Turbidity TMDL for Chippewa River Watershed

Wenck File #2248-01

Prepared for:

Chippewa River Watershed Project
Minnesota Pollution Control Agency

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Table of Contents

<u>TABLES</u>

FIGURES

ACRONYMS

BEHI	Bank Erosion Hazard Index
BMP	Best management practice
BWSR	Board of Water and Soil Resources
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CRWP	Chippewa River Watershed Project
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
HHW	Household hazardous waste
HRU	Hydrologic Response Unit
JD	Jurisdictional ditch
LA	Load allocation
MGD	Million gallons per day
mg/L	Milligrams per liter
MOS	Margin of safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
MULSE	Modified Universal Soils Loss Equation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbidity unit
RC	Reserve capacity
STORET	Storage and retrieval (a data warehouse maintained by the EPA)
SWAT	Soil Water Assessment Tool
SWCD	Soil and Water Conservation District
TDLC	Total daily loading capacity
TMDL	Total maximum daily load
TSS	Total suspended solids
TSVS	Total Suspended Volatile Solids
USGS	United States Geological Survey
WLA	Wasteload allocation
WQ	Water quality
WWTF	Wastewater treatment facility
WWTP	Wastewater treatment plant

<table>
<tr><th colspan="3">TMDL Summary Table</th></tr>
<tr><th>EPA/MPCA Required Elements</th><th></th><th>TMDL Page #</th></tr>
<tr><td>Location</td><td>The Chippewa River, one of 13 major tributaries of the Minnesota River, is located in western Minnesota in portions of the following counties: Chippewa, Swift, Kandiyohi, Pope, Stevens, Grant, Douglas, Stearns, and Otter Tail.</td><td>2-1</td></tr>
<tr><td>303(d) Listing Information</td><td>For all reaches the impaired beneficial is aquatic life and recreation, the pollutant of concern is turbidity, and the priority ranking is the schedule of the TMDL list.
<table>
<tr><td>Name</td><td>Description</td><td>ID#</td><td>Original Listing Year</td></tr>
<tr><td>Chippewa River</td><td>Little Chippewa River to Unnamed Creek</td><td>07020005-504</td><td>2010</td></tr>
<tr><td>Little Chippewa River</td><td>Unnamed Creek to Chippewa River</td><td>07020005-530*</td><td>2010</td></tr>
<tr><td>Shakopee Creek</td><td>Shakopee Lake to Chippewa River</td><td>07020005-559</td><td>2006</td></tr>
<tr><td>Unnamed Creek</td><td>Unnamed Creek to Unnamed Ditch</td><td>07020005-574</td><td>2006</td></tr>
<tr><td>Unnamed Creek</td><td>Freeborn Lake Inlet</td><td>07020005-901</td><td>2006</td></tr>
<tr><td>Chippewa River</td><td>Headwaters (Stowe Lake) to Little Chippewa River</td><td>07020005-503</td><td>2006</td></tr>
<tr><td>Chippewa River</td><td>Unnamed Creek to E Branch Chippewa River</td><td>07020005-505</td><td>2006</td></tr>
<tr><td>Chippewa River</td><td>Cottonwood Creek to Dry Weather Creek</td><td>07020005-508</td><td>2006</td></tr>
<tr><td>East Branch Chippewa River</td><td>Mud Creek to Chippewa River</td><td>07020005-514</td><td>2006</td></tr>
</table></td><td>2-4</td></tr>
<tr><td>Applicable Water Quality Standards/Numeric Targets</td><td>The turbidity standard for class 2B waters is 25 NTU (Minnesota Rules chapter 7050.0220). A turbidity surrogate of Total Suspended Solids (TSS) was developed for this TMDL based on paired lab turbidity and TSS samples taken from 2001-2008 at 11 sites located throughout the Chippewa River Watershed. A TSS surrogate of 54 mg/L is applied in</td><td>2-4</td></tr>
</table>

<table>
<tr><th colspan="7">TMDL Summary Table</th></tr>
<tr><th>EPA/MPCA Required Elements</th><th colspan="5"></th><th>TMDL Page #</th></tr>
<tr><td></td><td colspan="5">this TMDL.</td><td></td></tr>
<tr><td rowspan="27">Loading Capacity (expressed as daily load)</td><td colspan="5">The loading capacity is the total maximum daily load (TSS Load in tons/day) for each of these conditions. Critical Conditions are accounted for in this TMDL through the application of load duration curves.</td><td>3-6</td></tr>
<tr><td colspan="5">Chippewa River, Little Chippewa River to Unnamed Creek: ID# 07020005-504</td><td rowspan="5">3-8</td></tr>
<tr><td colspan="5">Flow Zones</td></tr>
<tr><td>Very High</td><td>High</td><td>Mid-range</td><td>Low</td><td>Dry</td></tr>
<tr><td>59.143</td><td>34.826</td><td>17.961</td><td>8.934</td><td>2.139</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Little Chippewa River, Unnamed Creek to Chippewa River ID#07020005-530*</td><td rowspan="5">3-10</td></tr>
<tr><td colspan="5">Flow Zones</td></tr>
<tr><td>Very High</td><td>High</td><td>Mid-range</td><td>Low</td><td>Dry</td></tr>
<tr><td>11.141</td><td>6.408</td><td>1.529</td><td>0.233</td><td>0.098</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Shakopee Creek, Shakopee Lake to Chippewa River ID#07020005-559</td><td rowspan="5">3-12</td></tr>
<tr><td colspan="5">Flow Zones</td></tr>
<tr><td>Very High</td><td>High</td><td>Mid-range</td><td>Low</td><td>Dry</td></tr>
<tr><td>50.834</td><td>22.208</td><td>9.401</td><td>3.680</td><td>0.283</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Unnamed Creek, Unnamed Creek to Unnamed Ditch ID#07020005-574</td><td rowspan="5">3-12</td></tr>
<tr><td colspan="5">Flow Zones</td></tr>
<tr><td>Very High</td><td>High</td><td>Mid-range</td><td>Low</td><td>Dry</td></tr>
<tr><td>2.542</td><td>1.110</td><td>0.470</td><td>0.184</td><td>0.014</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Unnamed Creek, Freeborn Lake Inlet, ID#07020005-901</td><td rowspan="5">3-7</td></tr>
<tr><td colspan="5">Flow Zones</td></tr>
<tr><td>Very High</td><td>High</td><td>Mid-range</td><td>Low</td><td>Dry</td></tr>
<tr><td>0.327</td><td>0.186</td><td>0.094</td><td>0.041</td><td>0.007</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Chippewa River, Headwaters (Stowe lake) to Little Chippewa River</td><td></td></tr>
</table>

TMDL Summary Table

EPA/MPCA Required Elements						TMDL Page #
	ID#07020005-503					3-6
	Flow Zones					
	Very High	High	Mid-range	Low	Dry	
	40.873	23.305	11.734	5.127	0.902	
	Chippewa River, Unnamed Creek to E Branch Chippewa River ID#07020005-505					3-9
	Flow Zones					
	Very High	High	Mid-range	Low	Dry	
	98.573	58.153	30.147	15.003	3.631	
	Chippewa River, Cottonwood Creek to Dry Weather Creek ID#07020005-508					3-14
	Flow Zones					
	Very High	High	Mid-range	Low	Dry	
	247.583	127.286	66.993	30.948	9.903	
	East Branch Chippewa River, Mud Creek to Chippewa River ID#07020005-514					3-11
	Flow Zones					
	Very High	High	Mid-range	Low	Dry	
	89.731	44.817	22.427	11.132	3.349	
Wasteload Allocation	Portion of the loading capacity allocated to existing and future permitted sources.					3-2
	Reach	**Source**	**Permit #**	**Gross WLA (tons/day)**		
	503	Farwell-Kensington WWTF	MNG580220	0.107		
		Evansville WWTF	MN0023329	0.140		
		Hoffman WWTF	MNG580134 (SD-1) MNG580134 (SD-3)	0.464		
		Millerville WWTF	MN0054305	0.048		

TMDL Summary Table

EPA/MPCA Required Elements					TMDL Page #
		Urbank WWTF	MN0068446	0.015	3-3
	505	Clontarf WWTF	MNG580108	0.040	
	506	Benson WWTF	MN0020036	0.098	
		Hancock WWTF	MN0023582	0.257	
		Chippewa Valley Eth	MN0062898	0.004	
	508	Danvers WWTF	MNG580119	0.034	
	514	Murdock WWTF	MNG580086	0.059	
		Sunburg WWTF	MN0063894	0.022	
	530*	Starbuck WWTF	MN0021415	0.044	
		Lowry WWTF	MN0024007	0.079	
	574	Kerkhoven WWTF	MN0020583	0.019	
		Construction Stormwater and Industrial Stormwater		A value of 0.001 times the TDLC for each reach	
General Permit Numbers	The general permit numbers for construction and industrial stormwater are as follows: Construction: MN R100001 Industrial: MN R050000				
Load Allocation	The portion of the loading capacity allocated to non-point sources that are not subject to NPDES permits, natural background, soil erosion from stream channel and upland areas, agricultural runoff and non-NPDES stormwater runoff.				3-5 thru 3-14
	Reach	**Flow Zone**	**Load Allocation (TSS tons/day)**		
	503	Very High	35.930		
		High	20.154		
		Mid-Range	9.763		
		Low	3.830		
		Dry	0.036		
	901	Very High	0.294		

		High	0.167	
		Mid-Range	0.084	
		Low	0.037	
		Dry	0.006	
	504	Very High	53.111	
		High	31.273	
		Mid	16.129	
		Low	8.023	
		Dry	1.921	
	505	Very High	88.478	
		High	52.182	
		Mid-Range	27.032	
		Low	13.433	
		Dry	3.220	
	530*	Very High	9.882	
		High	5.631	
		Mid-Range	1.250	
		Low	0.086	
		Dry	0.088	
	514	Very High	80.497	
		High	40.164	
		Mid-Range	20.059	
		Low	9.916	
		Dry	2.927	
	559	Very High	45.649	
		High	19.943	
		Mid-Range	8.443	
		Low	3.304	
		Dry	0.254	
	574	Very High	2.263	
		High	0.978	
		Mid-Range	0.403	
		Low	0.146	
		Dry	0.013	
	508	Very High	221.927	
		High	113.901	
		Mid-Range	59.758	

<table>
<tr><td rowspan="2"></td><td></td><td>Low</td><td>27.389</td><td rowspan="2"></td></tr>
<tr><td></td><td>Dry</td><td>8.491</td></tr>
<tr><td>Margin of Safety</td><td colspan="3">Since the Chippewa River is a major tributary to the Minnesota River an explicit10% Margin of Safety was applied in this TMDL to be consistent with the Minnesota River Turbidity TMDL.</td><td>3-4</td></tr>
<tr><td>Seasonal Variation</td><td colspan="3">Seasonal Variation was accounted for in this TMDL through the application of load duration curves. Seasonality is accounted for by addressing all flow conditions in each impaired reach.</td><td>3-5</td></tr>
<tr><td>Reasonable Assurance</td><td colspan="3">The source reduction strategies detailed in Section 5 have been shown to be effective in reducing turbidity in receiving waters. Many of the goals outlined in this TMDL study run parallel to objectives outlined in the local Water Plans, and will be included in the Implementation Plan that will be completed. It is reasonable to expect that the strategies will be widely adopted by landowners and resource managers, in part because they have already been implemented in some parts of the watershed over the last 20 years.</td><td>6-1</td></tr>
<tr><td>Monitoring</td><td colspan="3">Currently there is a continuation of the monitoring program created by the Chippewa River Watershed Project in 1998. The data collected by the CRWP in addition to the MPCA's scheduled intensive monitoring will be used to develop an intensive watershed wide monitoring plan that will be included in the Implementation Plan to be completed.</td><td>7-1</td></tr>
<tr><td>Implementation</td><td colspan="3">This TMDL sets forth an implementation framework and general load reduction strategies that will be expanded and refined through the development of an Implementation Plan. Implementation costs will range between $140 million to $170 million</td><td>5-1</td></tr>
<tr><td>Public Participation</td><td colspan="3">Over the course of this project a variety of public participation and outreach efforts have been conducted and/or planned for this TMDL process. Participating Stakeholders include citizens, Corn and Soybean Growers Associations, local elected officials, and local, state and federal governmental agencies</td><td>8-1</td></tr>
</table>

* Reach 530 was recently split by the MPCA into two reaches (713 and 714), with the turbidity impairment remaining with 713. However, reach 530 will be used to reference this reach in the remainder of this TMDL.

Executive Summary

The Clean Water Act, Section 303 (d), requires that states develop Total Maximum Daily Loads (TMDLs) for surface waters that do not meet, and maintain, applicable water quality standards necessary to support their designated uses. The TMDL provides a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. It is the sum of: wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, a margin of safety (MOS), and a reserve capacity (RC).

The Chippewa River is one of 13 major tributaries of the Minnesota River. The Chippewa River Watershed drains a 2,080 square mile, 1,331,200 acre basin. The counties in this basin include portions of Otter Tail, Grant, Douglas, Stevens, Pope, Swift, Kandiyohi, Chippewa and a very small portion of Stearns. The source of the Chippewa River is in southern Otter Tail County near the Fish Lake area, from where it flows 130 miles south to its mouth in the Minnesota River at Montevideo, Chippewa County in west-central Minnesota. There are a total of 2,091 miles of stream and ditches in the Chippewa River watershed.

The landscape within the Chippewa River Watershed is predominately agricultural, especially in the south and west. Agriculture depends on the river's connection to a network of drainage ditches and tile systems to move water off the land to increase yields, control soil moisture content, and allow more consistent access to the crop with farming machinery. Tile drainage also allows the use of less intensive tillage farming systems which have been shown to reduce movement of soil from the landscape. Pasture-based agriculture operations along riparian areas are also found.

The Minnesota Pollution Control Agency (MPCA) has listed 9 stream reaches in the Chippewa River watershed as impaired waters for exceeding the turbidity standard for aquatic life and recreation, which is currently set at 25 Nephelometric Turbidity Units (NTU). Turbidity is a measure of the cloudiness or haziness of water caused by suspended and dissolved substances in the water column. Since turbidity is a measure of light scatter and adsorption, loads need to be developed for a surrogate parameter. Total suspended solids (TSS) is a measurement of the amount of sediment and organic matter suspended in water and is often used to calculate loading capacities and allocations. To determine the TSS equivalent to the 25 NTU turbidity standard, paired lab turbidity and TSS samples taken from 2001-2008 at 11 sites located throughout the Chippewa River Watershed were used. The TSS surrogate was calculated to be 54 mg/L TSS.

This TMDL report used a load duration curve approach to determine the pollutant loading capacity of the Chippewa River under varying flow regimes. The load duration curve identifies the flow conditions that the exceedances are occurring in which will help identify the sources.

The exceedances occur at all flow regimes. The primary contributing sources of the turbidity impairment appear to be from upland soil erosion and stream-bank erosion.

Public Participation included initial meetings with stakeholders for presenting TMDL concepts, impaired reaches, and the timeline. Stakeholders include: citizens, agricultural grower associations, lake associations, and local, state and federal agencies. From the stakeholders a Stakeholder Advisory Group was formed to review the draft at a series of meetings before the public comment period. The Stakeholder Advisory Group was involved with the development of the draft Implementation Plan.

1.0 Introduction

1.1 *Purpose*

Section 303(d) of the Clean Water Act (40 C.F.R. 130.7) requires states to identify waters that do not meet applicable water quality standards and to establish Total Maximum Daily Loads (TMDL) for those pollutants exceeding water quality standards. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet established water quality standards. The TMDL allocates pollutant quantity to the various sources and establishes the allowable loadings of pollutants based on the relationship between the pollution sources and the receiving water. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of their water resources.

A TMDL includes separating the acceptable load among the Load Allocation (LA) and Wasteload Allocation (WLA). A TMDL must also account for seasonal variation and include a margin of safety (MOS). The MOS accounts for uncertainty in the relationship between effluent limitations and water quality in the receiving water. The reserve capacity (RC) is an allocation of loading for future growth. The total of all the allocations, including the wasteload allocations for permitted discharges, the load allocations for non-permitted sources, reserve capacity, which is an allocation of loading for future growth and the MOS (if explicitly defined) cannot exceed the maximum allowable pollutant load. The following TMDL equation summarizes these requirements:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS} + \text{RC}$$

These components are described in more detail below:

> WLA = Waste Load Allocation, which is the sum of all permitted sources, including wastewater treatment facilities, construction stormwater sources, industrial stormwater sources, and municipal stormwater sources, all of which are permitted under the NPDES program.
>
> LA = Load Allocation, which is the sum of all non-permitted sources, including runoff from cropland, non-permitted feedlots, non-NPDES stormwater runoff, livestock in riparian pastures, and in-stream sources.
>
> MOS = Margin of Safety, which may be implicit due to conservative assumptions used in the analysis to derive the allocations, or explicit, where an additional load is subtracted

from the available load prior to allocation among the sources or the load is based on achieving a better condition than the standard in the receiving water.

RC = Reserve Capacity, which is an allocation of loading for future growth that keeps the overall load to the receiving water at or below what it needs to be to meet water quality standards in the future.

Reserve capacity is not included in the loading calculations because population growth in the watershed is not expected to increase significantly and any new or expanding point sources will be incorporated according to the process detailed in section 3.4.1 below.

1.1.2 **Problem Identification**

A majority of these reaches were listed on the Minnesota 303(d) list in 2006 and 2010. Water quality monitoring collected from 2001-2008 determined that there were aquatic life and recreation use impairments in these reaches due to turbidity within the water column. The water quality values for the measured parameter were above the water quality standard (or surrogate target value). As a result of water quality evaluations, the State of Minnesota has determined that certain reaches within the Chippewa River Watershed in Minnesota exceed the State established standards for turbidity.

Excessive levels of turbidity can harm aquatic life by making it more difficult for sight-feeding organisms to find food, adversely affecting gill function, and smothering food organisms as well as spawning habitat.

1.1.3 **Priority Ranking**

The Chippewa River watershed was given a priority ranking for TMDL development due to; the impairment impacts on public health and aquatic life, the public value of the impaired water resource, the likelihood of completing the TMDL in an expedient manner, the inclusion of a strong base of existing data and the restorability of the water body, the technical capability and the willingness of local partners to assist with the TMDL, and the appropriate sequencing of TMDLs within a watershed or basin. Areas within the Chippewa River watershed are popular locations for aquatic recreation. Water quality degradation has led to efforts to improve the overall water quality within the Chippewa River watershed, and to the development of a TMDL.

1.2 *Criteria Used for Listing*

The criteria used for determining stream reach impairments are outlined in the MPCA document Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment – 305(b) Report and 303(d) List, October 2009. The applicable water body classifications and water quality standards are specified in Minnesota Rules Chapter 7050. Minnesota Rules Chapter 7050.0470 lists water body classifications and Chapter 7050.0222 lists applicable water quality standards for all waters with a given use classification. However, none of the reaches in this TMDL are specifically classified and therefore fall under Minnesota Rules

Chapter 7050.0430 which says that all water bodies have a 2B classification unless they are otherwise specifically classified.

Turbidity assessment protocol includes pooling of data over a ten-year period and requires a minimum of 20 independent observations. The MPCA recognized turbidity surface water standard for each of the nine impaired reaches covered in this report is 25 nephelometric turbidity units (NTUs) which is a statewide standard for Minnesota for class 2B waters. For assessment purposes, a stream is listed as impaired if at least three observations and 10% of the observations exceed 25 NTUs. Transparency and total suspended solids samples may also be used as a surrogate for the turbidity standard. As discussed below in section 2.5.2, transparency measurements below 20 cm are considered violations of the turbidity standard. The total suspended solid turbidity surrogate value for the Northern Glaciated and Western Corn Belt Plain ecoregions is 60 mg/L and 100 mg/L for the North Central Hardwood Forest Ecoregion. If there are two or more parameters observed in a single day, the hierarchy of consideration is turbidity, then transparency, then total suspended solids.

2.0 Watershed Description and Impairments

2.1 *Watershed Description*

The Chippewa River is one of 13 major tributaries of the Minnesota River. The Chippewa River Watershed drains a 2,080 square mile, 1,331,200 acre basin. The counties in this basin include portions of Otter Tail, Grant, Douglas, Stevens, Pope, Swift, Kandiyohi, Chippewa and a very small portion of Stearns. The source of the Chippewa River is in southern Otter Tail County near the Fish Lake area, from where it flows 130 miles south to its mouth in the Minnesota River at Montevideo, Chippewa County. The Chippewa's average gradient is 4.5 feet per mile. The annual mean flow at the mouth is 200 cubic feet per second, although it has been as high as 14,400 cubic feet per second at record flood stage in 1997 (USGS 2010). The main tributaries are: the Little Chippewa River, East Branch Chippewa, and Shakopee Creek. Together, these tributaries contribute nearly half the flow of the main stem. The total distance of the stream network is 2,091 miles of which 1,567 miles are intermittent streams and 525 miles are perennial streams.

A population base of roughly 41,000 residents make up the demographics of the watershed. Approximately 20,000 of the residents reside in the 25 cities, towns, and hamlets scattered across the watershed with the remainder residents in rural areas. According to the U.S. Census Bureau's Annual Estimates of the Population for incorporated places in Minnesota, April 1, 2000 to July 1, 2005, the population trend for the counties in the watershed is on the decline.

More than 75 lakes are found within its boundaries including notable recreational waters such as Lake Minnewaska, Emily, Pelican, Norway, Games, Andrew, Red Rock, Reno and Villard. Three state parks: Glacial Lakes, Sibley, and Monson Lake, call the watershed their home and more than 60 State Wildlife Management areas, including the 2,298 acre Danvers Marsh, dot the watershed's landscape.

Geomorphology of the Chippewa River Watershed includes a complex mixture of moraines, till, lacustrine deposits, and outwash plains. The eastern half of the Chippewa River Watershed, extending from approximately Evansville in the north to just below the town of DeGraff in the south, lies within the North Central Hardwood Forest Ecoregion. More specifically, with the exception of a long narrow section of the Belgrade-Glenwood outwash plain along the east-central edge of the basin, the eastern half of the watershed falls within the geomorphic setting of the Alexandria Moraine Complex. This morainal complex is composed of well drained, loamy, silty, sandy, and mucky soils with moderate to steep sloping landscapes (6-45%), producing a large potential for sediment delivery to streams. As such, water erosion potential within this section of the watershed is classified as moderate to high. The section of the watershed situated in the Belgrade-Glenwood outwash plain, lying east of the line from Glenwood in the north to

Lake Johanna in the south, is characterized by nearly level to gently sloping (2-6%), well drained landscapes with sandy-loamy soils of moderate water and wind erosion potential.

Lands in the western half of the Chippewa River Watershed fall within the Northern Glaciated Plains Ecoregion, primarily within three geomorphic settings: the Big Stone Moraine on the far western edge, the Appleton-Clontarf Outwash Plain along the lower Chippewa River, and the Benson Lacustrine Plain within the south-central section of the watershed. Landscapes within the Big Stone moraine are characterized as rolling (6-12%), with well drained, silty and loamy soils. Water erosion potential within the moraine is generally classified as moderate. Lands within the Appleton-Clontarf outwash are characterized as being nearly level to gently sloping (2-6%), poorly drained, and extensively tiled. Water and wind erosion potentials are classified as moderate for this region. The Benson Lacustrine Plain is also nearly level (0-2%), poorly drained and extensively tiled. Soil textures in the lacustrine plain range from silty clay to silty loam, water erosion potentials are high for lands adjacent to streams and much of the plain has the potential for significant wind erosion. In these three geomorphic areas approximately 978,432 acres have a classified land use of agriculture and of those acres 750,457 have been drained and tiled.

Under the federal watershed pilot program, several miles of the river near Benson in Swift County were channelized in the 1950's, including much of Shakopee Creek. Marsh numbers have been greatly reduced in this area through drainage. According to the Minnesota Board of Water and Soil Resources (BWSR) it is estimated that upwards of 95% of the original wetlands in the lower basin have been drained, (BWSR website 2010).

The climate within the Chippewa River Watershed is continental, with cold dry winters and warm wet summers. Averages of twenty-five to twenty-eight inches of precipitation annually fall within the watershed with two thirds of this precipitation normally falling from May through September. The average last frost date for the area is May 7 and the average first frost day is September 30, for an average growing season of 148 days (Minnesota Climatology Workgroup 2010).

2.1.1 Land Use Information

Land use in the watershed is predominately related to agriculture. Corn, soybeans and sugar beets are grown on approximately 66% of the approximate 980,000 cropped acres and small grains, hay and grassland acres enrolled in conservation easement programs make up the majority of the balance. Early 1996 estimates were that 10.5% of the agricultural acres within the watershed were enrolled in the Conservation Reserve Program (CRP), a voluntary federal program that offers annual rental payments to farmers in exchange for planting areas of grass and trees on lands subject to erosion. This figure changes from year to year as some CRP contracts expire and new CRP enrollments take place. Estimates from BWSR indicate that approximately 17,000 acres are currently enrolled in the Conservation Reserve Enhancement Program (CREP) which represents 1.27% of the watershed. Similar to CRP, CREP is a federal-state natural resource conservation program that works to meet state environmental objectives and to protect environmentally sensitive land through the use of contracts and easements.

The breakdown of land uses is as follows:

Table 2-1: Land Use Distribution.

73.50%	Agriculture (corn, soybeans, sugar beets, small grains)
11.14%	Grassland
5.38%	Forest
5.37%	Water
2.78%	Wetlands
1.77%	Urban or Residential
0.05%	Gravel pits or exposed
>0.01%	Unclassified

2.1.2 Municipalities

Several municipalities are located directly on the river or a branch of it and use the river for the discharge of wastewater treatment plant and/or storm water effluent. There are no municipalities directly on the river that depend on the Chippewa River for drinking water and there are no factories or industries in the watershed that heavily draw water directly from the river or discharge into it.

2.1.3 Agriculture

The landscape within the Chippewa River Watershed is predominately agricultural, especially in the south and west. Agriculture depends on the river's connection to a network of drainage ditches and tile systems to move water off the land to increase yields, control soil moisture content, and allow more consistent access to the crop with farming machinery. Tile drainage also allows the use of less intensive tillage farming systems which have been shown to reduce movement of soil from the landscape. Pasture-based agriculture operations along riparian areas are also found.

2.1.4 Recreation

A wide variety of recreational activities take place in the watershed. Fishing, canoeing, snowmobiling, bird watching, nature walks, camping and cross country skiing, along with duck and geese hunting, deer and pheasant hunting are all very popular activities throughout the watershed. The Ordway Prairie, Inspiration Peak, Terrace Mill Pond, Glacial Lakes Regional Trail, a state canoe and boat route and three State Parks all combine to make the Chippewa River Watershed a unique and special place to live.

2.2 *Description of Turbidity*

Turbidity is a measure of water clarity typically determined using a meter that measures the scatter of a beam of light passed through a water sample. Turbidity is caused by suspended soil particles, algae, dissolved salts, and other organic materials that scatter light in the water column, making the water appear cloudy. Excessive levels of turbidity can harm aquatic life by making it more difficult for sight-feeding organisms to find food, adversely affecting gill function, and smothering food organisms as well as spawning habitat.

2.3 *Applicable Minnesota Water Quality Standards*

The numeric criteria for turbidity, based on stream use classification, are provided in Table 2-2 (Minnesota Rules Chapter 7050.0220). All nine impaired reaches covered in this TMDL are classified as Class 2B waters. This beneficial use classification is assigned to cool and warm water fisheries where turbidity shall not exceed 25 NTUs to support aquatic life throughout the ecosystem.

Table 2-2 Minnesota Turbidity Standards by Stream Classification.

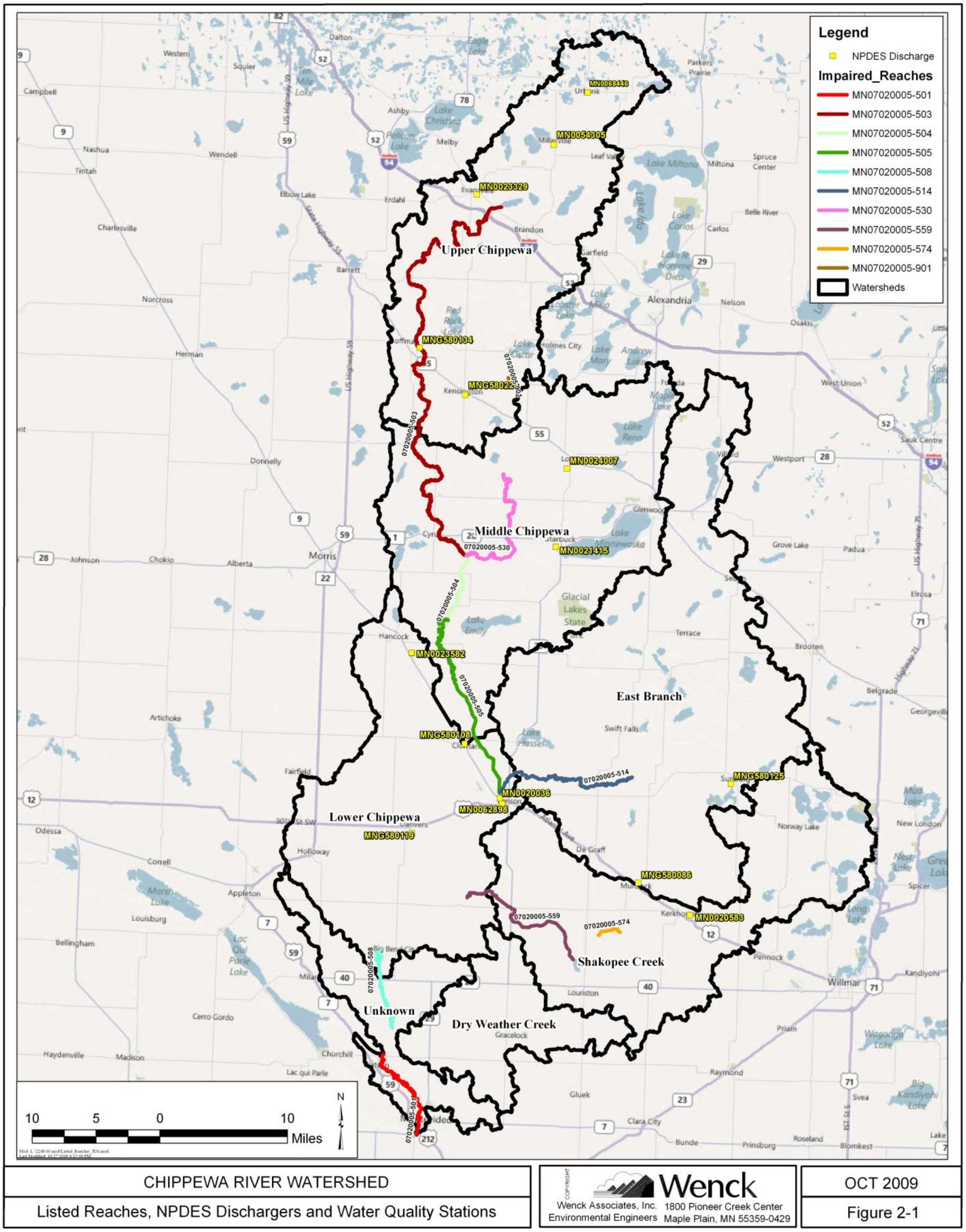
Class	Description	Turbidity (NTUs)
1B	Drinking water	10
2A	Cold water fishery, all recreation	10
2B	Cool and warm water fishery, all recreation	25
2C	Indigenous fish, most recreation	25

2.4 *TMDL Impaired Reaches*

This report includes TMDLs for 9 impaired reaches of the Chippewa River. The lowest reach (reach 501) is not included here because it is included in the Minnesota River Turbidity TMDL. Reach 530 was recently split by the MPCA into two reaches (713 and 714), with the turbidity impairment remaining with 713. However, reach 530 will be used to reference this reach in the remainder of this TMDL. A summary of each impaired reach is presented in Table 2-3, and the location of each reach within the major sub-watersheds is illustrated in Figure 2.1. Also shown in Figure 2-1 are the locations of the key gauging stations for which flow and TSS was collected and generated to support the TMDLs for each reach. Every impaired reach in the Chippewa River Watershed is impaired by turbidity for the same beneficial use of aquatic life and recreation.

Table 2-3 Impaired Stream Reaches.

Stream Name	Major Sub-Watershed	Description	MPCA River Assessment ID	Year Listed
Chippewa River	Middle Chippewa	Little Chippewa River to Unnamed Creek	07020005-504	2010
Little Chippewa River	Middle Chippewa	Unnamed Creek to Chippewa River	07020005-530	2010
Shakopee Creek	Shakopee	Shakopee Lake to Chippewa River	07020005-559	2006
Unnamed Creek	Shakopee	Unnamed Creek to Unnamed Ditch	07020005-574	2006
Unnamed Creek	Upper Chippewa	Freeborn Lake Inlet	07020005-901	2006
Chippewa River	Upper and Middle Chippewa	Headwaters (Stowe Lake) to Little Chippewa River	07020005-503	2006
Chippewa River	Middle and Lower Chippewa	Unnamed Creek to E Branch Chippewa River	07020005-505	2006
Chippewa River	Lower Chippewa	Cottonwood Creek to Dry Weather Creek	07020005-508	2006
East Branch Chippewa River	East Branch	Mud Creek to Chippewa River	07020005-514	2006



CHIPPEWA RIVER WATERSHED

Listed Reaches, NPDES Dischargers and Water Quality Stations

Wenck

Wenck Associates, Inc.
Environmental Engineers
1800 Pioneer Creek Center
Maple Plain, MN 55359-0429

OCT 2009

Figure 2-1

Figure 2-1 Location and Contributing Watersheds of Impaired Reaches. Note: Reach 501 is not included in this TMDL because it is included in the Minnesota River Turbidity TMDL.

2.5 *Selection of Turbidity Surrogates*

High turbidity may be the result of increased suspended soil or sediment particles, phytoplankton growth, and dissolved substances in the water column. Since turbidity is an optical measurement of light scatter and adsorption, a concentration-based turbidity surrogate is needed to develop the load estimates required for TMDLs. Total suspended solids (TSS) measures the amount of sediment and organic matter suspended in water. TSS grab samples have been collected throughout the Chippewa River Watershed for over 10 years and will be used as the turbidity surrogate to develop all load allocations and capacities for this TMDL.

2.5.1 Developing a Total Suspended Solids Surrogate

The relationship between turbidity and TSS varies in streams across Minnesota and depends on local soil types, geology, and water quality. To account for this variability, MPCA recommends that stream-specific relationships between turbidity and TSS be developed for each stream when adequate data exists. An adequate data set usually consists of several years of data in the last 10 years with paired samples of turbidity and TSS over all seasons and flow regimes. Table 2-4 presents some relationships developed by the MPCA for streams in Minnesota using site specific data. It is important to note that the value presented in the table was developed using data from the outlet of the entire Chippewa River drainage. This TMDL further develops a surrogate for the turbidity standard using data from monitoring locations throughout the Chippewa River watershed.

Table 2-4 Turbidity Surrogates Developed for Other Watersheds and Regions in Minnesota.

Location	TSS (mg/L) Value for 25 NTU	Source
North Central Hardwood Forest Ecoregion	100	MPCA listing protocol 2010 list
Western Cornbelt Plains/Northern Glaciated Plains Ecoregion	60	MPCA listing protocol 2010 list
North Fork Crow River Turbidity TMDL	79	Wenck (2009)
Chippewa River	51	MPCA memo 2008
Redwood River	72	
Cottonwood River	64	
Watonwan River	85	
Blue Earth River	90	
Le Sueur River	89	
Minnesota River at Jordan	105	

To determine the TSS equivalent to the 25 NTU turbidity standard, paired lab turbidity and TSS samples taken from 2001-2008 at 11 sites located throughout the Chippewa River Watershed were used. Based on protocols recommended by MPCA, only sample sets with a turbidity value of 40 NTU or below and TSS values greater than 10 mg/L were used to develop the turbidity-TSS relationship (MPCA 2008). A total of 629 paired turbidity/TSS samples met these criteria and were used to develop the relationship. A simple regression of the natural logarithm of TSS and turbidity was completed using the paired data available for all sites within the watershed (Figure 2-2). The analysis indicates that the turbidity standard of 25 NTU corresponds to a surrogate TSS concentration of 51.5 mg/L for this data set. However, informal guidance provided by MPCA suggests applying a Duan's smearing correction to the surrogate to account for the bias introduced when re-transforming the non-linear regression (Duan, 1983). After applying this bias correction method to the data set, the corrected TSS surrogate value for the 25 NTU standard is 53.7 mg/L. This TSS surrogate for the turbidity standard is consistent with the previously developed TSS surrogate for the Chippewa River by the MPCA for the Minnesota River Turbidity TMDL (Table 2.4) and was therefore determined to be reasonable. Appendix B of the Minnesota River Turbidity TMDL provides additional information in the development of TSS surrogates. Consequently, a TSS surrogate is applied in this TMDL of 54 mg/L TSS.

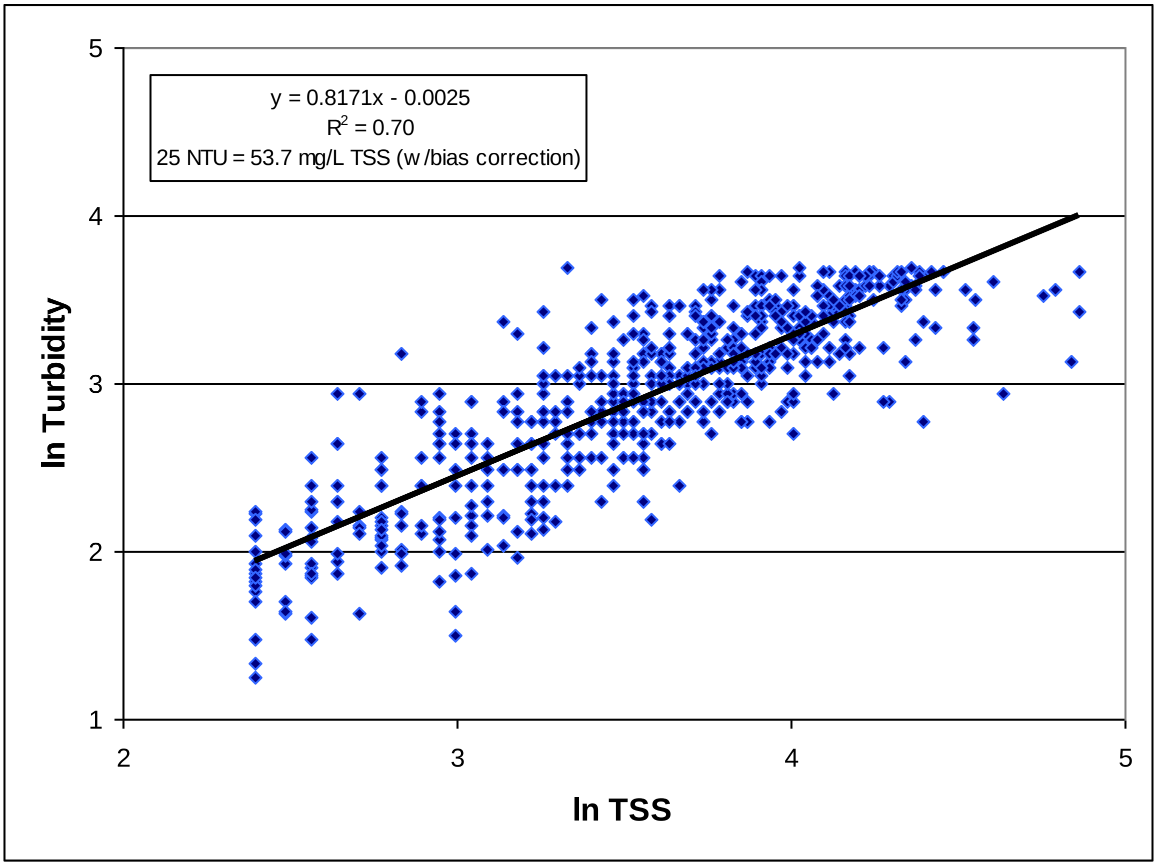


Figure 2-2 Turbidity/Total Suspended Solids Relationship for 11 Sites within the Chippewa River Watershed.

2.5.2 Converting Transparency to Total Suspended Solids

Turbidity is the only parameter needed for impairment as long as more than 20 measurements have been collected. If there is insufficient turbidity data, any combination of turbidity, transparency, and total suspended solids observations may be used to meet assessment criteria. Three of the reaches listed for turbidity, 07020005-504, 07020005-574 and 07020005-901 had no turbidity or TSS measurements and were listed based on field transparency readings. The other reaches had a mixture of field transparency, TSS and turbidity measurements. Relationships between transparency tube and turbidity as well as transparency tube and total suspended solids were constructed by combining paired data from all sampling stations in the watershed (Figures 2-3 and 2-4). The transparency standard values based on the transparency-turbidity and transparency-TSS regressions for the Chippewa River Watershed are nearly identical (19.5 and 18.1 cm, respectively) and very close to the MPCA's surrogate standard of 20 centimeters. These results justify applying the MPCA transparency surrogate to the Chippewa River Watershed and using these regression equations in converting transparency measurements to total suspended solid concentration equivalents.

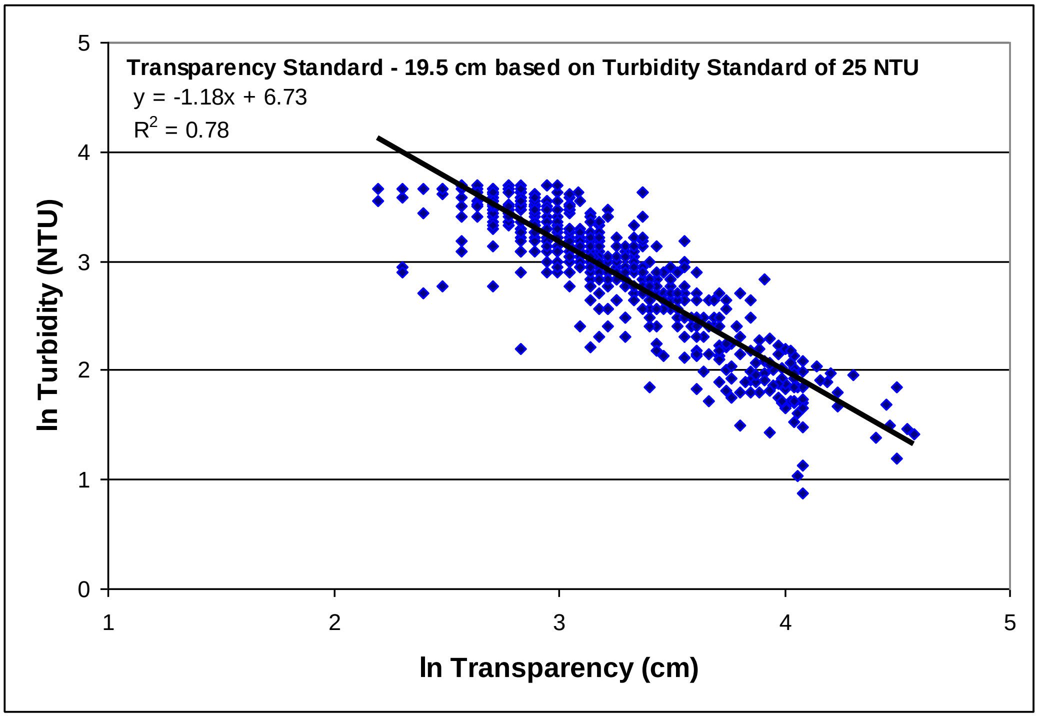


Figure 2-3 Turbidity/Transparency Relationship for 11 Sites within the Chippewa River Watershed.

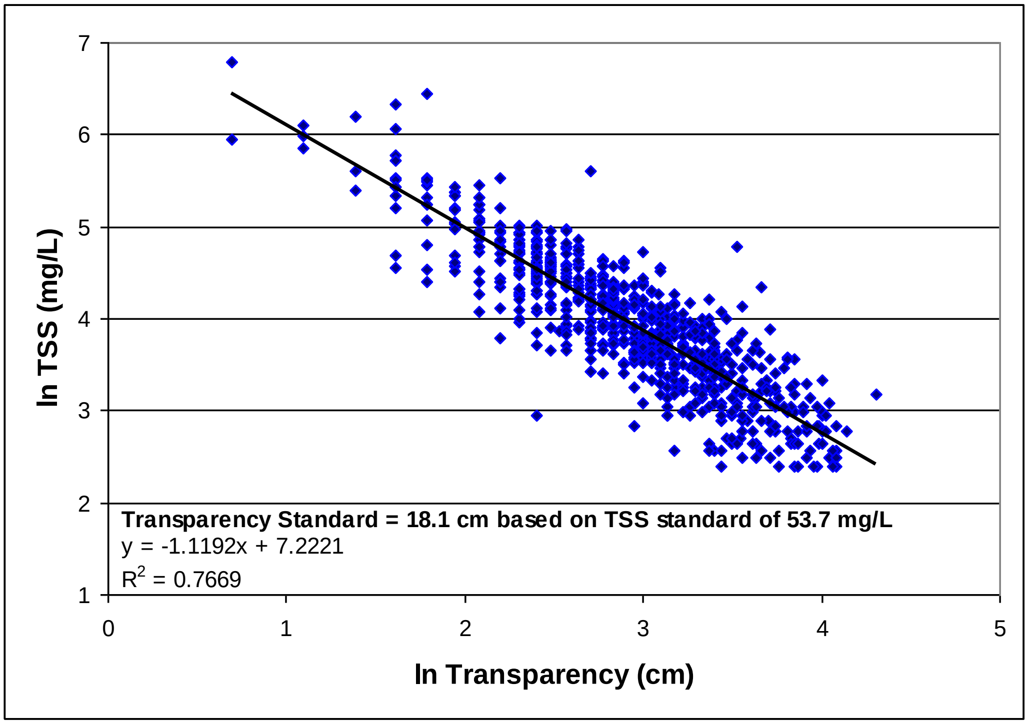


Figure 2-4 TSS/Transparency Relationship for 11 Sites within the Chippewa River Watershed.

2.6 *Impairment Assessment*

The Chippewa River Watershed Project (CRWP) has collected both continuous and gauged flow data at three mainstem locations (Upper, Middle and Lower Chippewa) and near the outlet of three major tributaries (Little Chippewa, East Branch Chippewa and Shakopee Creek).
The average daily flow data used in writing the TMDLs for each reach was selected based on proximity to one of these six flow stations. Reaches 504, 574, and 901 were the only reaches without a continuous flow monitoring station. Daily flow data for these reaches was calculated by multiplying flow from the closest downstream monitoring station by the fraction of the gauging station’s watershed draining to the reach. Table 2-5 summarizes the methods used to calculate daily flows in each reach.

Table 2-5 Continuous Flow Records for Each Listed Reach.

Reach ID	Gauging station used	Station Location and Adjustments	Flow Record (days)	Years
504	Middle Chippewa Mainstem	Outside reach – 60% of drainage area	2,022	1999-2008
530	Little Chippewa River	In reach – no adjustment	378	2007-2008
559	Shakopee Creek	In reach – no adjustment	2,039	1999-2008
574	Shakopee Creek	Outside reach – 5% of drainage area	2,039	1999-2008
901	Upper Chippewa Main Stem	Outside reach – 0.8% of drainage area	1,573	2001-2008
503	Upper Chippewa Main Stem	In reach – no adjustment	1,573	2001-2008
505	Middle Chippewa Mainstem	In reach – no adjustment	2,022	1999-2008
508	Lower Chippewa Mainstem	In reach – no adjustment	2,135	1999-2008
514	East Branch Chippewa River	In reach – no adjustment	2,005	1999-2008

The CRWP collects water quality data at all of the flow monitoring stations and various other sites throughout the Chippewa River Watershed. Monitoring station equipment measures water levels every 15 minutes 24 hours a day over the course of the monitoring season. State certified lab analyses of both turbidity and TSS along with field transparency (T-tube) are collected at the six primary flow monitoring stations. These analyses were collected 21 to 30 times a year at each site by trained CRWP staff. TMDL equations for each reach were written using flow and surrogate TSS concentrations from the primary flow monitoring stations. The CRWP's trained staff has also collected transparency tube readings and other field measurements from main-stem and tributary sites between the primary flow monitoring stations. All transparency measurements were converted to TSS-equivalents according to the methods discussed in 2.5.2. Table 2-6 summarizes the water quality stations(s) used in developing the TMDL for each listed reach.

Table 2-6 Available Water Quality Data Including Standard Exceedances for the Chippewa River Watershed.

Reach ID	WQ STORET Station ID	Measurement Method(s)	Years	Number of Measurements	Number of Exceedances	Percent Exceedances
504	S002-192	TTube	2005-2006	64	38	59
530	S004-705	TSS	2007-2008	42	9	21
559	S002-201	TSS	1998-2008	227	139	61
574	S001-866	TTube	2001-2002	42	6	14
901	S001-771	TTube	2001-2003	40	7	17
503	S002-190	TSS	1999-2008	163	62	38
	S001-772	TTube	2001-2007	53	27	51
	S004-234	TTube	2006-2008	29	15	52
505	S002-193	TSS	1998-2008	228	124	54
	S001-862	TTube	2001-2007	158	80	51
508	S002-203	TSS	1998-2008	235	144	61
514	S002-196	TSS	1998-2008	218	85	39

3.0 Turbidity TMDL Development

3.1 *Allocation Approach*

Assimilative loading capacities for the streams were developed from load duration curves (Cleland 2002). Load duration curves integrate flow and TSS data across stream flow regimes and provide assimilative loading capacities and necessary load reductions necessary to meet water quality standards.

First, flow duration curves were developed using the available flow data collected by the CRWP discussed in Section 2.6. Flow duration curves relate mean daily flow to the percent of time those values have been met or exceeded. For example, an average daily flow at the 50% exceedance value is the midpoint or median flow value suggesting average daily flow in the reach is at this value 50% of the time. The curve is divided into flow zones including high flows (0-10%), moist conditions (10-40%), mid-range flows (40-60%), dry conditions (60-90%) and low flow (90 to 100%).

To develop a load duration curve, all average daily flow values were multiplied by the TSS-surrogate (53.7 mg/L) and converted to a daily load to create "continuous" load duration curves (Figure 3-1). Now the line represents the assimilative capacity of the stream for each daily flow measurement (Figure 3-1). To develop the TMDL, the median load of each flow zone is used to represent the total daily loading capacity (TDLC) for that flow zone. The TDLC can also be compared to observed data by calculating a load for each TSS measurement and plotting these values against the TDLC curve. Each value above the TDLC line represents an exceedance of the water quality standard while those below the line are below the water quality standard. Necessary reductions to meet current state water quality standards are further explored in Section 4, and the individual plots of the LDCs are included in Section 4.5.

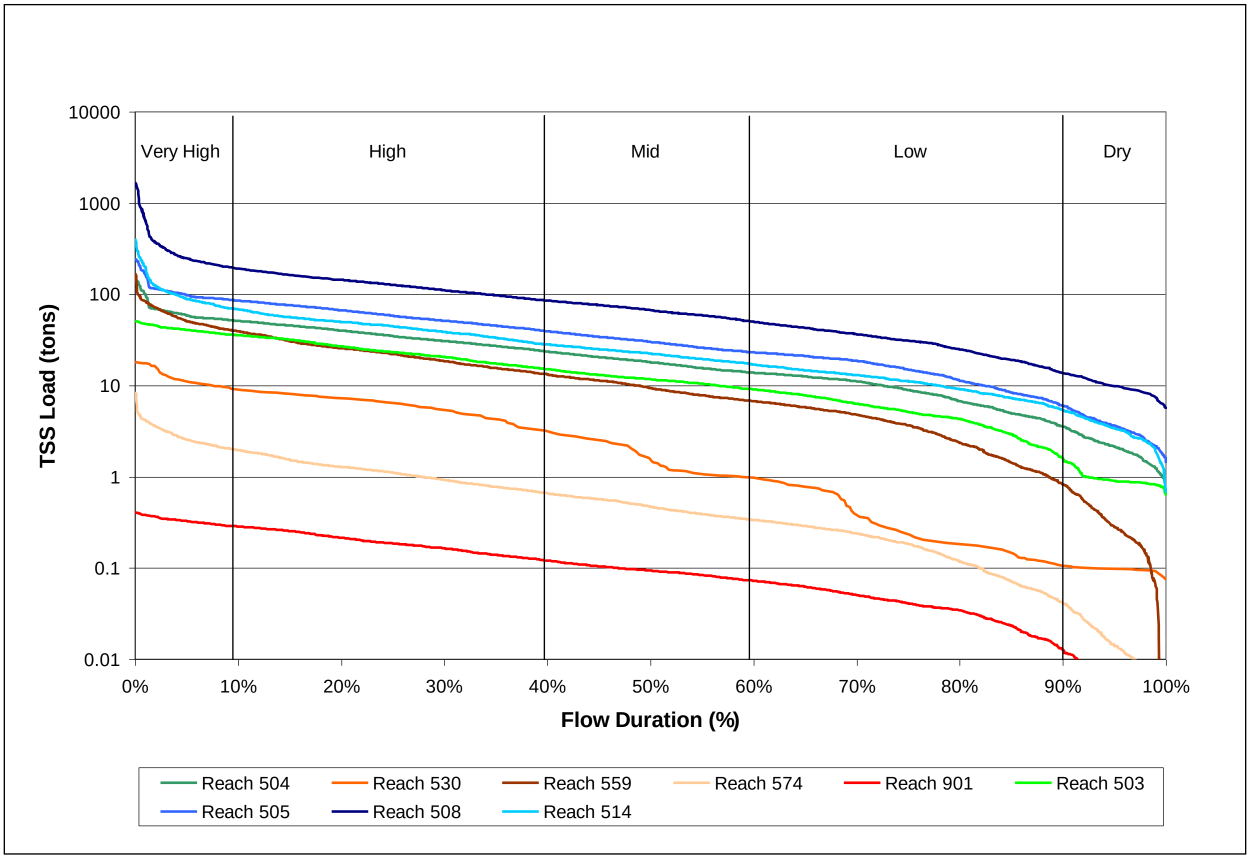


Figure 3-1 Load Duration Curve Representing Loading Capacity for Each Listed Reach.

3.2 *Wasteload and load allocations*

3.2.1 Wasteload Allocations

The wasteload allocations were divided into three primary categories including regulated point sources from wastewater treatment facilities, construction stormwater sites and industrial stormwater sites. Typically an allocation would also be included for MS4 stormwater. The city of Montevideo is the only MS4 in the Chippewa River watershed. However, this MS4 is located downstream and outside all listed reach watershed boundaries.

There is at least one permitted point source discharger located in six of the nine reaches throughout the Chippewa River Watershed. Wasteload allocations for continuous point sources were estimated by calculating the load generated from each facility's wet weather design flow and the facility's monthly TSS concentration limit. WLA was calculated for each pond facility by multiplying the ponds' surface area, volume and average daily drawdown times the facility's permitted TSS concentration limit. Current discharge design flows for each permitted point source were provided by the MPCA and presented in Table 3-1. Maximum monitored weekly TSS discharge concentrations were also reviewed for each point source. Some of the facilities do exceed the TSS surrogate, however the exceedances are relatively infrequent and not significantly higher than their monthly TSS concentration effluent limit and the TSS surrogate established in this TMDL.

Table 3-1 Point Source Description and Wasteload Allocation by Reach.

Reach	Facility Name	NPDES ID#	Facility Type	Discharge Design Flow (MGD)	Permitted TSS Calendar Month Average (mg/L)	TMDL Allocation (tons/day)
503	Farwell-Kensington WWTF	MNG580220	3-cell pond system	0.570	45	0.107
	Evansville WWTF	MN0023329	3-cell pond system	0.749	45	0.140
	Hoffman WWTF	MNG580134 (SD-1+SD-3)	4-cell pond system	2.473	45	0.464
	Millerville WWTF	MN0054305	Pond System	0.254	45	0.048
	Urbank WWTF	MN0068446	Pond System	0.080	45	0.015
			Totals	**3.791**		**0.774**
505	Clontarf WWTF	MNG580108	Pond System	0.235	45	0.040
			Totals	**0.235**		**0.040**
506*	Chippewa Valley Ethanol Co	MN0062898	Continuous	0.03088	30	0.004
	Benson WWTF	MN0020036	Continuous	0.0985	30	0.098**
	Hancock WWTF	MN0023582	Pond system	1.370	45	0.257
			Totals	**2.223**		**0.359**
508	Danvers WWTF	MNG580119	2-cell pond system	0.184	45	0.034
			Totals	**0.184**		**0.034**
514	Murdock WWTF	MNG580086	3-cell pond system	0.317	45	0.059
	Sunburg WWTF	MNG580125	2-cell pond system	0.118	45	0.022
			Totals	**0.435**		**0.081**
530	Starbuck WWTF	MN0021415	Continuous	0.350	30	0.044
	Lowry WWTF	MN0024007	2-cell pond system	0.422	45	0.079
			Totals	**0.772**		**0.123**
574	Kerkhoven WWTF	MN0020583	Continuous	0.150	30	0.019
			Totals	**0.150**		**0.019**

*Reach 506 is not impaired for turbidity but is located upstream of impaired reach 508. Reach 506 facilities are included in the allocations for reach 508.

**WLA based on the TSS calendar month average permit limit which is based on the facility's nondegradation design flow of 0.782 mgd.

For two of the impaired reaches (Little Chippewa River (530) and Unnamed Creek (574)) WWTF design flows exceed minimum observed stream flow for the dry weather flow zone. Clearly, WWTF flow does not currently exceed stream flow during these conditions since it is a component of stream flow. To account for this, the wasteload and load allocations are expressed as equations rather than actual numbers:

Allocation = (flow contribution from point source) X (permitted TSS concentration limit)

This method assigns the permitted concentration-based limit to commercial and industrial stormwater as well as nonpoint source load allocation sources. While this may appear stringent, these sources are not significant contributors under dry flow conditions.

A WLA for construction stormwater can be developed by calculating the average annual cumulative fraction of the watershed under construction and multiplying this fraction by the total loading capacity. This method assumes equal areal loading for all pollutant sources. At this time, there is no reliable construction stormwater permit information available for the Chippewa River Watershed. Fractions for other TMDL studies have ranged from about 0.0003 to 0.0015, regardless of location within the state. Consequently, it was decided a WLA of 0.001 times the TDLC will be used for each listed reach in the Chippewa River Watershed.

The above methodology for calculating a WLA can be applied to industrial stormwater. The industrial stormwater permit was reissued in 2010. As this permit is implemented, the MPCA believes the number of industrial facilities requiring a stormwater permit will greatly exceed the number of facilities that are currently permitted. The areal method described above has only been applied to the Rock Creek TMDL. The resulting fraction was 0.0003, which is at the low end of the number for construction stormwater. Industrial stormwater permit data is difficult to obtain and work with, and as stated above, is likely to underestimate the actual extent of industrial activity within a watershed. The MPCA Industrial Stormwater Program therefore advocates using a fraction that is equal to or less than the fraction used for construction stormwater. Thus, a value of 0.001 times the TDLC was also used to represent industrial storm throughout the listed reaches of the Chippewa River Watershed.

3.2.2 Margin of Safety

The purpose of the margin of safety (MOS) is to account for uncertainty that the allocations will result in attainment of water quality standards. A explicit 10% MOS was applied in this TMDL to be consistent with the Lower Minnesota River Turbidity TMDL since the Chippewa River is a major tributary to the Minnesota River. Section 303(d) of the Clean Water Act and EPA's regulations at 40 CFR 130.7 require that *"TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a margin of safety (MOS) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality."* The margin of safety can either be implicitly incorporated into conservative assumptions used to develop the TMDL or added as a separate explicit component of the TMDL (USEPA, 1991).

The explicit MOS was chosen by the MPCA to account for uncertainty that the pollutant allocations would attain the water quality targets The uncertainty was based on insufficient sampling data within specific subwatersheds, insufficient flow data within specific subwatersheds, potential flow variability in the subwatershed and flow measurement location (USGS gage at the outlet of the watershed), limitations associated with the calculation of load allocations, and the relationship between the TSS surrogate and the turbidity water quality standard.

3.2.3 Critical Condition and Seasonal Variation

Both seasonal variation and critical conditions are accounted for in this TMDL through the application of load duration curves. Load duration curves evaluate water quality conditions across all flow regimes including high flow, runoff conditions where sediment transport tends to be greatest. Seasonality is accounted for by addressing all flow conditions in a given reach.

3.2.4 Load Allocation

Once wasteload allocations (point source, construction and industrial stormwater) and MOS were determined for each reach and flow regime, the remaining loading capacity was considered the load allocation. The load allocation includes nonpoint pollution sources that are not subject to NPDES permit requirements, natural background, wind blown materials, as well as soil erosion from stream channel and upland areas. The load allocation also includes runoff from agricultural lands and non-NPDES stormwater runoff.

3.3 *Total Maximum Daily Loads*

Tables 3-2 through 3-10 present the wasteload and load allocations as well as the margin of safety for all listed reaches. Each table also presents the loads as percentages of the total loading capacity.

Table 3-2 Reach 503 TSS Total Daily Loading Capacities and Allocations.

Upper Chippewa River 07020005-503		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.774	0.774	0.774	0.774	0.774
	Construction Stormwater	0.041	0.023	0.012	0.005	0.001
	Industrial Stormwater	0.041	0.023	0.012	0.005	0.001
Load Allocation	Nonpoint source and channel	35.930	20.154	9.763	3.830	0.036
Margin of Safety (MOS)		4.087	2.331	1.173	0.513	0.090
Total Daily Loading Capacity		40.873	23.305	11.734	5.127	0.902
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	1.9%	3.3%	6.6%	15.1%	85.8%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	87.9%	86.5%	83.2%	74.7%	4.0%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-3 Reach 901 TSS Total Daily Loading Capacities and Allocations.

Unnamed Creek (Freeborn Lake inlet) 07020005-901		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	WWTFs	0.000	0.000	0.000	0.000	0.000
	Construction Stormwater	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	Industrial Stormwater	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Load Allocation	Nonpoint source and channel	0.294	0.167	0.084	0.037	0.006
Margin of Safety (MOS)		0.033	0.019	0.009	0.004	0.001
Total Daily Loading Capacity		0.327	0.186	0.094	0.041	0.007
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	WWTFs	0.0%	0.0%	0.0%	0.0%	0.0%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.8%	89.8%	89.8%	89.8%	89.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-4 Reach 504 TSS Total Daily Loading Capacities and Allocations.

Middle Chippewa River 07020005-504		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.000	0.000	0.000	0.000	0.000
	Construction Stormwater	0.059	0.035	0.018	0.009	0.002
	Industrial Stormwater	0.059	0.035	0.018	0.009	0.002
Load Allocation	Nonpoint source and channel	53.111	31.273	16.129	8.023	1.921
Margin of Safety (MOS)		5.914	3.483	1.796	0.893	0.214
Total Daily Loading Capacity		59.143	34.826	17.961	8.934	2.139
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.0%	0.0%	0.0%	0.0%	0.0%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.8%	89.8%	89.8%	89.8%	89.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-5 Reach 505 TSS Total Daily Loading Capacities and Allocations.

Middle Chippewa River 07020005-505		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.040	0.040	0.040	0.040	0.040
	Construction Stormwater	0.099	0.058	0.030	0.015	0.004
	Industrial Stormwater	0.099	0.058	0.030	0.015	0.004
Load Allocation	Nonpoint source and channel	88.478	52.182	27.032	13.433	3.220
Margin of Safety (MOS)		9.857	5.815	3.015	1.500	0.363
Total Daily Loading Capacity		98.573	58.153	30.147	15.003	3.631
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.0%	0.1%	0.1%	0.3%	1.1%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.8%	89.7%	89.7%	89.5%	88.7%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-6 Reach 530 TSS Total Daily Loading Capacities and Allocations.

Little Chippewa River 07020005-530		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.123	0.123	0.123	0.123	*
	Construction Stormwater	0.011	0.006	0.002	<0.001	<0.001
	Industrial Stormwater	0.011	0.006	0.002	<0.001	<0.001
Load Allocation	Nonpoint source and channel	9.882	5.631	1.250	0.086	0.088
Margin of Safety (MOS)		1.114	0.641	0.153	0.023	0.010
Total Daily Loading Capacity		11.141	6.408	1.529	0.233	0.098
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	1.1%	1.9%	8.0%	52.8%	*
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	88.7%	87.9%	81.8%	37.0%	89.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

*Note – Starbuck and Lowry WWTF effluent TSS concentrations under this TMDL shall not exceed their permitted limit of 30 mg/L and 45 mg/L, respectively, as a calendar monthly average. Permitted point source allocation values were calculated but not factored in the dry condition flow zone allocation since the facilities do not operate at their permitted design flow under these flow conditions. Instead, the point source discharge allocation for the dry flow zone is represented by the following equation: Allocation = (flow contribution from source) X (permitted TSS monthly average).

Table 3-7 Reach 514 TSS Total Daily Loading Capacities and Allocations.

East Branch 07020005-514		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.081	0.081	0.081	0.081	0.081
	Construction Stormwater	0.090	0.045	0.022	0.011	0.003
	Industrial Stormwater	0.090	0.045	0.022	0.011	0.003
Load Allocation	Nonpoint source and channel	80.497	40.164	20.059	9.916	2.927
Margin of Safety (MOS)		8.973	4.482	2.243	1.113	0.335
Total Daily Loading Capacity		89.731	44.817	22.427	11.132	3.349
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.1%	0.2%	0.4%	0.7%	2.4%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.7%	89.6%	89.4%	89.1%	87.4%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-8 Reach 559 TSS Total Daily Loading Capacities and Allocations.

Shakopee Creek 07020005-559		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.000	0.000	0.000	0.000	0.000
	Construction Stormwater	0.051	0.022	0.009	0.004	<0.001
	Industrial Stormwater	0.051	0.022	0.009	0.004	<0.001
Load Allocation	Nonpoint source and channel	45.649	19.943	8.443	3.304	0.254
Margin of Safety (MOS)		5.083	2.221	0.940	0.368	0.028
Total Daily Loading Capacity		50.834	22.208	9.401	3.680	0.283
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.0%	0.0%	0.0%	0.0%	0.0%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.8%	89.8%	89.8%	89.8%	89.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-9 Reach 574 TSS Total Daily Loading Capacities and Allocations.

Unnamed Creek 07020005-574		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.019	0.019	0.019	0.019	*
	Construction Stormwater	0.003	0.001	<0.001	<0.001	<0.001
	Industrial Stormwater	0.003	0.001	<0.001	<0.001	<0.001
Load Allocation	Nonpoint source and channel	2.263	0.978	0.403	0.146	0.013
Margin of Safety (MOS)		0.254	0.111	0.047	0.018	0.001
Total Daily Loading Capacity		2.542	1.110	0.470	0.184	0.014
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.7%	1.7%	4.0%	10.3%	*
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.1%	88.1%	85.8%	79.5%	89.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

*Note – Kerkhoven WWTF effluent TSS concentrations under this TMDL should not exceed its permitted limit of 30 mg/L as a calendar monthly average. Permitted point source allocation values were calculated but not factored in the dry condition flow zone allocation since the facility does not operate at their permitted design flow under these flow conditions. Instead, the point source discharge allocation for the dry flow zone is represented by the following equation: Allocation = (flow contribution from source) X (30 mg/L).

Table 3-10 Reach 508 TSS Total Daily Loading Capacities and Allocations.

Lower Chippewa River 07020005-508		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		TSS Load (tons/day)				
Wasteload Allocation	Permitted Point Source Dischargers	0.393	0.393	0.393	0.393	0.393
	Construction Stormwater	0.248	0.127	0.067	0.031	0.010
	Industrial Stormwater	0.248	0.127	0.067	0.031	0.010
Load Allocation	Nonpoint source and channel	221.936	113.91	59.767	27.398	8.500
Margin of Safety (MOS)		24.758	12.729	6.699	3.095	0.990
Total Daily Loading Capacity		247.583	127.286	66.993	30.948	9.903
Value expressed as percentage of total daily loading capacity						
Wasteload Allocation	Permitted Point Source Dischargers	0.2%	0.3%	0.6%	1.3%	4.0%
	Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
	Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	Nonpoint source and channel	89.6%	89.5%	89.2%	88.5%	85.8%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%

3.4 *Impact of Growth on Allocations*

3.4.1 Point Sources

The current TSS surrogate for meeting the state turbidity standard in the Chippewa River watershed is 54 mg/L. It is assumed that future dischargers will meet this watershed standard for

TSS. If the future dischargers meet this standard, the additional load will be offset by the additional flow associated with the discharge adding to the overall capacity of the receiving water. Consequently, as long as dischargers are required to discharge below 54 mg/L as a daily average, future dischargers will not impact attainment of the water quality standards.

New and Expanding Discharges

The MPCA used the Load Duration Curve (LDC) method to determine the loads required to attain water quality standards. The LDC method uses river flows to determine the allowable loads of TSS. A comparison between the in-stream TSS targets and technology-driven TSS effluent limits contained in MPCA NPDES permits shows that the effluent limits are below the in-stream targets. Thus, as demonstrated by Tetratech (Cleland, 2011), discharges from these facilities provide assimilative capacity beyond that which is required to offset their respective TSS loads. Although facilities are discharging below the in-stream targets, they are still discharging the pollutant of concern (TSS), and therefore individual wasteload allocations are required (wasteload allocations are listed in Table 3-1; derivation methodology is described in section 3.2.1).

The NPDES wasteload allocations in this TMDL are based upon current discharges. For a new or expanding (non-stormwater) NPDES-permitted facility in the watershed, permit limits will maintain discharge effluent at a concentration below the respective in-stream TSS concentration target. A new or expanding facility will increase both load and flow. This effect will be most pronounced in lower flows, when conventional point sources have the greatest impact. The increased flow will effectively increase the overall assimilative capacity of the river, as the flow increase will be larger proportionally than the load increase.

The analysis by Tetratech (Cleland, 2011) summarized above demonstrates that current discharges can be expanded and new NPDES discharges can be added while maintaining water quality standards, provided the permitted NPDES effluent concentrations remain below the in-stream targets. Given this circumstance, a streamlined process for updating TMDL wasteload allocations to incorporate new or expanding discharges will be employed. This process will apply to the non-stormwater facilities identified in section 3.2.1 of the TMDL (in the case of expansion) and any new wastewater or cooling water discharge in the portion of the Minnesota River Basin to which this TMDL applies:

1. A new or expanding discharger will file with the MPCA permit program a permit modification request or an application for a permit reissuance. The permit application information will include documentation of the current and proposed future flow volumes and TSS loads.

2. The MPCA permit program will notify the MPCA TMDL program upon receipt of the request/application, and provide the appropriate information, including the proposed discharge volumes and the TSS loads.

3. TMDL Program staff will provide the permit writer with information on the TMDL wasteload allocation to be published with the permit's public notice.

4. The supporting documentation (fact sheet, statement of basis, effluent limits summary sheet) for the proposed permit will include information about the TSS discharge requirements, noting that for TSS, the effluent limit is below the in-stream TSS target and the increased discharge will maintain the turbidity water quality standard. The public will have the opportunity to provide comments on the new proposed permit, including the TSS discharge and its relationship to the TMDL.

5. The MPCA TMDL program will notify the EPA TMDL program of the proposed action at the start of the public comment period. The MPCA permit program will provide the permit language with attached fact sheet (or other appropriate supporting documentation) and new TSS information to the MPCA TMDL program and the US EPA TMDL program.

6. EPA will transmit any comments to the MPCA Permits and TMDL programs during the public comment period, typically via e-mail. MPCA will consider any comments provided by EPA and by the public on the proposed permit action and wasteload allocation and respond accordingly; conferring with EPA if necessary.

7. If, following the review of comments, MPCA determines that the new or expanded TSS discharge, with a concentration below the in-stream target, is consistent with applicable water quality standards and the above analysis, MPCA will issue the permit with these conditions and send a copy of the final TSS information to the USEPA TMDL program. MPCA's final permit action, which has been through a public notice period, will constitute an update of the WLA only.

8. EPA will document the update to the WLA in the administrative record for the TMDL. Through this process EPA will maintain an up-to-date record of the applicable wasteload allocation for permitted facilities in the watershed.

3.4.2 Municipal Separate Storm Sewer Systems

There are currently no regulated MS4 communities in the watershed (besides Montevideo, which is accounted for in the Minnesota River Turbidity TMDL) although there are several small communities. There are no current plans to expand or develop MS4 communities in the watershed for the foreseeable future. Because there is no way to estimate the potential stormwater contributions from future MS4 communities and there are no current plans that suggest such development will occur, no future allocation has been established for MS4 stormwater. However, it is safe to assume that any development in the watershed will need to provide appropriate treatment to meet the established load allocations.

3.4.3 Municipal Separate Storm Sewer Systems

Reserve capacity refers to load that is available for future growth. With regard to permitted point source dischargers, the main potential impact could be to new or expanded discharges from treatment facilities requiring NPDES permits. Should authorization for new or expanded discharges be sought, approval is not likely to have an adverse impact on the listed reach involved provided discharge limits are met. This is because increased flows associated with those discharges will add to the overall loading capacity of the system.

The allocations for non-permitted sources are for all current and future sources. This means that any expansion of non-permitted sources will be expected to comply with the load allocations provided in this report.

4.0 Turbidity Source Assessment

4.1 *Assessment of Sources*

When assessing sources of turbidity and ultimately TSS in streams, the first step is to determine the relative proportions of external and internal sources. External sources include those sources outside of the stream channel and include point sources, field and gully erosion, livestock grazing and stormwater from construction sites and impervious surfaces. Internal sources of sediment include sediment resuspension, bank erosion and failure, and in-channel algal production. Following is a description of potential sediment sources in the Chippewa River watershed.

Identifying the sources of turbidity in a stream system is difficult because of the complex nature of stream systems and their interaction with the watershed. However, a general sense of the timing, magnitude and sources of TSS can be developed using available data to provide a weight of evidence for the sources. Following is a description of some methods used to develop a better understanding of potential sources in the system. It is important to note that these estimates of sources do not affect the established TMDL allocations which is based off of the load duration curves and flow developed for each of the streams.

4.2 *Surface Erosion and other Non-point Sources*

Surface erosion or erosion from sources other than in stream sources (stream banks, gullies, and bed load) has the potential to be a significant source of sediment given the nature of soil types and land use in the watershed. Surface erosion can include any of the following sources; urban storm water, field erosion, lakeshore development, overland runoff, construction sites, impervious surfaces, and all land uses to differing extents.

Pollution from agricultural runoff is generally considered non-point pollution, for which there is limited regulation. Methods other than enforcement are used for mitigating non-point source pollution, and funding exists from federal and state sources for the voluntary installation of best management practices for reduction or elimination of non-point source pollution.

Open tile intakes can directly deliver sediment to the stream during precipitation events. Field and gulley erosion can also occur during storm events, leading to direct contributions of sediment to streams. Feedlots near streams and watercourses with pollution hazards can contribute to excess turbidity via soil and phosphorus runoff. Livestock overgrazing in riparian areas can contribute to excess turbidity via soil and phosphorus runoff directly from devegetated areas, resuspending of sediments by walking in the stream, and by destabilizing the banks leading to increased bank erosion or slumping. Row cropland can contribute to excess turbidity via sheet/rill erosion of soil either overland or via surface tile intakes, wind-eroded soil settling in ditches that are then flushed during rain events, destabilization of banks (if inadequate buffers) leading to increased bank erosion, and also drainage alterations on cropped land can lead to increased flows which can then cause bank/bed erosion. Corn and soybeans are grown on much of the harvested cropland in the watershed, and much of the poorly drained row cropland in the watershed has been tiled to improve drainage. In cases where there are no stream buffers, runoff may enter streams directly and is not slowed to allow sediments to filter out.

Ditches and/or straightened stream segments can be turbidity sources. Such watercourses are shorter in length than the natural channel and, thus, steeper in gradient. As such they generally exhibit higher velocities and higher peak flows. Changes in gradient can result in headcutting. Also, their geometry is such that there is limited access to the floodplain. Downcutting can occur, exacerbating the entrenchment of the watercourse and thus further keeping and concentrating flow energy in the channel. Straightened channels also exhibit a continuous tendency to revert to a meandering condition. The net result is increased potential for bank erosion. Temporary release of sediments also occurs during ditch and pond cleaning/dredging. Tiling and impervious cover can exacerbate the condition depending on soil conditions by increasing the volume and peak rate of runoff to the system.

4.3 *Permitted Point Sources*

Discharge monitoring reports (DMRs) were downloaded to assess monthly average TSS effluent concentrations for each wastewater treatment facility in the Chippewa Watershed with DMR data. A TSS effluent summary for facilities with available monitoring data is presented in Table 4-1. The monitoring shows all facilities typically discharge at TSS concentrations below their permit limit and the TMDL TSS surrogate.

Table 4-1. Discharge Monitoring Report TSS effluent summary for facilities with monitoring records.

Facility	Reach	Years Monitored	TSS Monthly Permitted Limit (mg/L)	Monthly Measurements	Measurements Above Permit Limit	Measurements Above TMDL Surrogate
Evansville WWTF	503	1999-2008	45	44	4	3
Farwell-Kensington WWTF	503	2002-2008	45	25	1	1
Benson WWTF	508	1999-2008	30	116	1	1
Hancock WWTF	508	2002-2008	45	78	29	19
Starbuck	530	1999-2008	30	110	0	0
Hoffman	503	1998-2008	45	59	9	8
Clontarf	505	2006-2008	45	3	0	0

CVEC	506	1999-2008	45	55	5	3
Danvers	508	1998-2008	45	30	8	4
Murdock	514	1999-2008	45	39	17	17
Sunburg	514	2001-2008	45	17	5	3

Construction Stormwater: Categorical WLA

The wasteload allocation for stormwater discharges from sites where there is construction activities reflects the number of construction sites ≥ 1 acre expected to be active in the watershed at any one time, and the Best Management Practices (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. It should be noted that all local construction stormwater requirements must also be met.

Industrial Stormwater: Categorical WLA

The wasteload allocation 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 coverage under the appropriate NPDES/SDS General Stormwater 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. It should be noted that all local stormwater management requirements must also be met.

4.4 *Bank Erosion*

The primary sources of sediment in streams are sediment conveyed from the landscape and soil particles detached from the streambank. The amount of sediment conveyed from the landscape will vary based on general soil erodibility, land cover, slope, and conveyances to the stream. Streambank erosion is a natural process that can be accelerated significantly as a result of change in the watershed or to the stream itself.

To evaluate whether soil loss from streambank erosion may be contributing significantly to suspended sediment load, a random sampling of stream reaches on various streams within the watershed were evaluated for stability and amount of observed soil loss by severity. The annual soil loss by mile by stream order was estimated, and the results extrapolated to all streams in the watershed.

The annual soil loss by mile was estimated using field collected data and a method developed by the Natural Resources Conservation Service referred to as the “NRCS Direct Volume Method,” or the “Wisconsin method,” (Wisconsin NRCS 2003). Soil loss is calculated by:

1. measuring the amount of exposed streambank in a known length of stream;
2. multiplying that by a rate of loss per year;
3. multiplying that volume by soil density to obtain the annual mass for that stream length; and then
4. converting that mass into a mass per stream mile.

The Direct Volume Method is summarized in the following equation:

$$\frac{\underline{(\text{eroding area})\ (\text{lateral recession rate})\ (\text{density})}}{2000\ \text{lbs/ton}} = \text{erosion in tons/year}$$

The eroding area is in square feet, the lateral recession rate is in feet/year, and density is in pounds/cubic feet (pcf).

4.4.1 Streambank Conditions

The stream network used for this analysis was the Minnesota DNR Stream Order shapefile dated April 2008. As a first step, GIS analysis identified each quarter section of land in the watershed that contained a segment of stream of third order or higher on the stream order network. First and second order streams were not included in this part of the analysis because in most agricultural watersheds they consist mainly of stable grassed swales and very small streams that are rarely a significant source of in-stream sediment. Each identified quarter section was assigned a unique number, and a random number generator was used to select quarter sections for evaluation so that a representative number of quarter sections by stream order were selected.

Streams within these randomly selected quarter sections were walked and field evaluated for bank condition and potential risk for and severity of erosion. Not all of the randomly selected quarter sections were evaluated. Some were not accessible, and for others landowner permission was not able to be obtained. Staff availability also limited field data collection. A total of 161 quarter sections were selected. Data were available for 40 of those sites. The evaluated sites were geographically dispersed, and included stream segments primarily for stream orders three and four, although some fourth and fifth order stream segments were evaluated.

The following sections describe how each of the parameters in the Direct Volume equation was estimated for these streams.

Eroding Area

The eroding area is defined as that part of the streambank that is bare, rilled, or gullied, and showing signs of active erosion such as sloughed soil at the base. The length and width of the eroding face of the streambank is multiplied to get eroding area.

As the evaluators walked each of the randomly-selected quarter sections, each area of significant erosion on either side of the streambank was measured and recorded on a field sheet. Most of the reaches that were evaluated contained long stretches of continuous bare streambank. Elsewhere, professional judgment was used to determine which areas were significant.

Lateral Recession Rate

The lateral recession rate is the thickness of soil eroded from a streambank face in a given year. Soil loss may occur at an even rate every year, but more often occurs unevenly as a result of large storm events, or significant land cover change in the upstream watershed. Historic aerial or other photographs, maps, construction records, or other information sources may be available to estimate the total recession over a known period of time, which can be converted into an average rate per year. However, these records are often not available, so the recession rate is estimated based on streambank characteristics that evaluate risk potential. Table 4-2 presents the categories of bank condition that are evaluated and the varying levels of condition and associated risk severity score.

Table 4-2 Bank Condition Severity Rating.

Category	Observed Condition	Score
Bank Stability	Do not appear to be eroding	0
	Erosion evident	1
	Erosion and cracking present	2
	Slumps and clumps sloughing off	3
Bank Condition	Some bare bank, few rills, no vegetative overhang	0
	Predominantly bare, some rills, moderate vegetative overhang	1
	Bare, rills, severe vegetative overhang, exposed roots	2
	Bare, rills and gullies, severe vegetative overhang, falling trees	3
Vegetation / Cover on Banks	Predominantly perennials or rock	0
	Annuals / perennials mixed or about 40% bare	1
	Annuals or about 70% bare	2
	Predominantly bare	3
Bank / Channel Slope	V – shaped channel, sloped banks	0
	Steep V - shaped channel, near vertical banks	1
	Vertical Banks, U – shaped channel	2
	U – shaped channel, undercut banks, meandering channel	3
Channel Bottom	Channel in bedrock / non eroding	0
	Soil bottom, gravels or cobbles, minor erosion	1
	Silt bottom, evidence of active down cutting	2
Deposition	No evidence of recent deposition	1
	Evidence of recent deposits, silt bars	0

A Cumulative Rating score of 0-4 indicates a streambank at slight risk of erosion. A score of 5-8 indicates a moderate risk, and nine or greater a severe risk. The Wisconsin NRCS used its field data from streams in Wisconsin to assign a lateral recession rate for each category (Table 4-3). Professional judgment is necessary to select a reasonable rate within the category

Table 4-3 Estimated Annual Lateral Recession Rates Per Severity Risk Category.

Lateral Recession Rate (ft/yr)	Category	Description
0.01 - 0.05 feet per year	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06 - 0.15 feet per year	Moderate	Bank is predominantly bare with some rills and vegetative overhang. Some exposed tree roots but no slumps or slips.
0.16 - 0.3 feet per year	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross section becomes U-shaped as opposed to V-shaped.
0.5+ feet per year	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross section is U-shaped and stream course may be meandering.

At each of the measured erosion areas in the randomly selected quarter sections, evaluators performed the above severity assessment and recorded on the field sheet the score for each of the condition categories above. Evaluators also evaluated Rosgen's Bank Erosion Hazard Index (BEHI), a measure of bank erosion potential.

Density

At each of the evaluated locations, soil texture was field evaluated and noted on the field sheet.

4.4.2 Annual Streambank Soil Loss

Data were compiled into a spreadsheet database that summarized for each selected quarter section stream length, total eroding area, Bank Condition Severity Rating, and soil texture. The selected recession rates in Table 4-3 were applied.

Table 4-4 Assumed Recession Rate Based on Bank Condition.

Bank Condition Severity Rating	Assumed Recession Rate (ft/yr)
≤7	0.15
8-10	0.25
≥11	0.5

The assumed recession rate was multiplied times the total eroding area to obtain the estimated total annual volume of soil loss (Table 4-4). To convert this soil loss to mass, soil texture or actual measured bulk dry density was used to establish a volume weight for the soil. The following volume weights by texture were assumed:

Table 4-5 Assumed Volume Weight for Various Soil Textures.

Soil Texture	Wisconsin NRCS Average Range (lbs/cu-ft) (pcf)	Assumed Volume Weight (lbs/cu-ft) (pcf)
Clay	60-70	65
Silt	75-90	N/A
Silty Clay		75
Silty Clay Loam		80
Sand	90-110	N/A
Sandy Clay		85
Sandy Clay Loam		90
Loam	80-100	N/A
Sandy Loam	90-110	100

N/A = No field-identified soil textures of this type.

The total estimated volume of soil per quarter section was multiplied by the assumed volume weight and converted into annual tons. As a final step, the mass was divided by the evaluated stream length in miles to obtain an estimated annual soil loss in tons per mile. These data were used to establish a range of annual soil loss by stream order for each subwatershed. No first or second order sites were assessed; therefore the ranges used were based on annual soil loss experienced in other Minnesota agricultural watersheds.

It is important to note that the amount of soil lost from the bank does not translate directly to Total Suspended Solids. Only a portion of the soil eroded ends up being suspended in the water column the rest becomes bed load and does not get recorded by the Total Suspended Solids measurement.

Some of the evaluated sites on the main stem with the most severe erosion were estimated to experience annual soil loss at a rate significantly greater than seen at other sites, in the range of 600-800 tons per mile per year. Those values were not considered when establishing the typical range but do serve to illustrate the variability in the amount of streambank soil loss that appears to be occurring in the watershed.

As a final step in the estimation of soil loss from streambank erosion, these rates were applied to all streams in the watershed. Stream length by order was summed for each of the seven subwatersheds, and the rates applied to estimate the total mass of soil loss (Table 4-6).

Table 4-6 Extrapolated Annual and Monthly Streambank Soil Loss by Subwatershed

Subwatershed and Stream Order	**Stream Miles**	**Estimated Rates (tons/mi/yr)**		**Annual Soil Loss (ton/yr)**		**Monthly Soil Loss (ton/yr)**	
		Low Rate	**High Rate**	**Low Rate**	**High Rate**	**Low Rate**	**High Rate**
East Branch - includes Reach 514							
1st order	271.62	1	10	272	2,716	23	226
2nd order	77.99	10	50	780	3,900	65	325
3rd order	82.20	100	200	8,220	16,439	685	1,370
4th order	45.07	100	300	4,507	13,522	376	1,127
5th order	15.10	100	400	1,510	6,039	126	503
East Branch total	491.99			15,289	42,616	1,275	3,551
Lower Chippewa - includes Reach 508							
1st order	222.15	1	10	222	2,222	19	185
2nd order	78.59	10	50	786	3,929	66	327
3rd order	49.20	50	100	2,460	4,920	205	410
4th order	19.89	100	300	1,989	5,967	166	497
5th order	16.15	100	400	1,615	6,461	135	538
6th order	18.60	100	400	1,860	7,442	155	620
Lower Chip total	404.48			8,932	30,941	746	2,577
Middle Chippewa - includes Reaches 504,505,530							
1st order	268.29	1	10	268	2,683	22	224
2nd order	69.54	10	50	695	3,477	58	290
3rd order	90.10	100	200	9,010	18,019	751	1,502
4th order	46.70	100	400	4,670	18,680	389	1,557
Middle Chip total	474.62			14,643	42,859	1,220	3,573
Shakopee Creek - includes Reaches 559,574							
1st order	225.99	1	10	226	2,260	19	188
2nd order	100.37	10	50	1,004	5,019	84	418
3rd order	55.19	100	500	5,519	27,595	460	2,300
4th order	14.71	100	500	1,471	7,354	123	613
5th order	13.73	100	500	1,373	6,864	114	572
Shakopee Cr total	409.99			9,593	49,092	800	4,091
Upper Chippewa - includes Reach 503							
1st order	211.21	1	10	211	2,112	18	176
2nd order	80.59	10	50	806	4,029	67	336
3rd order	23.41	100	300	2,341	7,022	195	585
4th order	46.79	100	300	4,679	14,036	390	1,170
Upper Chip total	361.99			8,037	27,199	670	2,267

Table 4-6, cont. Estimated Annual and Monthly Soil Loss by Subwatershed.

A stream of the first order is a stream which does not have any other stream feeding into it. When two first-order streams come together, they form a second-order stream. When two second-order streams come together, they form a third-order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream. Thus, if a first-order stream joins a second-order stream, it remains a second-order stream. It is not until a second-order stream combines with another second-order stream that it becomes a third-order stream.

In many watersheds with primarily agricultural land use, first order streams tend to be relatively stable grassed swales that function mainly to convey snowmelt and large events. Second order streams also tend to be stable small streams, although they can experience significant streambank loss at crossings and where animals have direct access to the water. Nearly every third and fourth order stream segment evaluated for this stream assessment exhibited some evidence of current and ongoing streambank soil loss.

The Rosgen Bank Erosion Hazard Index (BEHI) findings corresponded well to the field findings of streambank soil loss. The BEHI evaluates susceptibility to erosion from different types of erosion processes and combines scores on seven variables into a single numerical rating. These variables include the relationship between bank height and bankfull height; the relationship between bank height and the depth of bank stabilized by vegetation roots; the density of the stabilizing root mass; the angle of the bank; and the amount of bank surface protected from erosion by sod, woody debris, bedrock, etc. Adjustments can be made to the score depending on the predominant bank material and its general susceptibility to erosion.

Streambanks that are generally high compared to bankfull elevation and rooting depths shallow compared to bank height, or where banks are nearly vertical, are more susceptible to erosion. These are characteristics typical of overly-incised streams. Stream segments in this stream assessment where measured erosion features suggest a higher rate of annual soil loss tended to have higher, more vertical banks and shallower rooting depths. Channel incision can result from many causes, but is typically a result of change in hydrologic regime such as adding flow from stormwater, historic or present-day agricultural ditching and tiling, or stream straightening. The resulting increase in stream power and shear stress accelerates streambank erosion. Significant changes in land use and land cover in the watershed can alter the historic bankfull elevation, increasing its frequency and subjecting additional streambank to erosive flows. Based on the stream assessment findings it is likely that watershed and hydrologic regime modifications in the watershed have resulted in increased rates of streambank erosion and volumes of streambank soil loss.

4.4.3 Other Monitoring Sites

Over the past ten years Chippewa River Watershed Project staff has monitored water chemistry at thirty four sites. Some of these sites have been monitored continuously over these ten years while others were monitored for a range of one to three years. Monitoring site equipment at most of these sites measured water levels every 15 minutes, 24 hours a day, over the course of the monitoring season. State certified lab analyses of both turbidity and TSS along with field transparency (T-tube) were collected at these sites. These analyses were collected 21 to 30 times a year at each site by trained CRWP staff. These sites represent a wealth of information that will help in the assessment of upstream sources.

4.4.4 Total Suspended Volatile Solids

The significance of sediment vs. organic matter to the Chippewa River turbidity impairments is important. In the Chippewa River watershed, in numerous cases, Total Suspended Volatile Solids (TSVS) (the organic component of TSS) was key in the TSS sample exceeding the standard. Organic matter contributions to turbidity must be addressed along with inorganic sediment to meet water quality standards. Although TSVS constitutes less of the total TSS load in the Chippewa River than sediment, high summer TSVS concentrations prolong the duration of high turbidity and water quality standard exceedance.

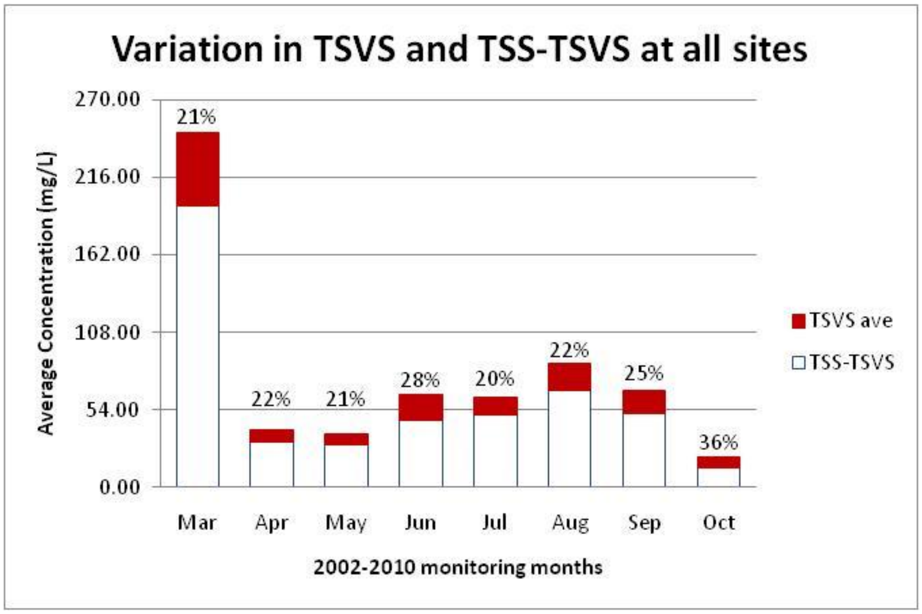


Figure 4-1 Variation of organic and inorganic suspended solids (Chippewa R.).

In numerous cases during the summer months TSVS levels on top of already high inorganic sediment levels pushed the turbidity exceedances above the standard. Inorganic sediment from other sources is abundant, contributing to high TSS and turbidity levels in streams. However in the warm months, some lakes, wetlands and instream regions contribute TSVS to streams and rivers via algae, diatoms and other organic particles.

4.4.5 Transparency Transect Surveys

Transparency Transect Surveys are a powerful assessment tool used in the Chippewa River Watershed. Transparency Transect Surveys were conducted by CRWP staff from 1999 through 2010. They essentially consist of following a tributary from its farthest point to its confluence with the main tributary. As the stream being surveyed flows under a road crossing, the water is sampled for various parameters (transparency, presence and width of stream buffer, etc.)

Ten years of transect surveying on the Chippewa River and its tributaries have resulted in fairly consistent patterns from one site to the next as water moves downstream. The patterns suggest across the watershed that areas with histories of high transparency areas of low transparency are not shifting significantly. This pattern has proven to repeat consistently from year to year.

Transparency transect surveys have identified sites that consistently exhibit poor transparency in certain regions. These can suggest possible sources to the turbidity impairments.

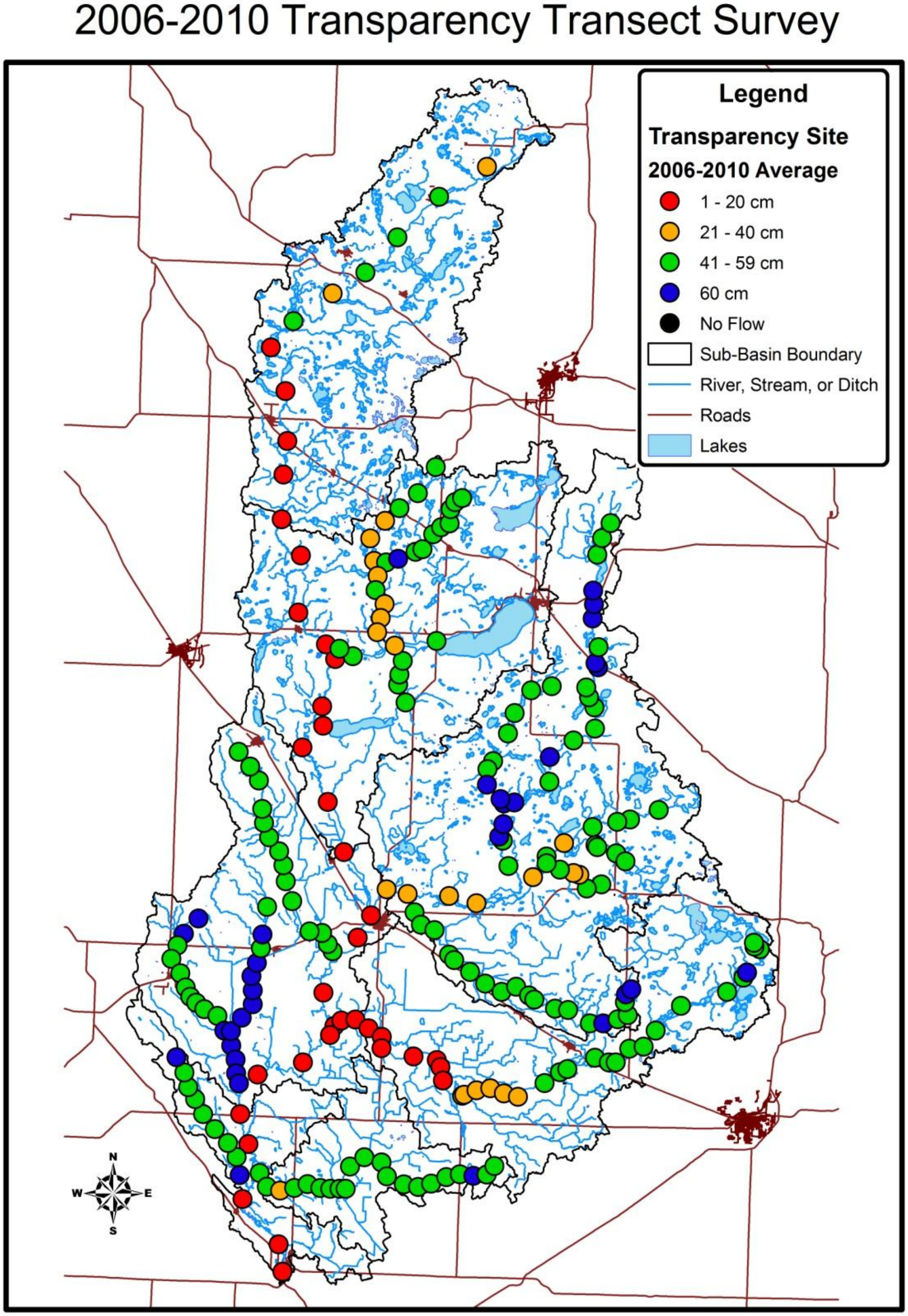


Figure 4-2 Transparency Transect Survey Averages 2006-2010**.**

4.5 *Source Summary*

A potential source assessment was developed for each of the major subwatersheds in the Chippewa River watershed. An important concept in the development of TMDLs for specific reaches in a watershed is that of scale. The Chippewa River watershed is quite complex with dominant landscape features including wetlands and lakes both on and off of the main drainage channels. For the purposes of this source assessment, the TMDL analysis for the nine impaired stream reaches provides an indication of the overall magnitude of sediment issues in the watershed and the source assessment focuses on all of the potential sources. Some of these sources may not contribute directly to the listed reach (i.e. they may pass through a wetland or lake first) however, these processes still contribute to turbidity issues in the entire watershed. Consequently, this TMDL is focused on obtaining the turbidity standard throughout the entire watershed and not just the listed reaches.

TSS for each reach was plotted on a load duration curve using the continuous flow data from the closest in-reach or downstream monitoring station. The following figures show all TSS and/or TSS-equivalent (from transparency readings) samples collected from the station(s) located within the reach as well as the daily loading capacity over the entire flow record. Values that lie above the standard load duration curve represent samples that exceed the 54 mg/L TSS-surrogate. The data show that TSS concentrations commonly exceed the 54 mg/L standard across all flow regimes and some reaches have significantly more violations than others. Also plotted in these figures is the 90th percentile TSS load for each flow regime and the loading capacity at the 45th percentile (median minus MOS). The difference between the loading capacity and the 90th percentile of sampled loads produced an estimated percent reduction in TSS that will be needed to remove each reach from the impaired waters list.

4.5.1 Upper Chippewa River

The main stem of the Chippewa River in the Upper Chippewa subwatershed demonstrated the majority of exceedances in the low to high flow range with few violations in the very high and dry conditions (Figure 4-3). Exceedances in low flow conditions may be related to algal growth in the channel or point source discharges. There are three point sources in the Upper Chippewa subwatershed including the Farwell-Kensington and Evansville WWTFs. Each of these facilities did have at least one monthly average TSS violation but both consistently discharge well below their effluent limits. Only the Hoffman WWTF discharges directly to the main stem Chippewa River.

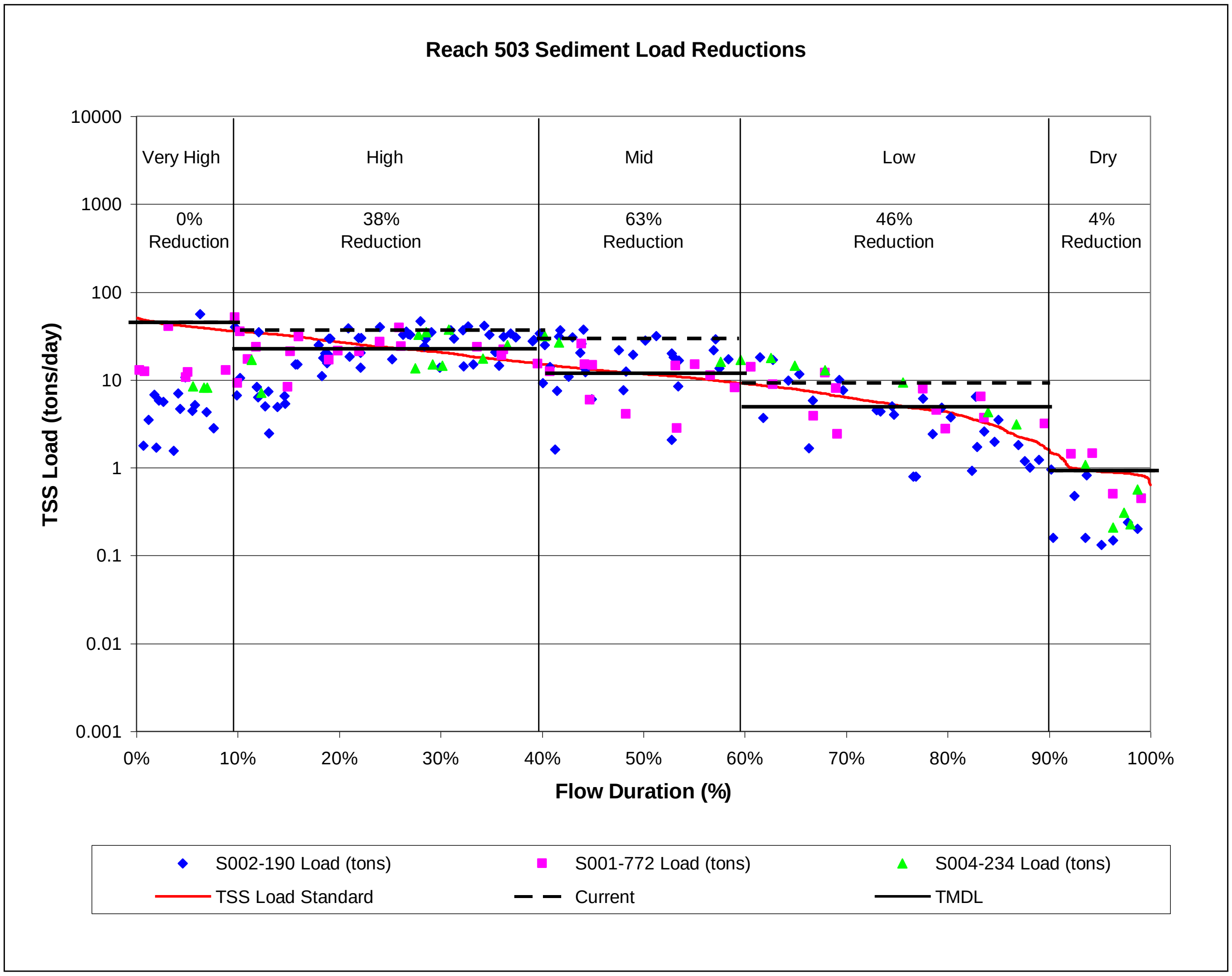


Figure 4-3 Reach 503 (Upper Chippewa) Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

Exceedances in the low to high flow range are partially attributed to rain events impacting bank and surface erosion. The Upper Chippewa Watershed has many steep slopes and erodible soils. Surface erosion has the potential to be high. The Upper Chippewa basin largely flows through wetland and open water especially in the northern most portion of the watershed. The wetland

and lakes provide a fair amount of settling in the watershed preventing the soil from making it to the channel.

Transparency transect surveys from 2006-2010 in the Upper Chippewa suggest issues in and around Peterson Lake in NE Grant County. Average transparency drops from 47 cm before the lake to 19 cm after the lake (below the 20 cm surrogate). Furthermore, it is not until Peterson Lake that transparency levels exceed the standard more than ten percent of the time. 73% of all samples exceeded the standard at the transect site below Peterson Lake. Water transparency averaged below 20 cm for all transect sites downstream of this point.

Water chemistry and transparency samples collected in 2009-2010 upstream of Peterson Lake at MPCA site S005-630 (between Erwin and Albert Lakes) documented exceedances for only 7% of samples (total number samples=29). This and the previously mentioned transparency samples suggest that the excessive turbidity begins at Peterson Lake and continues to be an issue as the river makes its way downstream.

One prospective source of TSS in Peterson Lake is carp. Schools of carp have been observed swimming into or out of Peterson Lake. More information is needed to determine how significant of an impact these fish are having on Peterson Lake TSS levels.

Another possible source of in stream TSS in the river channel below Peterson Lake is cattle in the river. Many of the transect samples were accompanied by comments noting the presence of cattle in the river. The impact of cattle in the river and on the river banks could be significant dependant on their numbers and the duration of their disturbance.

At the Upper Chippewa River outlet site (S002-190), Total Suspended Volatile Solids (TSVS) represent a sizable portion of the overall TSS. TSVS measures the organic component of a TSS sample and is generally comprised of algae, diatoms and other organic particles. Since 2002 TSVS has accounted for on average about 27% of the TSS in any given sample. This would suggest that the algae and organic particles are a sizable source of TSS.

Algae data were not available for the channel; however several lake outlets were monitored for TSS (Figure 4-4). Of the five lake outlets monitored, none of them exceeded the Chippewa River TSS standard. The only exceedances occurred in an inflow channel to Freeborn Lake.

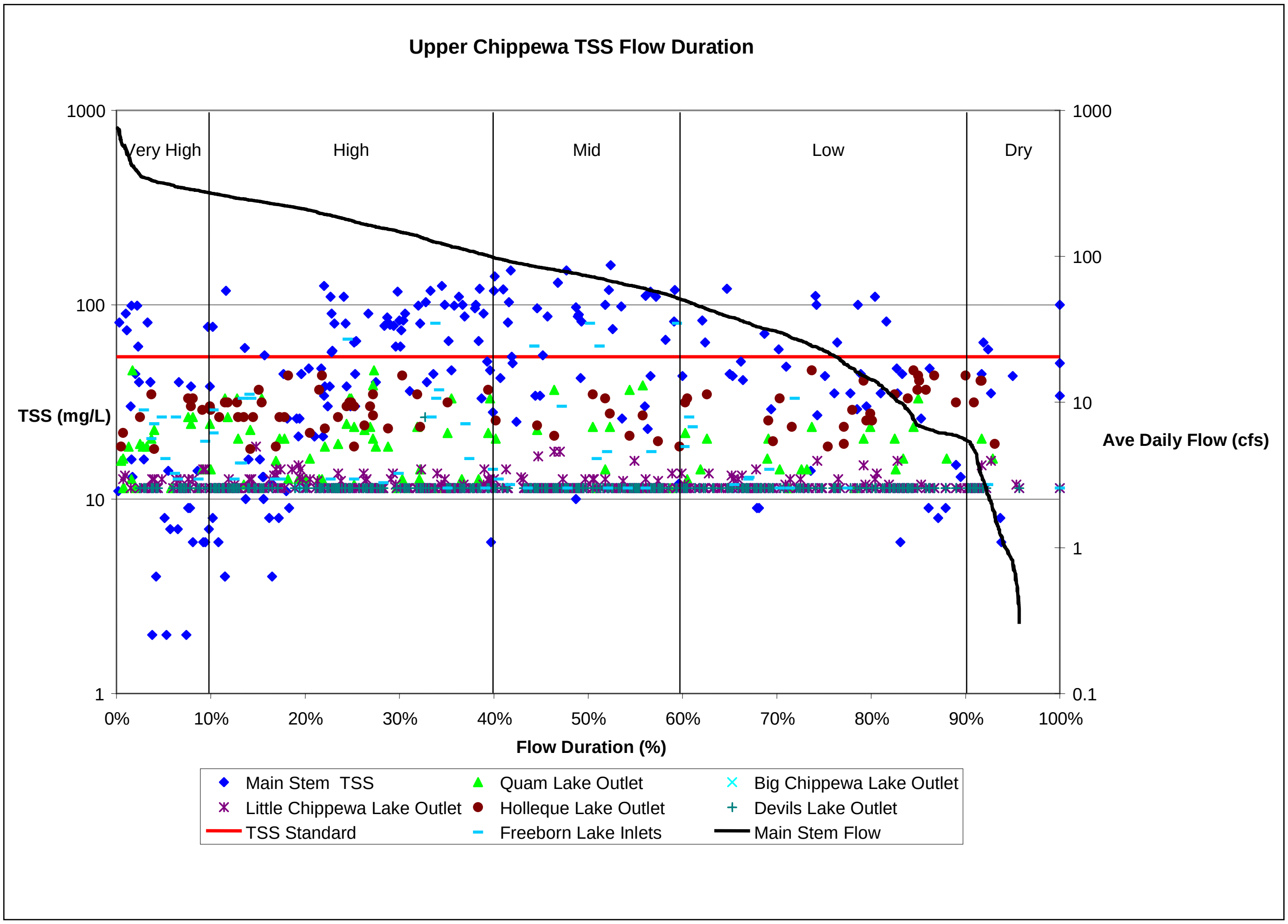


Figure 4-4 Reach 503 (Upper Chippewa) Lake Outlet TSS. TSS results of 10 mg/L or less are at detection limit.

4.5.1.1 Freeborn Lake, Reach 901

The Freeborn Lake inlet channel, Reach 901, was included on the 303(d) list of impaired waters in 2006 and the TMDL is included in this report. The data set for the Freeborn Lake inlet is fairly limited and includes exceedances in the mid and high flow ranges.

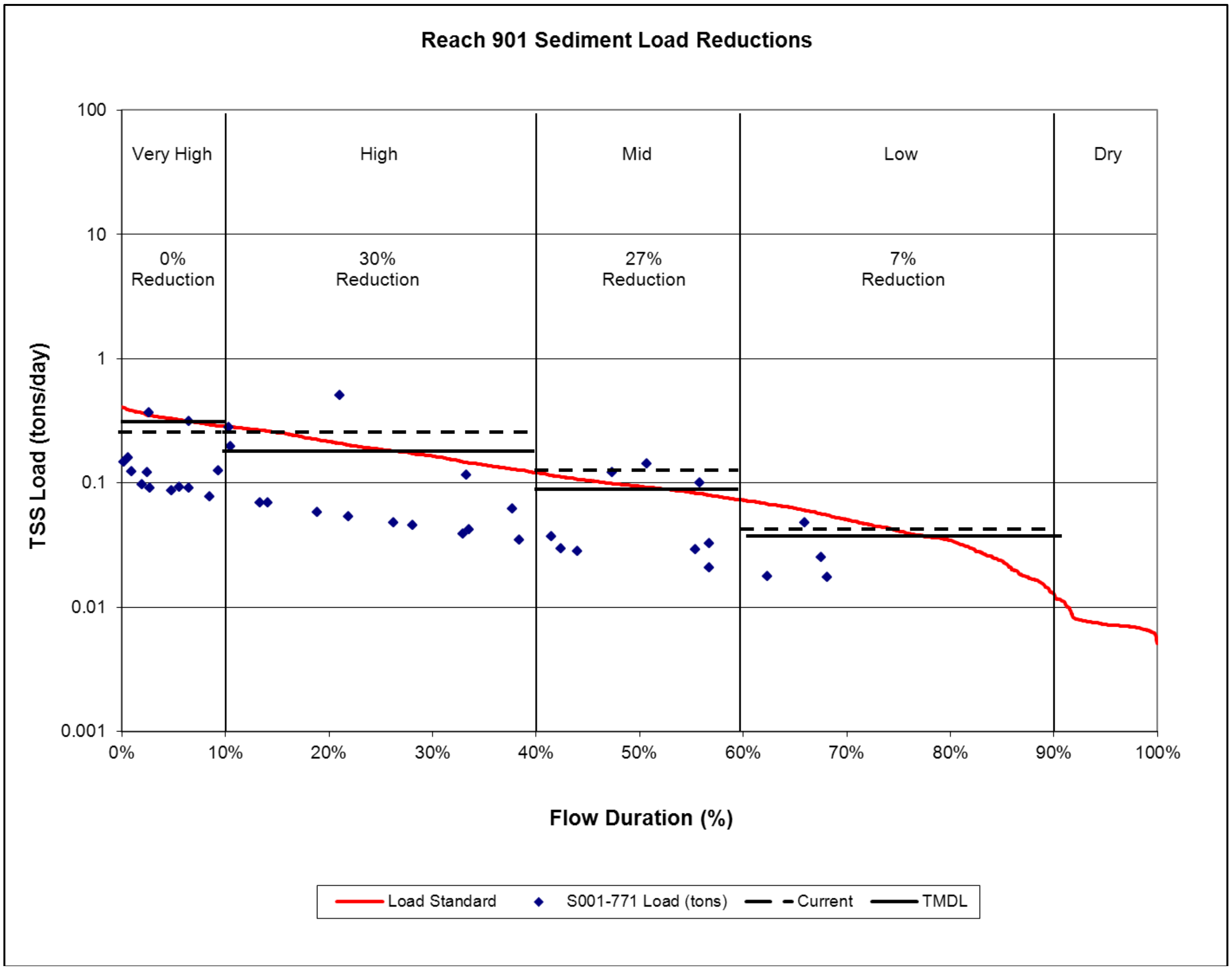


Figure 4-5 Reach 901, Freeborn Lake, Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

4.5.2 Middle Chippewa River

Two reaches comprise the main stem of the Chippewa River in the Middle Chippewa River subwatershed (Reach 504 and 505). Reach 504 has a limited amount of data; however exceedances occurred in all of the flow categories (Figure 4-6). Reach 505 had a robust data set and demonstrated exceedances across all of the flow conditions except for extremely high flows (Figure 4-7). There are no point sources discharging directly to either of these two reaches.

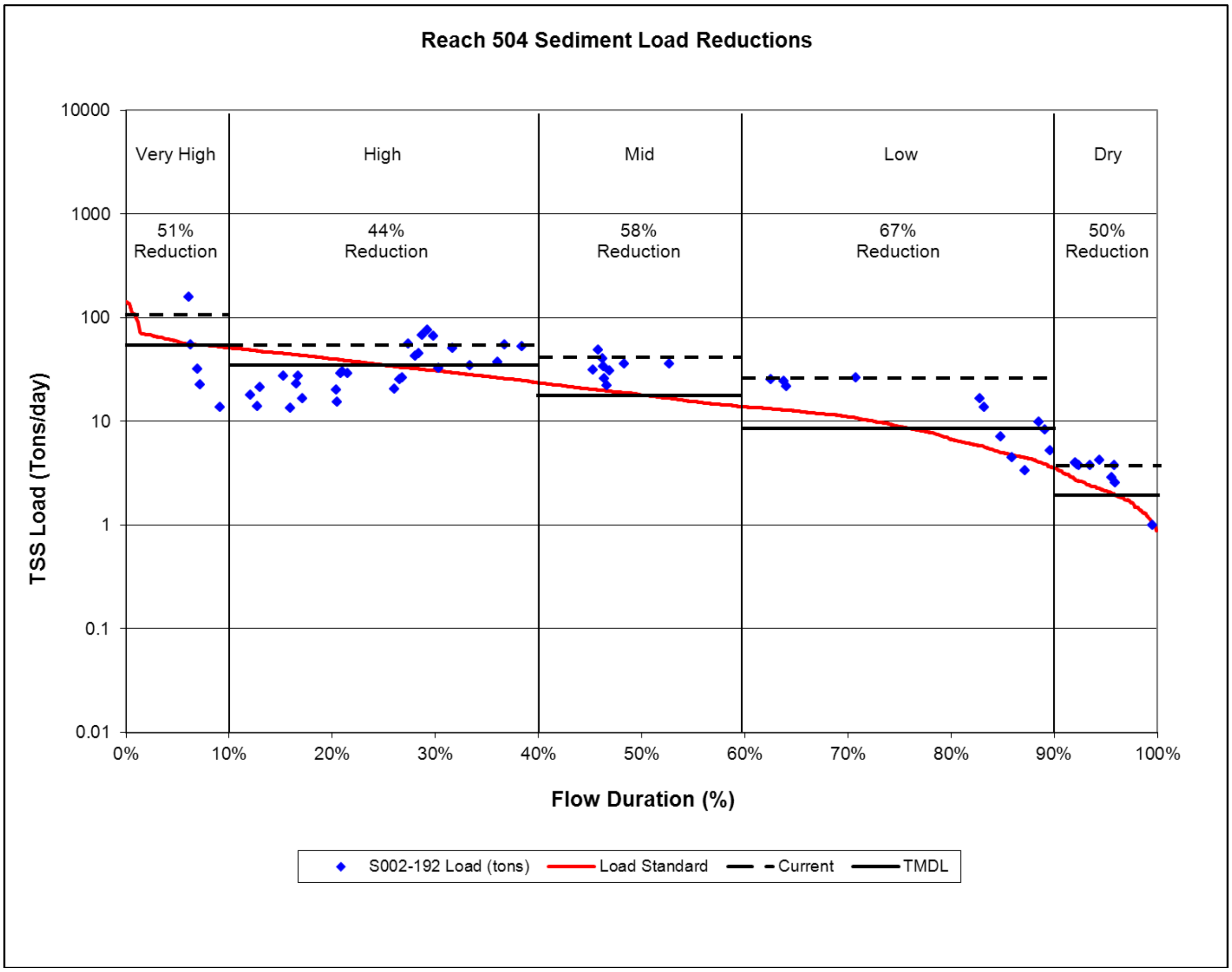


Figure 4-6 Reach 504 (Middle Chippewa River) Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

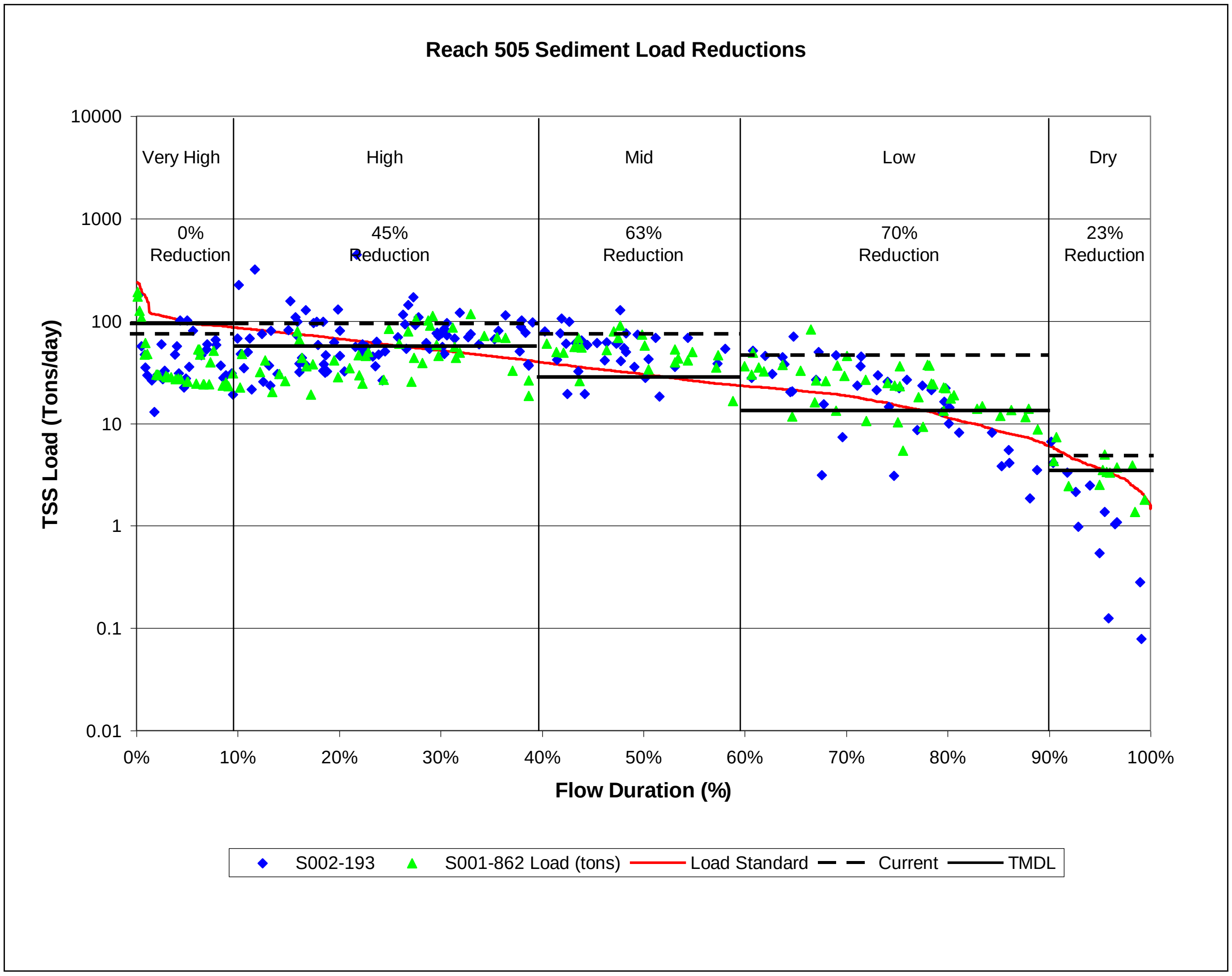


Figure 4-7 Reach 505 (Middle Chippewa River) Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

The Middle Chippewa River subwatershed has many steep fields and highly erodible soils. This subwatershed also has many wetlands, lakes and depressed areas where sediments can settle out. Bank erosion estimates suggest that significant sediment is generated in-channel. Based on these considerations, bank erosion and surface erosion are likely influential sources of TSS in the Middle Chippewa River.

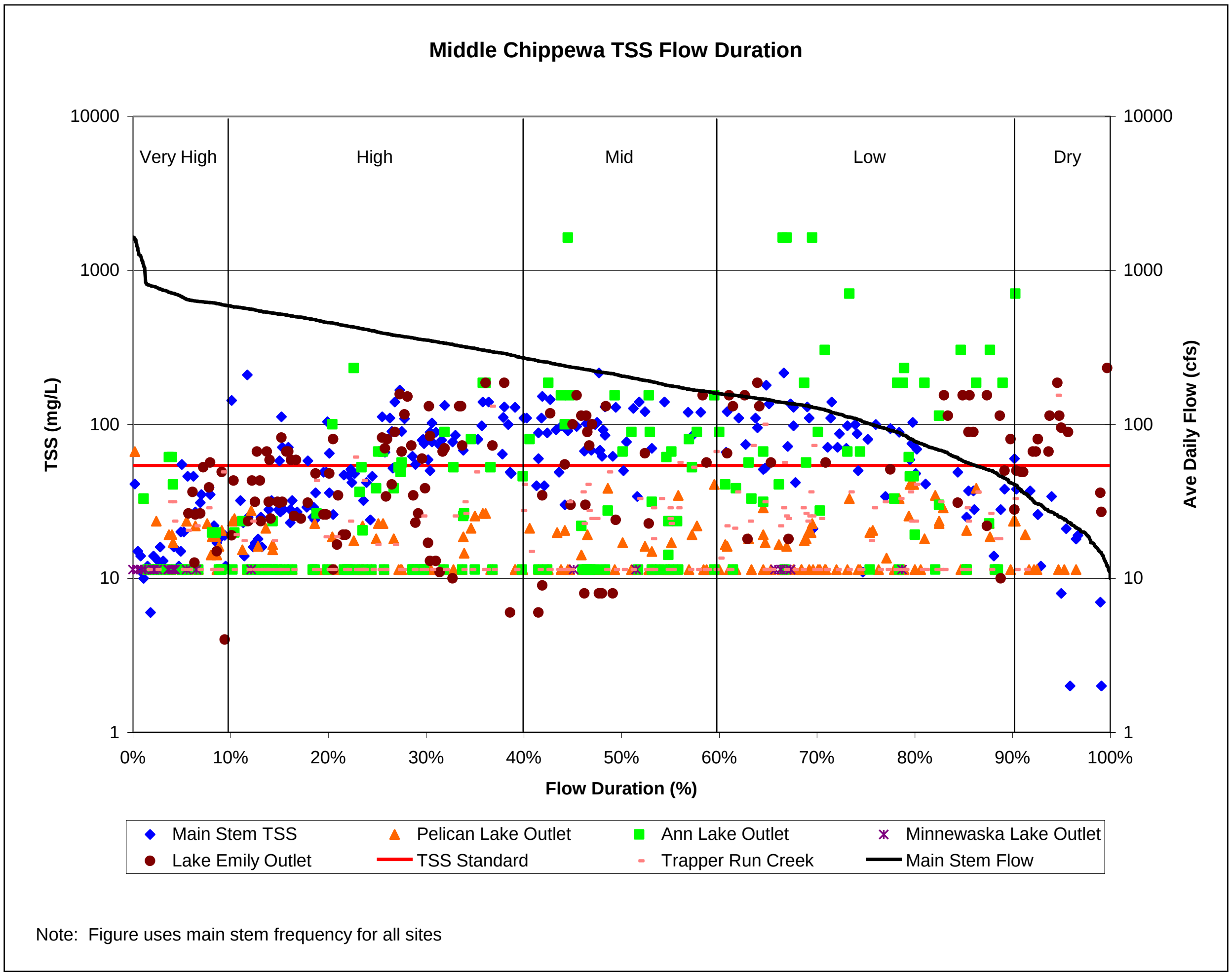
Four lake outlets were monitored for TSS including Pelican, Ann, Minnewaska, and Emily (Figure 4-8). Outflow from both Ann Lake and Lake Emily exceeded the Chippewa River TSS surrogate over most of the flow regimes. Ann Lake is relatively far from the main stem Chippewa River and is not likely contributing to turbidity in this reach although it is likely contributing to turbidity issues at its outlet. Lake Emily does discharge close to the main stem and is likely contributing to exceedances in reach 505. Lake Emily nutrients will likely need to be reduced in order to help reach 505 meet turbidity standards.

Transparency transect surveys for this region indicate that the river experiences high turbidity for the entire length of the impaired 505 reach. The surveys also indicate that the inlet to Lake

Emily maintains relatively good turbidity levels. Conditions in Lake Emily are such that they resulted in 83% of the samples taken at Lake Emily Outlet exceeding the turbidity standard.

At the Middle Chippewa River outlet site (S002-193), Total Suspended Volatile Solids (TSVS) represent a portion of the overall TSS. (TSVS measures the organic component of a TSS sample and is generally comprised of algae, diatoms and other organic particles.) Since 2002 TSVS has accounted for on average about 22% of the TSS in any given sample. This would suggest that the algae and organic particles are a source of TSS.

Bank surveys of the lower section of reach 505 have documented significant bank erosion. The lower ten miles of the reach have been straightened and cut through layers of sand, silt and clay. As the river rises and falls it mines out the sand and then the silt and clay collapse into the river.



Note: Figure uses main stem frequency for all sites

Figure 4-8 Lake Outlet TSS in the Middle Chippewa River Subwatershed. TSS results of 10 mg/L or less are at detection limit.

Data was also available for Trapper's Run, one of the tributaries in the Middle Chippewa River subwatershed (Figure 4-9). Trapper's Run demonstrated a few exceedances of the Chippewa

River TSS surrogate, however it does not appear to be a significant source of TSS to the main stem Chippewa River.

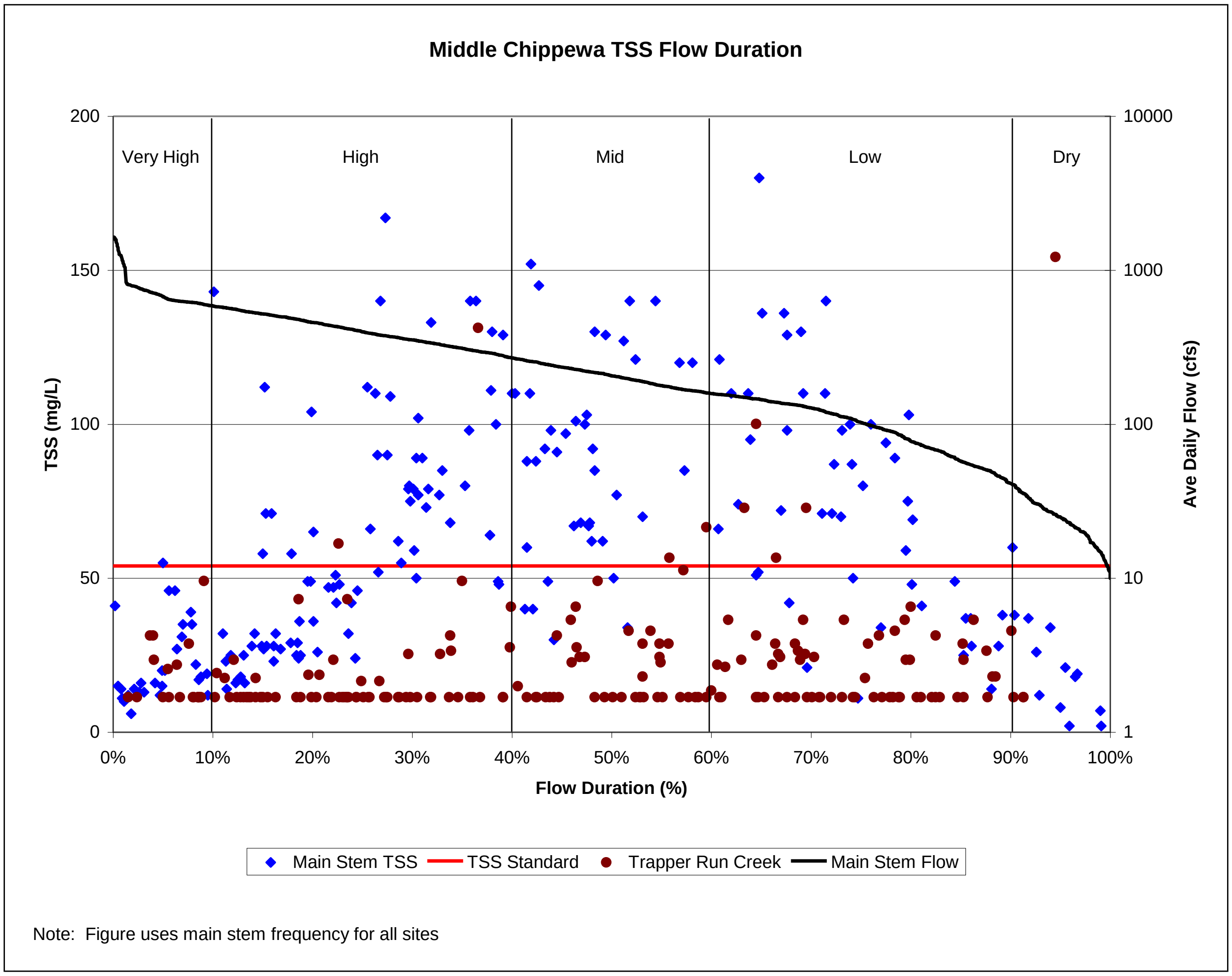


Figure 4-9 Tributary TSS Concentrations in the Middle Chippewa River Subwatershed. TSS results of 10 mg/L or less are at detection limit.

Reach 530 in the Middle Chippewa River subwatershed, the Little Chippewa River, is also listed for turbidity. Most of the exceedances occur in the high and very high flow categories suggesting that exceedances are related to runoff events (Figure 4-10). The data set for this reach is limited and more data would provide a clearer picture of potential sources.

Transparency transect surveys indicate that the lower half of the western branch of the Little Chippewa River appears to exhibit lower transparency. This begins just South of Hwy55 and continues until MN Hwy 26. On this stretch of river the survey documented several sections of bank with little or no buffer. Cattle standing in the river were also frequently observed.

The monitoring data taken from the Little Chippewa monitoring site (S004-705), while limited, did indicate that TSVS was around 20% of TSS. There are a number of lakes along the path of the Little Chippewa River. These could be a potential storage and release source for turbidity during the different flow categories.

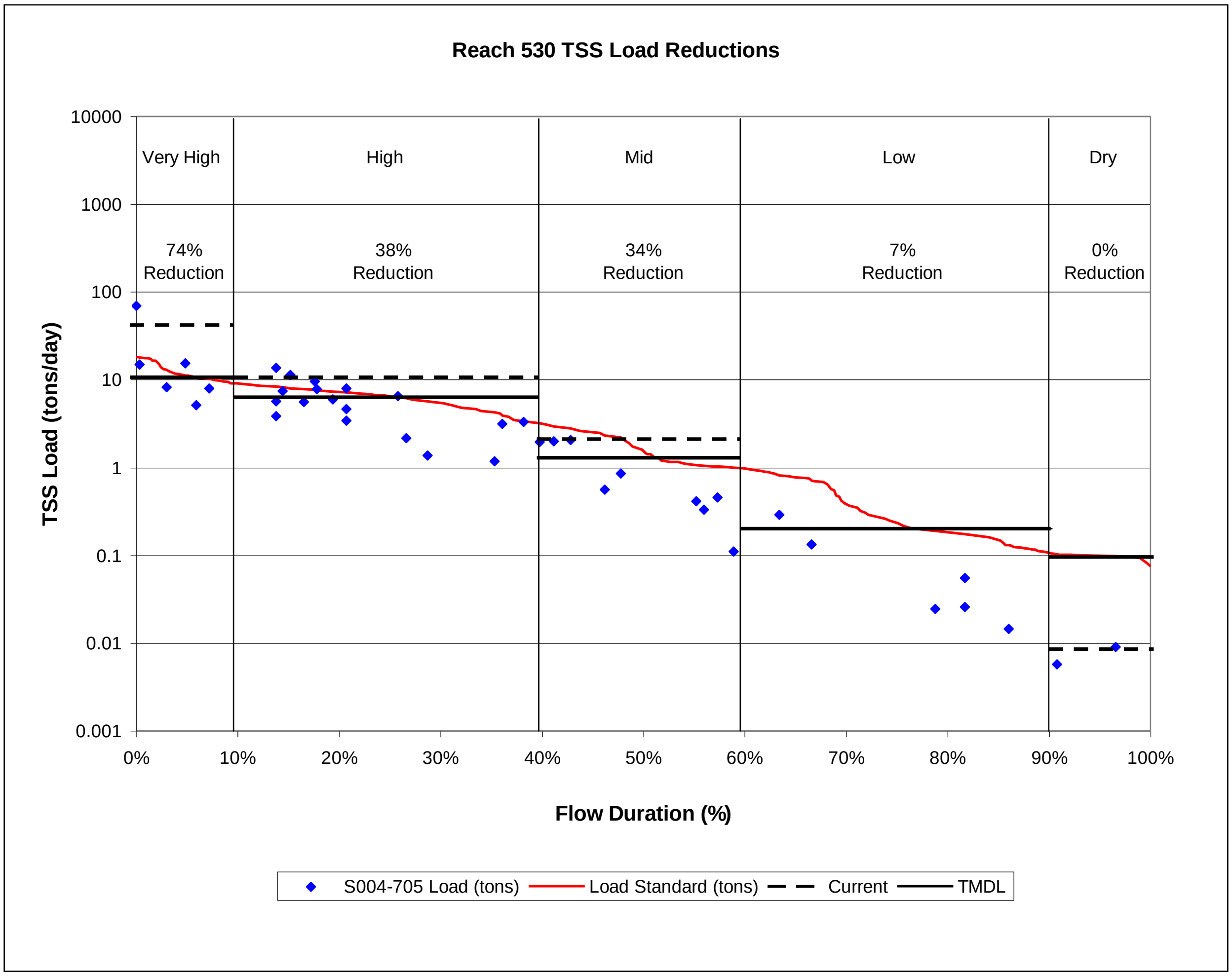


Figure 4-10 Reach 530 Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

4.5.3 East Branch Chippewa River

Reach 514 is the main stem of the East Branch Chippewa River from Mud Creek to the main stem Chippewa River. Exceedances occur in all of the flow categories except extreme low flow (Figure 4-11). There are two point sources in the East Branch Chippewa River subwatershed; the Murdock and the Sunburg WWTPs. (A third will eventually be added for DeGraff. The WLA will then be added pursuant to the new and expanding discharge language detailed in section 3.4.1 above.) These point sources had maximum weekly TSS values higher than the Chippewa River TSS surrogate however they all discharge at extremely low rates, less than one tenth MGD. Consequently, these sources are not likely significant contributors of TSS. Furthermore, all of these discharges are a significant distance from the listed reach which is likely mitigated by the long travel time and numerous wetlands.

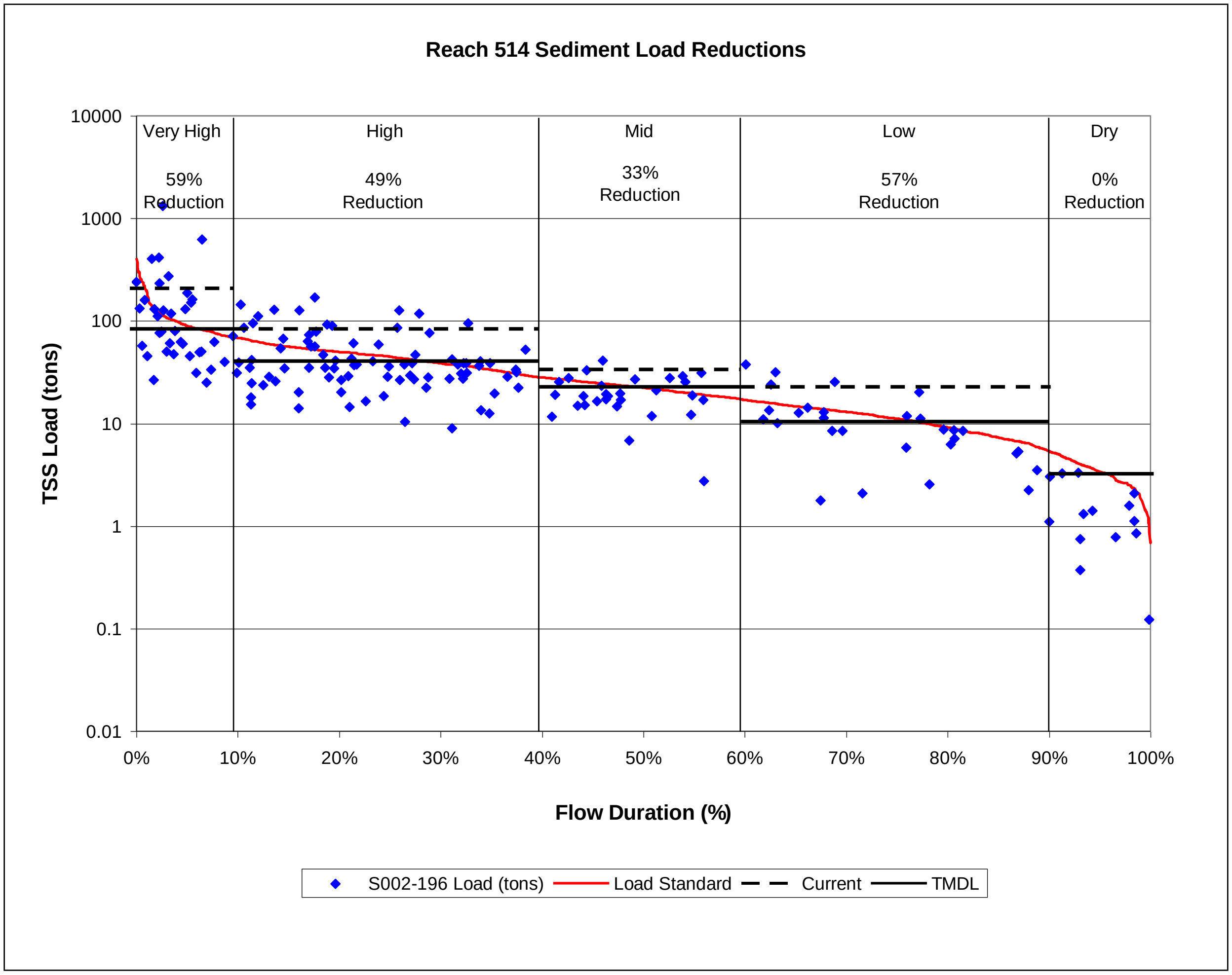


Figure 4-11 Reach 514 (East Branch Chippewa River) Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

The prevalence of steep terrain and erodible soil types suggest that significant amounts of sediment could be eroded from the fields annually. Much of these sediments are likely intercepted by the substantial number of lakes wetlands and other depressions in the subwatershed. While these sediments may have a major impact on local lake water quality they are unlikely sources of turbidity at the impaired reach. The potential for bank erosion in the East Branch subwatershed has been observed to be very high. Consequently, it is likely that turbidity in the East Branch subwatershed is primarily a result of bank erosion or other in-channel sources such as algal productivity.

Transparency transect surveys indicate that the turbidity problem arises where the Northern East Branch and Mud Creek come together. Field surveys of this region observed that the relatively high energy flow of the Northern East Branch and Mud Creek come down off of their glacial moraine topography into the silt dominated lakebed of ancient Glacial Lake Benson. As these high energy waters hit the silty banks of this region they undermine the banks and pick up significant sediment.

Downstream of the Northern East Branch/Mud Creek confluence there are numerous cattle operations that have been observed with cattle in the river. Additionally, in this same region the river has been straightened as it comes closer to the City of Benson. Both of these factors are contributing to elevated turbidity levels.

Mud Creek, which is at the upper end of this reach, has been sampled for TSS and rarely exceeds the Chippewa River TSS surrogate (Figure 4-12). Monitoring at Lake Gilchrist (S005-860 & S005-861) did not reveal turbidity or TSS to be in exceedance of the standard.

At the East Branch outlet site (S005-364) Total Suspended Volatile Solids (TSVS) represent a portion of the overall TSS. TSVS measures the organic component of a TSS sample and is generally comprised of algae, diatoms and other organic particles. Since 2002 TSVS has accounted for on average about 16% of the TSS in any given sample. This would suggest that the algae and organic particles are a lesser source of TSS.

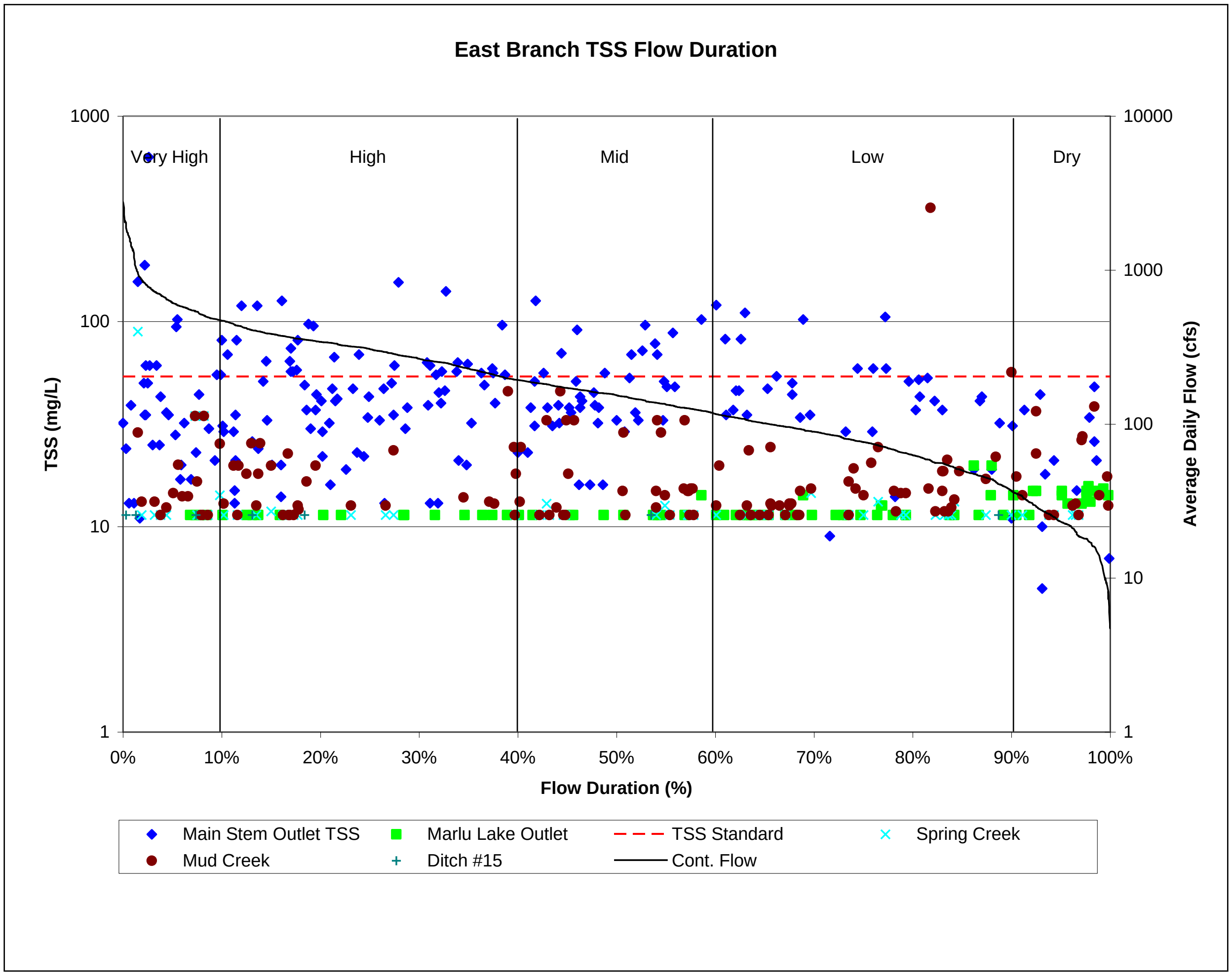


Figure 4-12 TSS Data for Sampled Tributaries and Lake Outlets in the East Branch Chippewa River Subwatershed. TSS results of 10 mg/L or less are at detection limit.

4.5.4 Shakopee Creek (JD18)

Reach 559 is the main stem of Shakopee Creek from Shakopee Lake to the Chippewa River. This reach of Shakopee Creek demonstrates exceedances across all of the flow categories and requires a 64 to 88% reduction to meet the Chippewa River TSS surrogate (Figure 4-13). There is one point source in the Shakopee Creek subwatershed, the Kerkhoven WWTF. This facility is relatively high in the watershed and drains to Shakopee Lake so it likely does not contribute directly to the listed reach in the subwatershed.

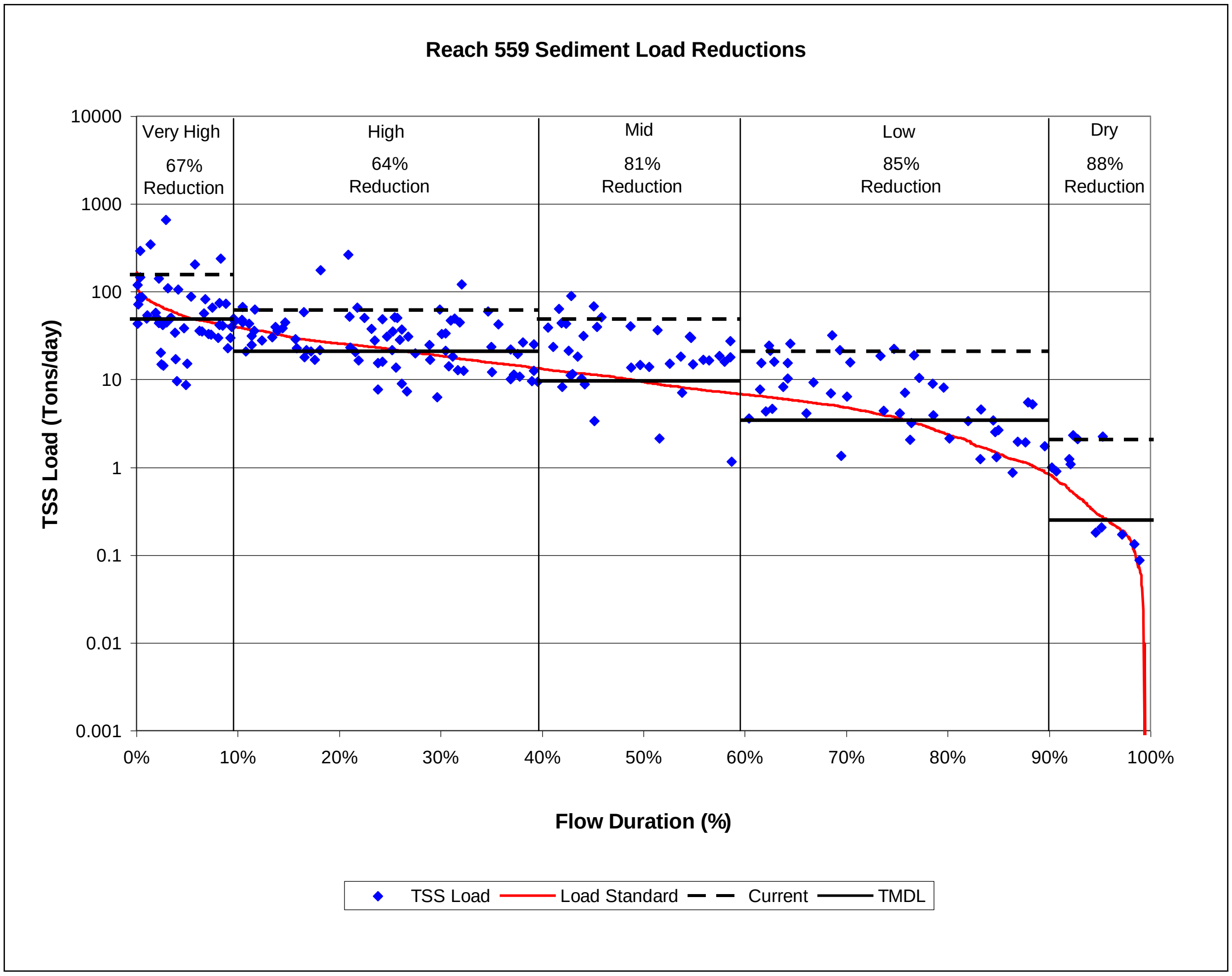


Figure 4-13 Reach 559 (Shakopee Creek) Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

The Shakopee Creek subwatershed is dominated by relatively low slopes and clay and silt soil types. This subwatershed is also dominated by a very efficient system of drainage. While the surface erosion in this subwatershed is likely low, its efficient drainage and predominance of open tile intakes means that much of this erosion makes it into the channel. Bank erosion is high in portions of this subwatershed.

The most likely driver of turbidity in the listed reach of Shakopee Creek is Shakopee Lake where the outlet demonstrates exceedances in all of the flow categories (Figure 4-14). Another indicator that surface erosion may be adding sediment to Shakopee Lake is that the main inlet to Shakopee Lake also demonstrates high concentrations especially at extremely high flows (Figure 4-12). Andrew and Henchien Lakes did not exceed the Chippewa River TSS surrogate.

The majority of the tributaries of the headwaters of Shakopee Creek; CD29, CD27, Huse Creek, JD29 and unnamed stream, had very few exceedances suggesting that the headwaters region of Shakopee Creek is not a significant contributor of TSS (Figure 4-15).

Monitoring at the two Shakopee Lake sites and transect sites both up and downstream of the lake have documented the presence of large numbers of carp. The presence of carp in Shakopee Lake is well known by local residents and has also been noted by CRWP. During low and moderate flows carp agitating the lake sediments and wave action are likely sources of turbidity in the impaired reach.

Below the Shakopee Lake dam a 2005 CRWP survey of bank erosion documented accelerated amounts of bank erosion. The effects described by the 2005 report are typical symptoms associated with the downstream impacts of dams, and increasing stream channel slope as a result of ditching and watershed expansion.

Transparency transect surveys indicate that turbidity is an issue throughout the length of the ditch/stream. The highest number of exceedances occur below Shakopee Lake (93% of samples). Above the lake, the exceedance frequency drops but is still high enough to be listed as impaired for turbidity.

A 2010 buffer survey of the Shakopee Creek transect survey sites found that 20% of the sites had no buffer. In these cases the row crops were planted right up to the edge of the ditch. Additionally, a number of small gullies were noted going from adjacent fields to the ditch.

At the Shakopee Creek outlet site (S002-201) Total Suspended Volatile Solids (TSVS) represent a significant portion of the overall TSS. TSVS measures the organic component of a TSS sample and is generally comprised of algae, diatoms and other organic particles. Since 2002, TSVS has accounted for on average about 19% of the TSS in any given sample. This would suggest that the algae and organic particles are a source of TSS.

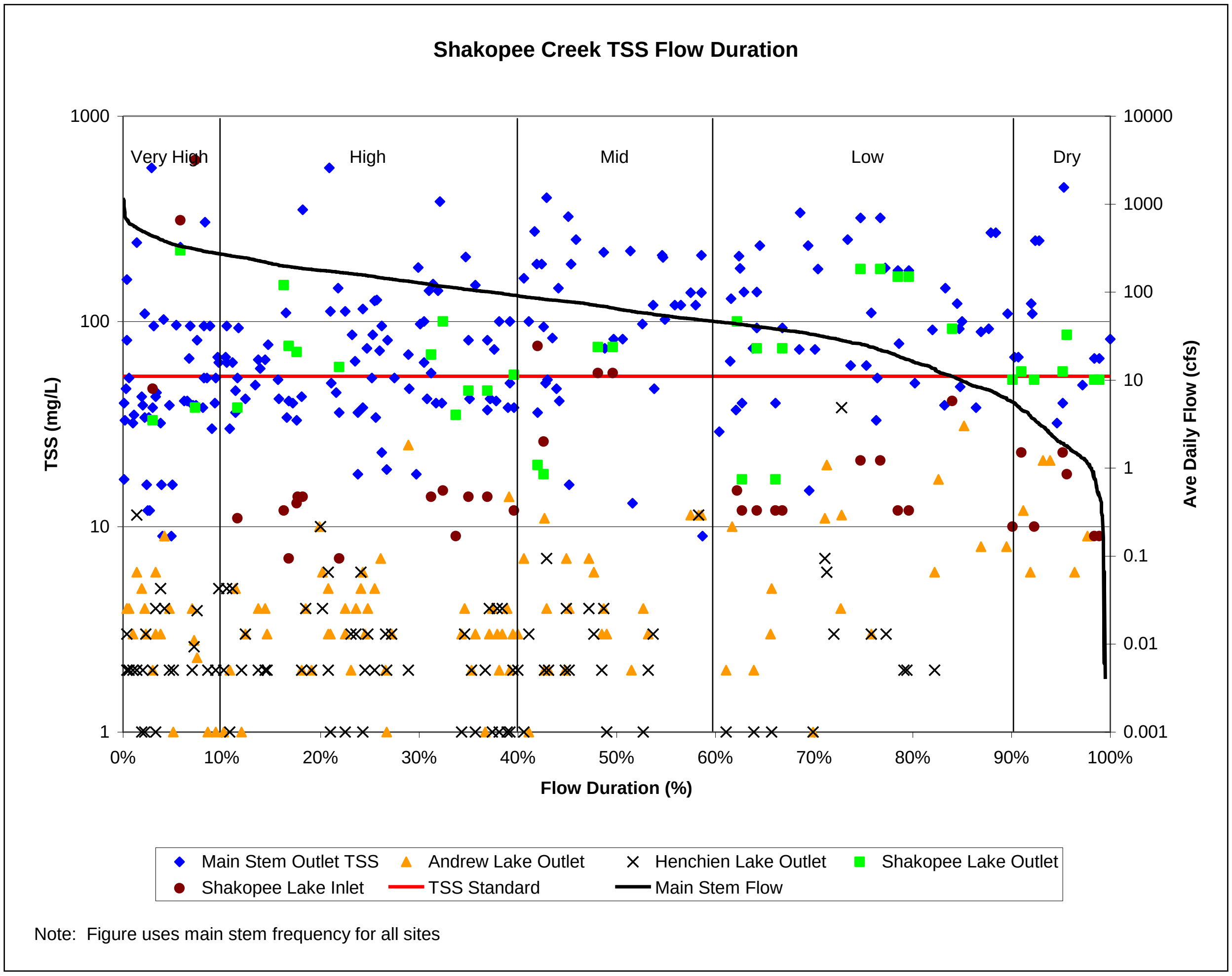
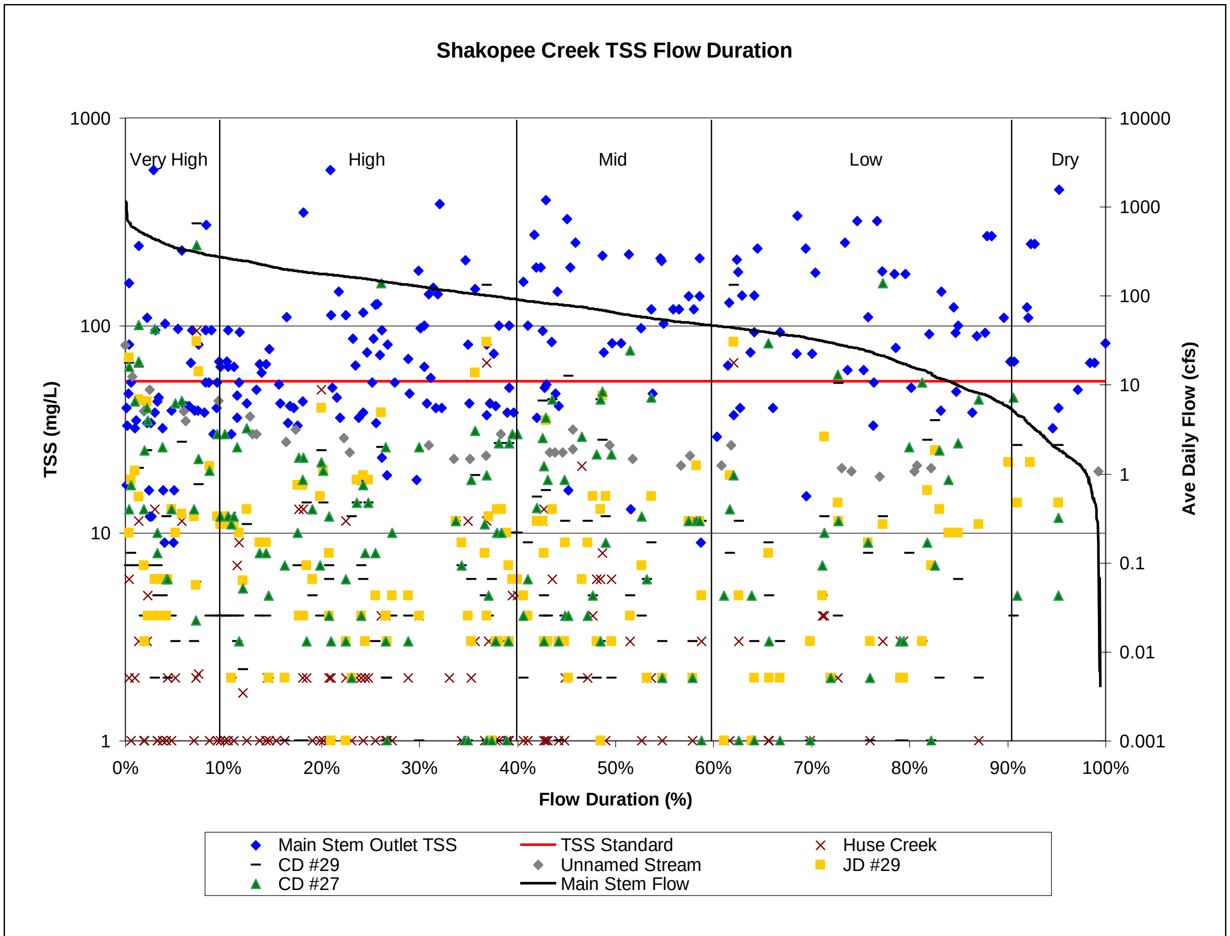


Figure 4-14 TSS Data at Monitored Lake Outlets in the Shakopee Creek Subwatershed. TSS results of 10 mg/L or less are at detection limit.

Several other monitored ditches in the Shakopee Creek subwatershed demonstrated some exceedances of the Chippewa River TSS surrogate. Field surveys in Shakopee Creek suggest that the smaller order streams and ditches tend to be relatively stable with relatively few large erosion areas. Assuming this holds true for these monitored ditches, the sediment observed is likely from surface erosion.



Note: Figure uses main stem flow duration for all sites

Figure 4-15 TSS Data for Tributaries in the Shakopee Creek Subwatershed. TSS results of 10 mg/L or less are at detection limit.

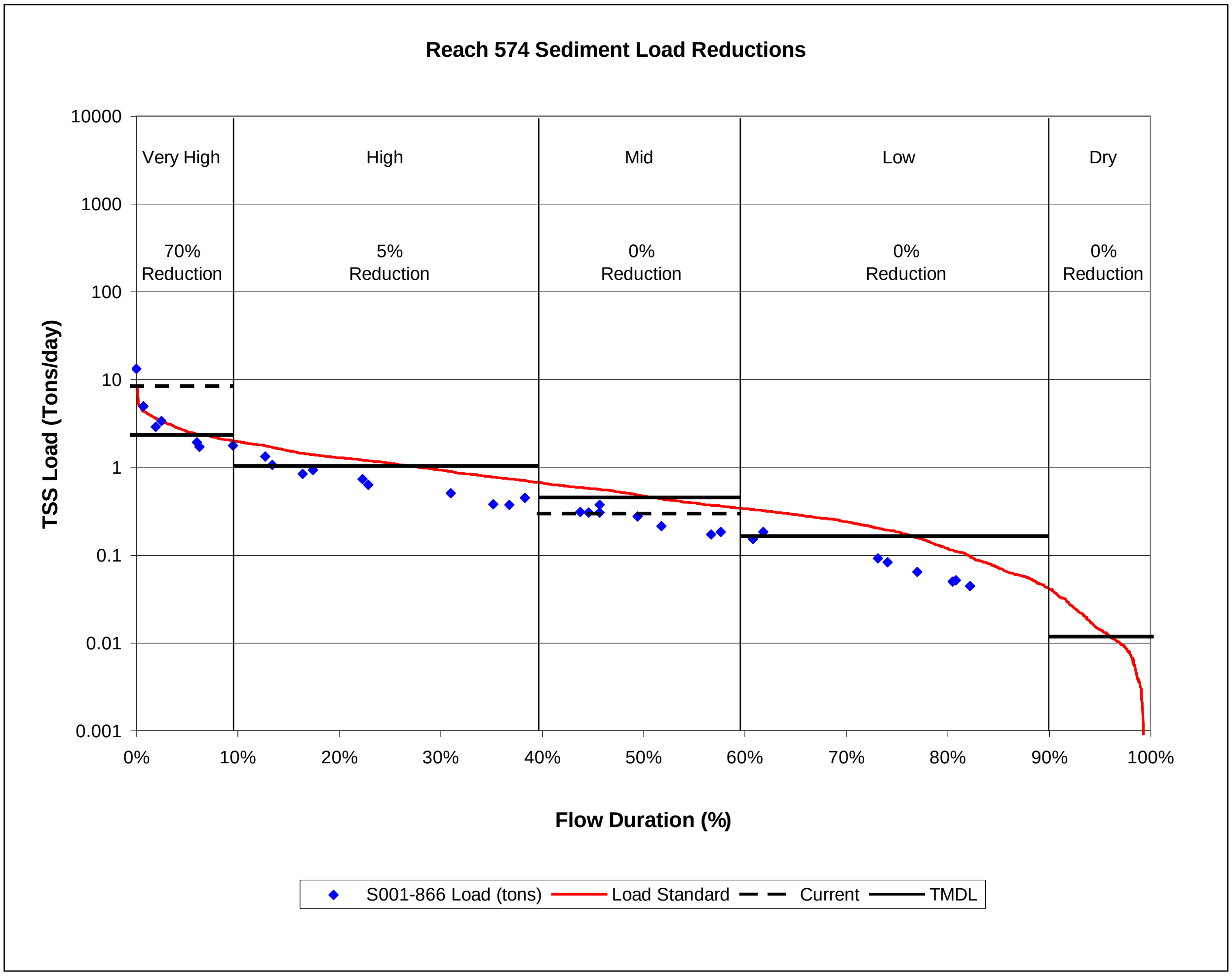


Figure 4-16 Reach 574 Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

Reach 574, a small creek in the Shakopee Creek subwatershed, is also listed as impaired for turbidity (Figure 4-16). The impairment is based on fairly limited data and exceedances only occurred under extreme high flow conditions. It is likely that field sources are a large contributing source under these flow conditions.

4.5.5 Lower Chippewa River

The lower reach of the Chippewa River (Reach 508) listed as impaired for turbidity is the stretch from Cottonwood Creek to Dry Weather Creek. Exceedances occurred under all flow conditions except for dry conditions and require a 54 to 78% reduction in TSS to meet the Chippewa River TSS surrogate. There are no point sources discharging directly to this section of the river (Figure 4-17), however all the point sources listed in Table 3-1 are located upstream of this reach.

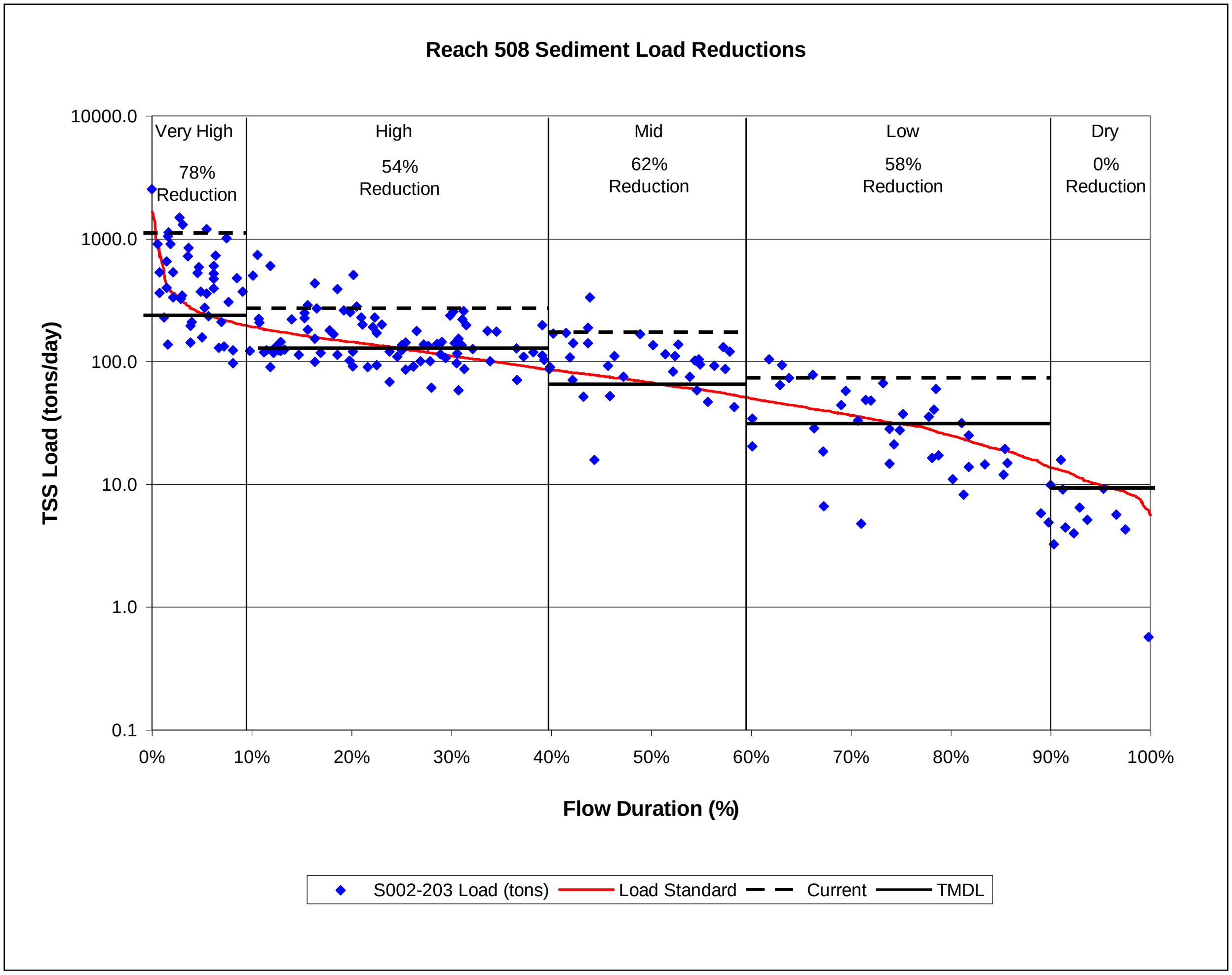
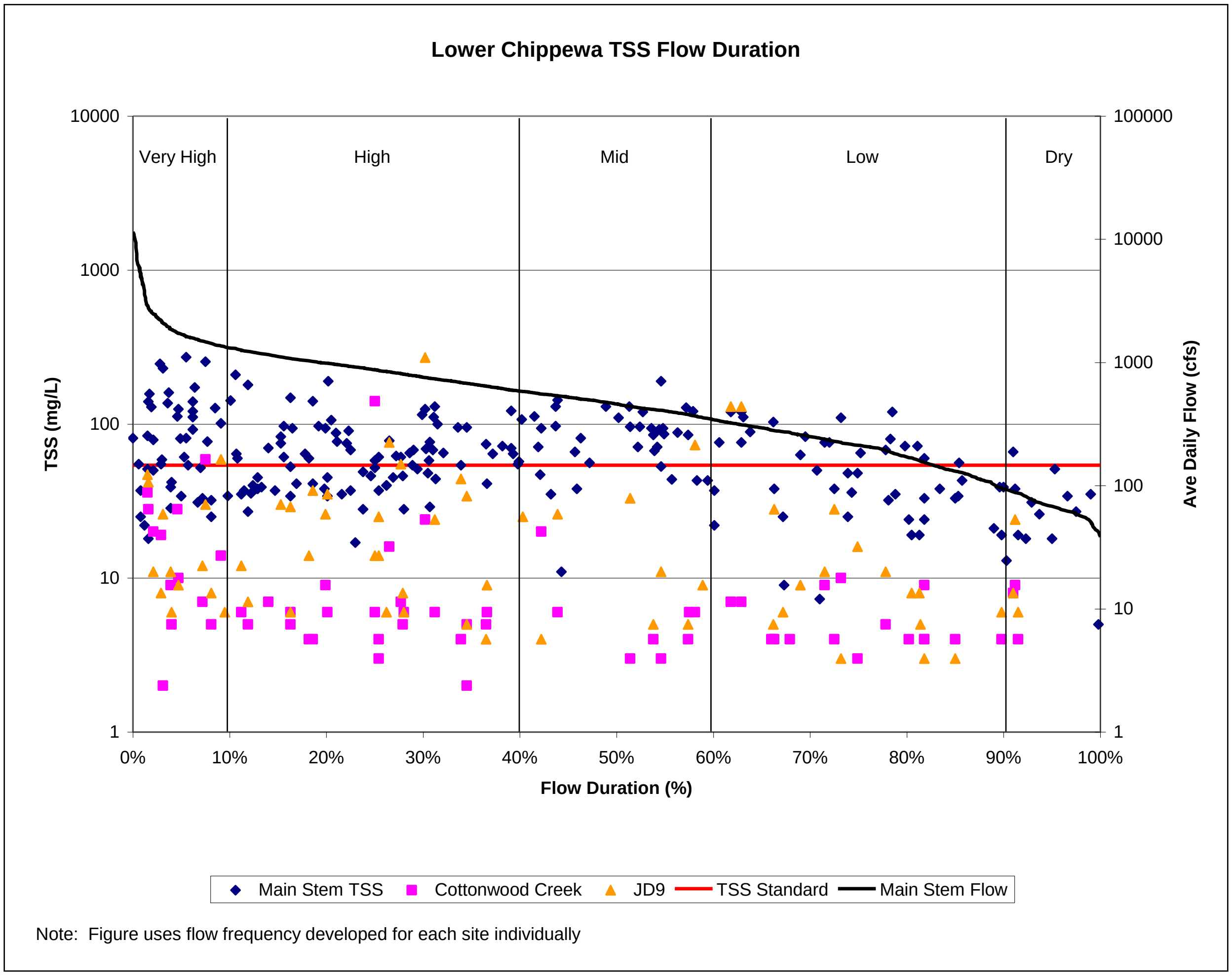


Figure 4-17 Reach 508 (Lower Chippewa River) Necessary Load Reductions by Flow Category. The red line represents the carrying capacity at the TMDL surrogate standard.

The Lower Chippewa subwatershed has a wide variety of soil types, land uses and soil conditions. In certain areas of the subwatershed these conditions combine to create the right conditions for significant field and gully erosion. The subwatershed lacks significant wetland and open water so little settling of eroded soils are predicted to occur. It is likely that much of the erosion that occurs makes its way to the channel. Bank erosion especially along the main channel of the Chippewa River is high.

Cottonwood Creek and JD9 in the Lower Chippewa River subwatershed have also been monitored for TSS. Cottonwood Creek demonstrates few exceedances while JD9 has several more in the low to high flow categories suggesting that surface erosion may be supplying sediment to the channels through the ditches (Figure 4-18). However, monitoring data (1999-2010) demonstrates that sediment from Cottonwood Creek and JD9 represents only about 7% of the sediment derived from the Lower Chippewa subwatershed. Monitoring indicates that the region of the Lower Chippewa within several miles of the mainstem contributes 93% of the sediment. This region has many steep sloped fields, gullies and significant bank erosion.

Transparency transect surveys document that the water entering the Lower Chippewa River subwatershed from the Middle Chippewa, the East Branch and Shakopee Creek in all cases start off exceeding the standard. While the surveys do document the relatively good water quality of the JD9 and Cottonwood Creek watersheds the trend of the Chippewa River does not improve with their addition of clean water. This suggests that the turbidity sources are likely significant and widespread along the mainstem of the Chippewa.



Note: Figure uses flow frequency developed for each site individually

Figure 4-18 Lower Chippewa River Tributary TSS Concentrations.TSS results of 10 mg/L or less are at detection limit.

5.0 Implementation Activities

This section provides general implementation strategies targeted towards nonpoint source reduction of turbidity in the impaired reaches and other non-impaired reaches of the Chippewa River watershed. Implementation measures are likely to be needed to control erosion and sediment transport from upland areas, stabilize key riparian areas, and perhaps to make adjustments in in-channel processes to control scour and sediment conveyance. Following approval of this TMDL, the draft implementation plan will be reviewed and approved which will include a customized combination of BMPs to address these components for the TMDL project area. A completed Watershed Restoration and Protection Strategies (WRAPS) report is scheduled to be completed on the Chippewa River watershed in 2014. This WRAPS will be completed as a result of the MPCA’s Watershed Approach and will guide implementation of water restoration and protection strategies throughout the watershed.

Point sources will be addressed through NPDES permit programs within the MPCA. Activities within those programs include establishment of effluent limits, compliance tracking and enforcement, including requiring corrective action. Construction stormwater activities are considered in compliance with provisions of the turbidity TMDL if they obtain a Construction General Permit under the NPDES program and properly select, install and maintain all BMPs required under the permit, including any applicable additional BMPs required in Appendix A of the Construction General Permit for discharges to impaired waters, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit. Similarly, industrial stormwater activities are considered in compliance with provisions of the TMDL if they obtain an Industrial Stormwater General Permit or General Sand and Gravel general permit (MNG49) under the NPDES program and properly select, install and maintain all BMPs required under the permit, or meet local industrial stormwater requirements if they are more restrictive than requirements of the permit.

5.1 *BMP Guidance for Urban Areas*

Approximately 20,000 of the 41,000 residents reside in the 25 cities, towns, and hamlets scattered across the watershed with the remainder residents in rural areas. Populations range from a mere 30 residents in the smallest community to only 5,346 in the largest community. Urban BMP's for such small communities will be done on a voluntary basis, like the BMP's for agricultural nonpoint sources. All the communities except Montevideo are nonpermitted for stormwater. Montevideo does hold an MS4 (Municipal Separate Storm Sewer System) permit but is not located in this TMDL project area. The urban BMPs available for residents in small communities include the following: Recycle motor oil, direct downspouts to lawns or to rain barrels, retention ponds, rain gardens, sweep paved areas to keep waste out of storm drains, repair leaks from motor vehicles, limit fertilizer and pesticide use, leave grass clippings on the lawn, clean up pet waste, dispose of Household Hazardous Waste (HHW) and other toxic business wastes properly, wash vehicles on lawns or at a car wash, use construction site erosion control, and shoreline restoration/naturalization projects.

5.2 *BMP Guidance for Rural Areas*

This section describes management alternatives and strategies for the reduction of total suspended solids from non-point sources in rural areas affected by surface erosion. The list outlines practices that have been used in the Chippewa River Watershed in the past and/or have been suggested as practices to be considered for reducing turbidity in the river system. As a more detailed implementation plan is written strategies will be prioritized to those that have the greatest ability to enhance water quality and are most likely to be adopted by landowners.

5.2.1 Livestock and Manure Management

- Manure Management plans
- Observation of setbacks
- Vegetative buffers
- Feedlot fixes
- Agricultural waste pit closures
- Pasture management
- Agricultural waste pit investigations

5.2.2 Structural Practices

- Terraces
- Water and sediment control basins
- Stream barbs or j-hooks
- Side inlets
- Alternative tile intakes
- Controlled drainage
- Pattern tile
- Two-stage ditch design
- Dam removal
- Carp barriers and removal
- Individual Sewage Treatment Systems
- Well sealing

5.2.3 Vegetative Practices

- Wetland restorations
- Rain gardens
- Buffer strips

- Conservation tillage
- Residue management
- Grass waterways
- Biomass harvesting
- Shoreline restoration
- Lake management

5.3 *Cost of Implementation*

The Clean Water Legacy Act requires that a TMDL include an overall approximation "(…a range of estimates") of the cost to implement a TMDL [Minn. Statutes 2007, Section 114D.25]. There are 2091 miles of streams and ditches in the Chippewa River watershed, of this approximately 1,673 miles are buffered at an average width of 2 rods (approximately 32 feet). To buffer the remaining 418 miles of the stream/ditch system to a width of 2 rods (32 feet) would require $164,667 in buffer incentive money (at $50/acre) and $7.4 million in federal Conservation Reserve Program dollars (an average payment of $150/acre for 15 years). This is only for buffer strips. Based on cost estimates made in 2004 by a state-level interagency working group which assessed restoration costs for several TMDLs, an initial cost estimate would be $140 to $170 million. The working group estimates are for projects that include a broad range of the types of practices outlined in Section 5.2, implemented throughout watersheds with impairments. The Chippewa River estimate will be refined when the detailed implementation plan is developed following approval of the TMDL study.

5.4 *Adaptive Management*

This list of implementation elements and the more detailed implementation plan that will be prepared following this TMDL assessment focuses on adaptive management (Figure 5-1). As the suspended solids dynamics within the watershed are better understood, management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired reaches.

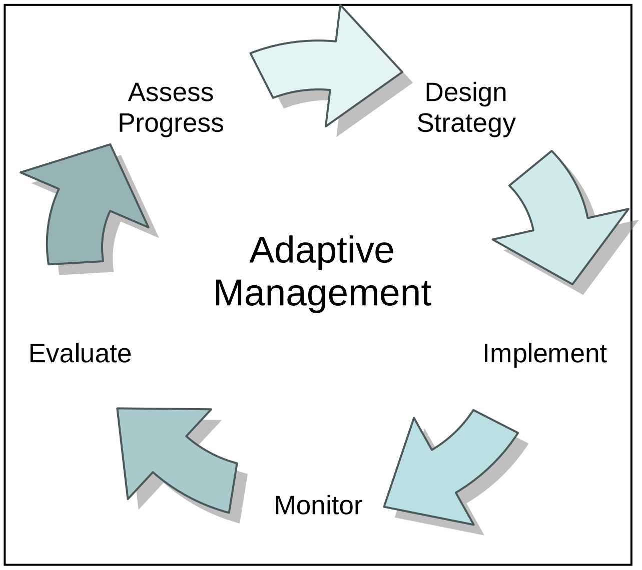


Figure 5-1 Adaptive Management.

6.0 Reasonable Assurance

As a requirement of TMDL studies, reasonable assurance must be provided that demonstrates the ability to reach and maintain water quality endpoints. The source reduction strategies detailed in Section 5 have been shown to be effective in reducing turbidity in receiving waters. It is reasonable to expect that these measures will be widely adopted by landowners and resource managers, in part because they have already been implemented in some parts of the watershed over the last 20 years.

In the past 10 years alone, the Chippewa River Watershed Project has obtained funds through federal 319 grants and state Clean Water Partnership (CWP) grants for the installation of over 450 projects involving BMPs.

The CRWP also has current state CWP funding for installation of BMPs in the watershed, and actively works with a team of Soil and Water Conservation District technicians and other water quality professionals in the watershed to complete projects. The CRWP has partnered with the Land Stewardship Project to form the "Chippewa 10% Project" who's goal is to increase perennial vegetative cover in the watershed by 10% by working with landowners to find ways to increase plant diversity while improving economic opportunities, water quality and wildlife habitat.

The CRWP maintains contact with landowners who have expressed interest in installation of BMPs so projects can be completed as funds become available. CWP funds are expected to continue to be available for watershed projects such as the CRWP in the future.

The state of Minnesota is developing a Minnesota Agricultural Water Quality Certification Program designed to increase the voluntary adoption of conservation practices that protect local rivers, streams and other waters by reducing fertilizer run-off and soil erosion. Through this partnership, producers who undertake a substantial level of conservation activities to reduce nutrient run-off and erosion will receive assurance from the state that their farms will meet Minnesota's water quality standards and goals during the life of the agreement.

The Chippewa River Watershed is listed as a major priority in the Water Plans of Douglas, Pope, Grant, Stevens, Kandiyohi, Swift and Chippewa counties. Many of the goals outlined in this TMDL study are consistent with objectives outlined in the County Comprehensive Local Water Management Plans and the Chippewa River Watershed Implementation Plan (Olson and Hoffman, October 2000). These plans have the same objective of developing and implementing strategies to bring impaired waters into compliance with appropriate water quality standards and thereby establish the basis for removing those impaired waters from the 303(d) Impaired Waters List. These plans provide the watershed management framework for addressing water quality issues. In addition, the stakeholder processes associated with both this TMDL effort as well as the broader planning efforts mentioned previously have generated commitment and support from the local government units affected by this TMDL and will help ensure that this TMDL project is carried successfully through implementation.

Various technical and funding sources will be used to execute measures detailed in the implementation plan that will be developed within one year of approval of this TMDL. Technical resources will come from the Local Work Group of the CRWP. The Local Work Group is comprised of representatives from the SWCD, NRCS, DNR, County water planners and environmental offices, feedlot officers and ditch inspectors located in the counties mentioned above. The CRWP facilitates a monthly meeting of the Local Work Group. Funding resources include a mixture of state and federal programs, including (but not limited to) the following:

- Conservation Reserve Program
- Federal Section 319 program for watershed improvements
- Funds ear-marked to support TMDL implementation from the Clean Water, Land, and Legacy constitutional amendment, approved by the state's citizens in November 2008.
- Local government cost-share funds
- County water plan funds

Finally, it is a reasonable expectation that existing regulatory programs such as those under NDPES will continue to be administered to control discharges from industrial, municipal, and construction sources as well as large animal feedlots that meet the thresholds identified in those regulations.

7.0 Monitoring

Two types of monitoring are necessary to track progress toward achieving the load reduction required in the TMDL and the attainment of water quality standards. The first type of monitoring is tracking implementation of Best Management Practices. The CRWP and members of the Local Work Group will track the implementation of these projects annually, both through the MN BWSR eLink program and MS Excel spreadsheets. The second type of monitoring is physical and chemical monitoring of the resource. The CRWP plans to monitor the affected resources routinely for water quality and water quantity as financial resources allow.

This type of effectiveness monitoring is critical in the adaptive management approach. Results of the monitoring identify progress toward benchmarks as well as shape the next course of action for implementation. Adaptive management combined with obtainable benchmark goals and monitoring is the best approach for implementing TMDLs.

The watershed is also on the MPCAs schedule of intensive monitoring which began in the Chippewa River Watershed in 2009 and continued in 2010 and will be monitored by the MPCA in this way every ten years in addition to routine load monitoring through the Watershed Pollutant Load Monitoring Network. Work from this monitoring in addition to ongoing data collection by the Chippewa River Watershed Project which started in 1998 will be used to develop an intensive watershed wide plan for the Chippewa River Watershed.

8.0 Public Participation

Over the course of this project a variety of public participation and outreach efforts have been conducted and/or planned for three phases of the TMDL process. The first phase introduced the concept of impaired waters and TMDLs at public information meetings. The second phase engaged a specific stakeholder advisory group on the details of the TMDL and reviewed the draft document. The third phase is the formal public comment period required by federal and state regulations. Table 8-1 provides the location and dates of the meetings, in addition to the stakeholder groups that were represented.

Table 8-1 Meeting Dates and Locations.

Phase	Meeting Location	Meeting Date	Stakeholder Groups
Phase I	Benson, MN	January 15, 2009	Citizens, Lake Associations, Corn and Soybean Growers Associations.
Phase I	Benson, MN	January 16, 2009	Local, state and federal governmental units and citizens
Phase II	Benson, MN	January 14, 2011 February 3, 2011 February 10, 2011 February 24, 2011 March 3, 2011 March 10, 2011 March 31, 2011 April 7, 2011 April 14, 2011	Stakeholder Advisory Group (a combination of citizens, corn and soybean grower association members, local, state and federal governmental units)
Phase III	Public Comment Period	September 24-October 24, 2012	Public and all of the above

A fourth phase for this TMDL, not required by federal law, is the development of the Implementation Plan to implement this TMDL. A draft has been completed and will undergo MPCA review upon approval of this TMDL.

9.0 References

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APPENDIX A – MPCA's Response to Comments

Following is a compilation of comments received for the Chippewa River Turbidity TMDL.

These comments were received from each of the following: Minnesota Corn Growers Association, Swift County Corn Growers Association, Michael O'Leary, and Anthony Hughes:

Comment #1:
"<u>Executive Summary</u>
The report states that land use is dominated by agricultural cropping and is "extensively drained" for that purpose. The structure of this sentence suggests that land use is extensively drained. We suggest the following revision:
Agricultural production is the primary land use in the watershed, gradually increasing in prevalence from north to south. Artificial drainage, which allows for efficient crop production and also protects homes, businesses and roads, also becomes more important in the southern and western portions of the watershed, where soils limit natural drainage.

The report states that the Stakeholder Advisory Group was involved with the development of the Implementation Plan. We suggest inserting a word "preliminary" ahead of Implementation Plan to reflect that the final implementation plan will be developed with stakeholder input after final approval of the TMDL report by the US EPA."

MPCA Response:
The language in the TMDL (found in paragraph two on page ES-1) was changed to be consistent with the language in section 2.1.3.

The reference to the implementation plan on page ES-2 was changed in the TMDL to "draft implementation plan." This plan, which was developed using stakeholder input, has already been submitted and will be approved by the MPCA once the TMDL is approved by EPA.

Comment #2:
"<u>Turbidity Source Assessment</u>
The report states that "tiling and impervious cover exacerbate the condition (referring to streambank erosion) by increasing the volume and peak rate of runoff to the system." While impervious cover, unless corresponding water retention practices are in place, almost always does increase volume and peak runoff, tiling is more complicated. Well-engineered, modern tiling systems can moderate peak rate of runoff, as pointed out by University of Minnesota researchers.
[Drainage systems are designed to alter field hydrology (water balance) by removing excess water from waterlogged soils. There are concerns about the downstream hydrological effects caused by draining this excess water. Anecdotal evidence indicates that streams and ditches have become "flashier" over time, spilling over their banks and causing localized crop damage. Some research articles suggest that the most dramatic hydrological changes in a landscape occur when it's converted from native vegetation to agricultural production, and that subsurface drainage may reduce peak flows in some situations. (5,6,7) A recent regional publication (8) summarized the environmental impacts of subsurface draining on agricultural land. The authors concluded that subsurface drainage reduces

surface runoff by 29 to 45 percent, reduced peak flows from watershed by 15-30 percent, and has little impact on the total annual flow from watersheds. A publication that summarized drainage studies from several countries concluded that subsurface drainage generally decreases peak flows in fine textured soils but often increases those flows in coarser, more permeable soils (9). This publication also found that subsurface drainage often increases base flow to streams. Locally based research in necessary, however, to better understand the impact that drainage can have a watershed scales. In addition, the impact of surface inlets on watershed hydrology in an important issue currently being examined.]

From http://www.extension.umn.edu/distribution/cropsystems/DC7740.htm., accessed October 1, 2012."

MPCA Response:
The MPCA acknowledges the comment. The language in the TMDL (found in section 4.2) was reworded to read: "Tiling and impervious cover can exacerbate the problem depending on soil conditions…"

Comment #3:
"Implementation Activities
How does the completion of the Watershed Restoration and Protection strategies report align with this TMDL and the associated implementation plan? Given the statement that the WRAP will "guide implementation of water restoration and protection strategies throughout the watershed, we strongly encourage that the WRAP process also include significant stakeholder input."

MPCA Response:
TMDL calculations for the stream reaches will not be re-done as part of the WRAPS. Once approved, this TMDL is completed and the TMDL calculations will be in effect going forward.

A specific objective in the WRAPS process is civic engagement which involves stakeholder input. The WRAPS for the Chippewa River watershed will not directly relate to this TMDL because it will cover more issues than just turbidity. It will relate indirectly in that the WRAPS will represent comprehensive water restoration and protections strategies for the whole Chippewa River watershed, many of which will deal with turbidity.

Comment #4:
"Reasonable Assurance
We suggest deletion of the reference to the Land Stewardship Project's "Chippewa 10% Project: in the TMDL. Elements of the program should be discussed by the stakeholder advisory group during development of the implementation plan.

We also suggest deletion of the reference to the Minnesota Agricultural Water Quality Certification Program, as it is premature to claim reasonable assurance based on a program that is still under development.

MPCA Response: The reference to the Chippewa 10% Project and Minnesota Agricultural Water Quality Certification Program (MAWQCP) are left in section 6.0 the TMDL. The Chippewa 10% Project has shown to be a vibrant program that shows promise in helping to create a collaborative approach to water quality implementation. The MAWQCP program is indeed still under development, but nonetheless represents a long term commitment on the part of many groups to work collaboratively toward water quality efforts.

EPA requires a “Reasonable Assurance” section be included in TMDLs to demonstrate activities that show promise that clean water implementation actions for non-point sources of pollution will successfully achieve load reductions. Both programs demonstrate capacity to succeed at the local level.

This comment was received from the Minnesota Department of Natural Resources:

“The DNR shares your agency’s interest in moving toward watershed TMDL reports and implementation plans. This strategy should help address these issues. We believe a watershed approach should include an analysis of existing data, field investigations identifying stressors and sources, finding links between physical and chemical conditions and biological impairments, using empirical data to develop and calibrate models (SWAT, etc.), calculating loads, and prioritizing an implementation plan and monitoring strategy targeting known problem areas. We believe that this process will improve TMDL reports and leave less for the implementation plan.

As currently drafted, the Chippewa River TMDL report includes identification of the causes and sources of turbidity, non-point sources, total suspended solids, load allocations as well as reasonable assurance of implementation activities and monitoring plans. We believe the September 2012 draft TMDL plan has addressed major issues and will, as stated in Section 5.0 Implementation Activities, follow through with a more detailed implementation plan in a Watershed Restoration and Protection (WRAP) report in 2013. We look forward to reading that report.”

MPCA Response: The comment is acknowledged. The MPCA would like to clarify that this turbidity TMDL will have its own approved implementation plan, in addition to a Watershed Restoration and Protection Strategy (WRAPS). The WRAPS is anticipated to be completed in 2014 and will cover strategies for other pollutants in addition to turbidity.