, meetings, workshops, focus groups, trainings, websites, etc. Local staff (SWCD, county, etc.) and board members work to educate the residents of the watersheds about ways to clean up their streams on a regular basis. Education and engagement will continue throughout the watershed.

8.2.4 Technical Assistance

The cities, counties and SWCDs within the watershed assist landowners for a variety of projects that benefit water quality. Assistance provided to landowners varies from agricultural to rural to urban BMPs. This technical assistance includes education and one-on-one training. It is important that outreach opportunities for watershed residents continue. Marketing is necessary to motivate landowners to participate in voluntary cost-share assistance programs.

Programs, such as Clean Water Legacy funding, Environmental Quality Incentives Program (EQIP), and Conservation Reserve Program (CRP), are available to help implement the best conservation practices that each parcel of land is eligible for to target the best conservation practices per site. Conservation practices may include, but are not limited to stormwater bioretention, septic system upgrades, feedlot improvements, invasive species control, wastewater treatment practices, as well as agricultural and rural BMPs. More information about types of practices and implementation of BMPs are discussed in the ZRW WRAPS Report.

8.2.5 Partnerships

Partnerships with counties, cities, townships, citizens, businesses, and Zumbro Watershed Partnership are mechanisms through which watershed partners will protect and improve water quality. Strong partnerships with state and local government to protect and improve water resources and to bring waters within the ZRW into compliance with State standards will continue. A partnership with LGUs and regulatory agencies such as cities, townships and counties may be formed to develop and update ordinances to protect the area's water resources.

8.3 Cost

The CWLA requires that a TMDL include an overall approximation of the cost to implement a TMDL [Minn. Stat. 2007 § 114D.25]. The initial estimate for implementing the Zumbro River Turbidity TMDLs ranged from approximately $140 to $170 million (citation: Zumbro Turbidity TMDLs).

While phosphorus and nitrogen are not pollutants addressed in the ZRW TMDLs, the following references of nonpoint source BMP implementation costs are useful in this context.

The ZRW WRAPS Report includes cost estimates for achieving 12% reductions of phosphorus loading and 20% reductions of nitrogen loading for five HUC-10 subwatersheds. These nutrient reduction goals are consistent with Minnesota's NRS and include nonpoint source measures only. The cost of the phosphorus BMPS at the HUC-10 scale range from $0 (savings of $105,000 due to input reductions) to $700,000 to achieve 12% reduction goal; the costs vary because suitable acres for different BMPs vary across the CRW and stakeholders described different combinations of BMPs that achieve the reduction goal. Regarding nitrogen, the BMP spreadsheets indicate that to achieve a 20% reduction of loading at the HUC-10 scale the costs range from $600,000 to $1.4 million.

Applying the BMP spreadsheets (see WRAPS document for more detail) at the HUC-8 scale indicates that a 12% reduction of phosphorus loading would cost approximately $1 million and a 20% reduction of nitrogen loading would cost approximately $2.3 million; both estimates generally agree with the sums of the respective HUC-10 estimates.

Internal phosphorus load management measures have been effective in temporarily attaining water quality goals in Rice Lake through water level management to foster aquatic plants and manage fish populations. In recent years, biomanipulations have included stocking northern pike as a predator fish. Executing and maintaining minor drawdowns costs approximately $500 to $1000 per year, and implementing periodic rough fish removal (every 3 to 5 years) costs approximately $1500. Fish toxicants have been used in conjunction with drawdown on similar lakes to attain more complete rough fish removal and potentially, longer lived benefits and may be considered for Rice Lake in the future. A chemical reclamation is estimated to cost about $50,000 (Jeanine Vorland, personal communication 2017).

TSS and pathogen TMDLs typically do not have significant impacts for municipal and industrial wastewater dischargers in Minnesota because in nearly every case the discharge permits include TSS and *E. coli* limits that are equal to or less than the respective water quality standards for the impaired waters. Because there are already approved TSS and *E. coli* impairments downstream of all the watershed Municipal Separate Storm Sewer Systems (MS4s) their permits/Stormwater Pollution Prevention Plans (SWPPPs) should already reflect BMPs to address these pollutants. As such, the new MS4 WLAs noted in Table 13 will require consideration but will be added to existing lists of downstream WLAs for TSS and *E. coli*. The initial estimate for implementing Lower Mississippi River Basin Fecal Coliform TMDL was $240 million; the ZRW is approximately 20% of the basin and given the regional and ubiquitous nature of pathogen impairments in southeast Minnesota a 20% apportionment of the overall cost is a reasonable estimate for addressing the issue at the HUC-8 ZRW scale.

9 Public Participation

9.1 WRAPS and Watershed TMDLs Development

The WRAPS document describes in detail the civic engagement and public participation that were integral to development of the ZRW strategies for both restoration and protection.

The excerpt below describes outreach efforts and meetings that were held regarding TMDLs and WRAPS.

WRAPS Planning and Process Design

The ZRW WRAPS development began with a 'kick off' meeting in March 2016, followed by three "lobe" meetings in June, August, and November 2016. The lobe meetings functioned as an update for the new watershed science that consisted of water quality impairments and modeling, geographically targeted sources of nutrient loading, and discussions of restoration and protection priorities and strategies. Guest speakers also made presentation at the lobe meetings on the status of Lake Zumbro, Rochester's storm water and WWTFs, and Discovery Farms' water quality monitoring. A finale meeting was held on January of 2017, where a draft section of the ZRW WRAPS was presented to attendees, followed by discussion and feedback on the document. All meeting agendas and presentation can be found on the ZWP web site under the WRAPS tab.

In 2013, prior to the WRAPS process, the consulting firm The Research Edge LLC was hired by the ZWP to assess the current knowledge and attitudes of ZRW residents. Participants of the survey resided within the watershed and were contacted via phone. The 'Information Sources' component of the survey revealed that watershed residents rely heavily on traditional media, with online or public forums as the strongest alternative to newspapers or magazines for local water quality and flooding issues. The stakeholder outreach conducted in the ZRW WRAPS reflects this preference.

Before commencing the ZRW WRAPS, several stakeholders within the ZRW assisted with the Cannon River Watershed WRAPS pilot. At the Cannon finale meeting, stakeholders completed a short survey on the WRAPS process. That feedback has been heavily incorporated into the ZRW WRAPS, specifically the depth of involvement with SWCDs, county staff, and agricultural industry representatives.

Stakeholder Outreach

The watershed approach and WRAPS have been frequently discussed in the ZRW. This has been done through a variety of mediums, both preceding and throughout the ZRW WRAPS process. The Zumbro Watershed Partnership hosts and promotes the free monthly *Waterways Speaker Series* in Rochester. This platform affords the public an opportunity to engage with scientists, managers, and commodity groups. Presenters discuss the watershed approach, innovative projects, and grass roots efforts within our region that promote cleaner water and reduce flooding.

Recent *Waterways Speaker Series* topics include:

- November 2016: *Mapping Our Way to Cleaner Water* presented by Bill Huber, DNR Buffer Mapping Hydrologist

- October 2016: *Farmer-led Solutions for Water Quality Improvement* presented by Jeremy Geske, Minnesota Agricultural Water Resource Center (MAWRC)
- November 2015: *Solutions to Stormwater Pollution* presented by Megan Moeller, Rochester Stormwater Educator
- February 2015: *How Farmers Are Protecting Water and Soil Resources* presented by Ryan Buck, Farm and President of the Minnesota Corn Growers
- December 2014: *A "Watershed Approach" to Restoring and Protecting the Zumbro* presented by Justin Watkins, MPCA
- February 2014: *Using Civic Engagement to Mobilize Clean Water Projects* presented by Barb Radke, University of Minnesota Extension

To best reach target audiences and stakeholders on watershed issues, monthly newspaper articles and the quarterly newsletter *The Zumbro River News* are published. Written by Kevin Strauss, ZWP Education Coordinator, these pieces highlight the watershed approach, provide updates on the ZRW WRAPS process and innovative water quality projects, and are a source for news on water and river issues. Both literary formats are distributed throughout the watershed. The monthly newspaper articles are published in community newspapers, whereas quarterly newsletter is distributed to ZWP members and community hubs (libraries, community centers, etc.), and posted on the ZWP website.

The ZWP website serves as a repository for the ZRW WRAPS information, including meeting announcements, contact information, and a WRAPS Library. The *Zumbro River Watershed Management Plan (2007 through 2012)* and *Zumbro River Watershed Interim Watershed Management Plan (2013)* can also be found at this site, along with related publications and reports, data and mapping, news articles, and web links (http://www.zumbrowatershed.org/).

Meetings

The ZWP served as both host and facilitator for meetings held throughout the WRAPS process (see Table 53). This convening of stakeholders offered valuable feedback and input from entities across the watershed. These meetings also functioned a platform to voice concerns, values, and priorities that then manifested into strategies that vary among each region of the ZRW.

The meetings highlighted in Table 53 were directly associated with building the WRAPS. Numerous watershed-wide meetings and initiatives preceded the ZRW's participation in, but greatly informed, the WRAPS process. These include, but are not limited to:

- March 2015: Minnesota Buffer Summit in Mazeppa, Minnesota
- 2012 to 2015: PAC (Project Advisory Committee) Meetings. Updates on watershed approach, modeling scenarios determined, etc.
- June 2012 to July 2014: *Slow the Flow* Educational Campaign (ZWP). This educational initiative was designed with short and long-term strategies to engage residents, LGUs, landowners, and businesses to take action to slow down and reduce the amount of water running into the Zumbro River. Part of this campaign resulted in the installation of 126 bridge signs, and 12 education signs throughout the watershed; the idea being, once you know the name of a creek, you can then begin to develop a relationship with it/foster stewardship.

- February 2015 MPCA Professional Judgment Group Meeting for Monitoring and Assessment, and Biological SID in the ZRW
- 2012 and 2013: TMDL meetings and Zumbro Watershed 1st and 2nd Colloquiums that manifested into the *Zumbro Watershed Management Plan: Sediment Reduction Component (2012)*, and the *Interim Zumbro Watershed Management Plan (2013)*

Lobe Meetings

Throughout the summer and fall of 2016, three lobe meetings were held. Subsequent follow-up consultations took place during that time with county, city, and SWCD staff, and crop consultants (see Table 53). This engagement was the primary source for stakeholder input for the ZRW WRAPS. Upon receiving an overview of the WRAPS tools (HSPF modeling, N and P BMP spreadsheets, and zonation), key end users collaborated to apply lobe-specific knowledge of resources to generate example combinations of BMPS that would result in attainment of nitrogen and phosphorus reduction goals.

Table 53. Zumbro WRAPS and TMDLs meeting summaries.

Date	Title/Topic	Attendees
November 20, 2014	ZWP Professional Advisory Group. Watershed stakeholders discussed several potential management or BMP scenarios that could be set-up and run with the ZRWHSPF model with LimnoTech consultants. A total of 10 scenarios were developed to estimate the effect of potential management practices on sediment and nutrient transport and delivery to local tributaries, Lake Zumbro, and the watershed outlet.	County, city, and SWCD staff; state agency staff; ZWP Board members and staff.
March 19, 2016	Zumbro WRAPS Kick Off Meeting. WRAPS and TMDL process overview. Lake Zumbro phosphorus impairment and BATHTUB modeling. HSPF model development and results. Overview of other tools and example WRAPS in Cannon.	County, city, and SWCD staff; elected officials; state agency staff; urban & rural residents; landowners; lakeshore residents; farmers; ZWP Board members; commodity group representatives; The Nature Conservancy
April 14th, 2016	ZWP Water Ways Speaker Series: *Choices, Choices: Deciding What's Important in the Zumbro Watershed* presented by Paul Wotzka, ZWP. What landscape features and conservations measures are most valued in the ZRW? Attendees filled out a questionnaire and ranked their priorities as part of the Zonation values-based modeling for ZRW WRAPS.	Urban and rural residents; farmers; academics; ZWP members and staff; county, city, and SWCD staff; elected officials; lakeshore residents
June 7th & 8th, 2016	1st Round Lobe Meetings: An overview of the Zumbro Watershed Management Plan (2013); lobe characteristics and impairments/stressors; Discovery Farms	County, city, and SWCD staff; elected officials; state agency staff; urban & rural residents; landowners; lakeshore residents; farmers; ZWP Board

Date	Title/Topic	Attendees
	water quality research and programming; 1st round of HSPF modeling scenarios; Lake Zumbro BATHTUB modeling; results from Zonation survey/systematic conservation; Rochester WWTF history and overview; Lake Zumbro restoration approach.	members; commodity group representatives; The Nature Conservancy
June 9th, 2016	ZWP Water Ways Speaker Series: *SimZumbro: High Tech Tools for Cleaner Water* presented by Ben Roush, MPCA. An overview of water quality models (HSPF), how they can incorporate changes in land use and BMPs, and management scenarios developed to realize these changes.	Urban and rural residents; farmers; academics; ZWP members and staff; county, city, and SWCD staff; elected officials; lakeshore residents
July 19, 2016	BMP Tool Meeting with Crop Consultants: An overview of the N/P BMP Tool & applications in the ZRW; discussion of U of MN approach (BMP Tool) versus IA & IL, and are the BMP Tool assumptions made realistic	Crop consultants from the ZRW
August 9th & 10th, 2016	2nd Round Lobe Meetings: Review of sources & pathways of sediment & nutrients in ZRW; soil organic matter – importance & how it is gained/lost; nutrient & sediment reduction goals; application of N/P BMP Tool; review of HSPF & 2nd wave of scenarios	County, city, and SWCD staff; elected officials; state agency staff; urban & rural residents; landowners; lakeshore residents; farmers; ZWP Board members; commodity group representatives; The Nature Conservancy
August 24, 2016	Cover Crop & Strip Till Demo Day: ZRW farmer-led tour of effective agricultural conservation practices and challenges. The ZWP had an informational ZWR WRAPS booth at this event.	Farmers; landowners; urban and rural residents; county & SWCD staff; commodity group representatives
September 7th, 2016	Applications of the N/P BMP Tool Meeting – Wabasha County	ZWP and MPCA staff met with SWCD & county staff
September 8th, 2016	Applications of the N/P BMP Tool Meeting – Dodge County	ZWP and MPCA staff met with SWCD & county staff
September 14, 2016	Applications of the N/P BMP Tool Meeting – Goodhue County	ZWP and MPCA staff met with SWCD & county staff
September 15, 2016	Applications of the N/P BMP Tool Meeting – Olmsted County	ZWP and MPCA staff met with SWCD & county staff
November 15th & 16th, 2016	3rd Round Lobe Meeting: Protection strategies – fully supporting waters, drinking water, DNR protection efforts; Review of N/P BMP Tool summary tables and revised Zonation Priority Area Maps	County, city, & SWCD staff; elected officials; state agency staff; urban & rural residents; landowners; lakeshore residents; farmers; ZWP Board members; commodity group

Date	Title/Topic	Attendees
	from meetings with counties; summary and update on watershed TMDLs	representatives; The Nature Conservancy
December 14th, 2016	Meeting with City of Rochester (MS4): Discussion of WRAPS applications to an MS4, Zonation, and BMP Tools.	City of Rochester stormwater staff & MPCA staff
January 28th, 2017	ZRW WRAPS Finale Meeting: A review and discussion of draft sections of the ZRW WRAPS document and solicited feedback on the entire process. Detailed presentation of watershed TMDLs and discussion of site specific standard development for South Fork Zumbro River and Lake Zumbro.	County, city, & SWCD staff; elected officials; state agency staff; urban & rural residents; landowners; lakeshore residents; farmers; ZWP Board members; commodity group representatives; The Nature Conservancy
February 9, 2017	ZWP's Water Ways Speaker Series: BWSR 1W1P coordinator, Julie Westerlund, spoke about the 1W1P planning efforts and how it relates to the WRAPS.	Urban and rural residents; farmers; academics; ZWP members and staff; county, city, and SWCD staff; elected officials; lakeshore residents

Public Notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from August 21, 2017 through September 20, 2017.

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Appendix A

Aquatic Life Impairment Listings Not Addressed in this TMDL Report

Lobe	Reach Name	AUID or HUC	Designated Use	Bases for Aquatic Life Listing: MIBI Exceed Criteria?	FIBI Exceed Criteria?	Based on Turbidity Only?	New Data Confirm Use not Impaired	Non-pollutant Stresor(s)?	Insufficient Information to Link Stressor to a Pollutant	No Water Quality Standard for Identifed Stressor(s)	Notes	Proposed Category
Lower Zumbro	Cold Creek/Cold Spring	07040004-510	AQL	YES				Habitat				4c
Lower Zumbro	Trout Brook (Mazeppa Creek)	07040004-515	AQL	YES				Habitat				4c
Lower Zumbro	Trout Brook (Dumfries)	07040004-585	AQL		YES			Habitat				4c
Middle Fork Zumbro	Unnamed Creek	07040004-578	AQL	YES				Habitat & flow alteration		Nitrate		5
Middle Fork Zumbro	Henslin Creek	07040004-618	AQL	YES						Nitrate		5
Middle Fork Zumbro	Middle Fork	07040004-973	AQL	YES						Nitrate		5
Middle Fork Zumbro	North Fork Middle Branch Zumbro	07040004-975	AQL			Yes	•					list correct
Middle Fork Zumbro	SMBF Zumbro (DC Creek to Oxbow)	07040004-976	AQL	YES							Approved TSS TMDL (conclusive stressor); no other stressors identified.	4a
Middle Fork Zumbro	SBMF Zumbro (DS rice lake)	07040004-980	AQL	YES				Habitat & flow alteration				4c
Middle Fork Zumbro	Judicial Ditch 1	07040004-987	AQL	YES				Habitat & flow alteration	Dissolved Oxygen	Nitrate	Dissolved oxygen stressor not conclusively linked to phosphorus load; no TMDLs for other stressors.	5
Middle Fork Zumbro	JD 1	07040004-988	AQL	YES	YES			Habitat & flow alteration		Nitrate		5
Middle Fork Zumbro	Dodge Center Creek	07040004-989	AQL	YES				Habitat			TSS TMDL for this AUID per SID; other stressors are not pollutants.	4a
North Fork Zumbro	Shingle Creek	07040004-562	AQL	YES						Nitrate		5
North Fork Zumbro	Spring Creek	07040004-568	AQL	YES				Temperature			TSS TMDL for this AUID per SID; other stressors are not pollutants.	4a
North Fork Zumbro	Spring Creek	07040004-570	AQL		YES			Habitat			TSS TMDL for this AUID per SID; other stressors are not pollutants.	4a
North Fork Zumbro	Unnamed Creek	07040004-579	AQL	YES				Habitat				4c
North Fork Zumbro	Unnamed creek (Spring Creek Tributary)	07040004-605	AQL	YES						Nitrate		5
North Fork Zumbro	Silver Creek/Spring Creek	07040004-606	AQL	YES				Habitat	Dissolved Oxygen	Nitrate	Dissolved oxygen stressor not conclusively linked to phosphorus load; no TMDLs for other stressors.	5
North Fork Zumbro	Unnamed creek	07040004-964	AQL	YES				Habitat		Nitrate		5
North Fork Zumbro	Zumbro River, North Fork	07040004-971	AQL	YES				Habitat			TSS TMDL for this AUID; new listing, but also confirmed TSS stressor per SID; other stressors are not pollutants.	4a
South Fork Zumbro	Salem Creek	07040004-503	AQL	YES				Habitat		Nitrate		5
South Fork Zumbro	Zumbro River, South Fork	07040004-507	AQL	YES				Habitat & flow alteration			Approved TSS TMDL; other stressors are not pollutants; site specific river eutrophication standad in development (RES listing should remain in category 5).	4a
South Fork Zumbro	South Fork Zumbro	07040004-534	AQL	na	na	Yes	•					list correct
South Fork Zumbro	Zumbro River, South Fork	07040004-536	AQL	YES				Habitat			Approved TSS TMDL; other stressors are not pollutants.	4a
South Fork Zumbro	Bear Creek	07040004-538	AQL			Yes	•					list correct
South Fork Zumbro	Bear Creek	07040004-539	AQL			Yes	•					list correct
South Fork Zumbro	Cascade Creek	07040004-581	AQL	YES				Habitat & flow alteration			Approved TSS TMDL; other stressors are not pollutants.	4a
South Fork Zumbro	Salem Creek Trib	07040004-597	AQL	YES	YES			Habitat & flow alteration		Nitrate		5
South Fork Zumbro	Unnamed Creek (Kings Run)	07040004-601	AQL	na	na	Yes	•					list correct
South Fork Zumbro	Badger Run	07040004-620	AQL		YES			Habitat & flow alteration				4c
South Fork Zumbro	Unnamed Creek	07040004-621	AQL		YES			Habitat, and flow alteration				4c
South Fork Zumbro	Unnamed Creek (Trib to Willow)	07040004-800	AQL	YES	YES			Habitat & flow alteration/connectivity				4c
South Fork Zumbro	Unnamed Creek (Willow)	07040004-986	AQL			Yes	•					list correct
South Fork Zumbro	Cascade Creek	07040004-991	AQL		YES			Habitat & flow alteration			Approved TSS TMDL; other stressors are not pollutants.	4a

Appendix B

Individual WWTF's WLAs

As previously stated in Section 4.3.3, Bacteria impaired AUIDs in this TMDL report are for *E. coli*, and as such, WLAs are based on an *E. coli* standard. However, permit limits continue to be expressed as fecal coliform bacteria, which is 200 organisms/100mL. Facilities receiving a bacteria WLA will need to comply with the fecal coliform standard as specified in their permit. For the sake of these summary tables, facility WLAs are expressed as an *E. coli* limit and are assumed to be the equivalent to 200 organisms/100mL of fecal coliform.

Table 54. Individual WLAs for permitted facilities discharging to Zumbro River – 07040004-973.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	*E. coli* Load (billion organisms/day)
West Concord WWTP	MN0025241	0.473	126	2.26
TOTAL		-	-	**2.26**

Table 55. Individual WLAs for permitted facilities discharging to Zumbro River – 07040004-992.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	*E. coli* Load (billion organisms/day)
Pine Island WWTP	MN0024511	0.705	126	3.36
West Concord WWTP	MN0025241	0.473	126	2.26
TOTAL		-	-	**5.62**

Table 56. Individual WLAs for permitted facilities discharging to Trout Brook – 07040004-515.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	*E. coli* Load (billion organisms/day)
Goodhue WWTP	MN0020958	0.099	126	0.47
TOTAL		**-**	**-**	**0.47**

Table 57. Individual WLAs for permitted facilities discharging to Zumbro River – 07040004-971.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	TSS Permit Limit (mg/L)	*E. coli* Load (billion organisms/day)	TSS Load (tons/day)
Kenyon WWTP	MN0021628	0.357	126	30	1.70	0.04
Mazeppa WWTP	MN0046752	0.073	126	30	0.35	0.01
Wanamingo WWTP	MN0022209	0.458	126	30	2.18	0.06
Zumbrota WWTP	MN0025330	1.110	126	30	5.29	0.14
TOTAL		-	-	-	**9.53**	**0.25**

Table 58. Individual WLAs for permitted facilities discharging to Zumbro River – 07040004-993.

NPDES Facility	NPDES No.	Design Flow (MGD)	TSS Permit Limit (mg/L)	TSS Load (tons/day)
Byron WWTP	MN0049239	1.400	30	0.18
Claremont WWTP	MN0022187	0.206	30	0.03
Dodge Center WWTP	MN0021016	0.973	30	0.12
Hayfield WWTP	MN0023612	0.780	30	0.10
Kasson WWTP	MN0050725	2.070	30	0.26
Mantorville WWTP	MN0021059	0.232	30	0.03
Pine Island WWTP	MN0024511	0.705	30	0.09
Stussy Construction Inc	MNG490134	0.540	30	0.07
West Concord WWTP	MN0025241	0.473	30	0.06
TOTAL		-	-	**0.92**

Table 59. Individual WLAs for permitted facilities discharging to Zumbro River – 07040004-978.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	*E. coli* Load (billion organisms/day)
Byron WWTP	MN0049239	1.400	126	6.68
Claremont WWTP	MN0022187	0.206	126	0.98
Dodge Center WWTP	MN0021016	0.973	126	4.64
Hayfield WWTP	MN0023612	0.780	126	3.72
Kasson WWTP	MN0050725	2.070	126	9.87
Mantorville WWTP	MN0021059	0.232	126	1.11
Stussy Construction Inc	MNG490134	0.540	NA	NA
TOTAL		-	-	**27.00**

Table 60. Individual WLAs for permitted facilities discharging to Dodge Center Creek – 07040004-989.

NPDES Facility	NPDES No.	Design Flow (MGD)	*E. coli* Permit Limit (MPN/100mL)	TSS Permit Limit (mg/L)	*E. coli* Load (billion organisms/day)	TSS Load (tons/day)
Claremont WWTP	MN0022187	0.206	126	30	0.98	0.03
Dodge Center WWTP	MN0021016	0.973	126	30	4.64	0.12
Hayfield WWTP	MN0023612	0.780	126	30	3.72	0.10
TOTAL		-	-	-	**9.34**	**0.25**