Turbidity TMDL Assessment for the Pomme de Terre River
Final Report

Submitted by:

Pomme de Terre River Watershed Association

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Acknowledgements

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Acronyms

AU:	Animal Units
BMP:	Best Management Practice
BWSR:	Minnesota Board of Water and Soil Resources
CAFO:	Confined Animal Feeding Operation
CCRP:	Continuous Conservation Reserve Program
cf/L:	Cubic Feet per Liter
cfs:	Cubic Feet per Second
CREP:	Conservation Reserve Enhancement Program
CRP:	Conservation Reserve Program
CWA:	Clean Water Act
DNR:	Minnesota Department of Natural Resources
EQUIP:	Environmental Quality Incentive Program
FNMU:	Formazin Nephelometric Multibeam Units
HUC:	Hydrologic Unit Code
JPB:	Pomme de Terre River Association Joint Powers Board
LA:	Load Allocation
LWMP:	Local Water Management Plan
mg/L:	Milligram per Liter
mg/ton:	Milligram per Ton
MN:	Minnesota
MOS:	Margin of Safety
MPCA:	Minnesota Pollution Control Agency
MS4:	Municipal Separate Storm Sewer System
NPDES:	National Pollutant Discharge Elimination System
NRCS:	Natural Resources Conservation Services
NTRU:	Nephelometric Turbidity Ratio Units
NTU:	Nephelometric Turbidity Units

PdT:	Pomme de Terre River
RC:	Reserve Capacity
RIM:	Reinvest in MN conservation easement program
SWCD:	Soil and Water Conservation District
SWPPP:	Storm Water Pollution Prevention Plan
TAC:	Technical Advisory Committee
TDLC:	Total Daily Loading Capacity
TMDL:	Total Maximum Daily Load
TSS:	Total Suspended Solids
US EPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
WLA:	Waste Load Allocation
WRP:	Wetlands Reserve Program
WWTF:	Wastewater Treatment Facilities

TMDL Summary Table

EPA/MPCA Required Elements	Summary	TMDL Page #
Waterbody ID	Pomme de Terre River, Muddy Creek to Marsh Lake: Turbidity 07020002-501	6
Location	The Pomme de Terre River Watershed is located in the upper Minnesota River Basin in southwestern MN. The river starts in southern Otter Tail county, flows south through Grant, Stevens, and Swift counties. Parts of Douglas and Big Stone counties are included in the watershed also.	7, 8
303(d) Listing information	The impaired reach of the Pomme de Terre River from Muddy Creek to Marsh Lake was listed in 2002 for failure to meet turbidity standards. The MPCA's projected schedule for the TMDL completions, as indicated on Minnesota's 303(d) impaired waters list, implicitly reflects Minnesota's priority ranking of this TMDL. This TMDL was prioritized to begin in 2007 and be completed in 2011.	6
Impairment/TMDL Pollutants of Concern	Turbidity	6
Impaired Beneficial Uses	The applicable water body classifications and water quality standards are specified in Minnesota rules Chapter 7050. Minnesota rules chapter 7050.0407 lists water body classifications and chapter 7050.0200 lists the beneficial uses. This water body is classified as impaired for aquatic life.	6, 12
Applicable Water Quality Standards/Numeric Targets	The Minn. R. ch. 7050.0222 subp. 4 and 5 sets the water quality standard for class 2B waters, which is the classification of the impaired reach in the Pomme de Terre River. If the standards in this part are exceeded, it is considered indicative of a polluted condition which is actually or potentially deleterious, harmful, or injurious with respect to designated uses or established classes of the waters of the state. The numeric criterion for turbidity, based on stream classification of a class 2B stream, is a standard of 25 NTU. Turbidity, however, is a dimensionless measurement and thus loading capacities cannot be calculated. A TSS surrogate is used to calculate loading capacity and to determine allocations. The TSS surrogate numeric target was determined to be 52 mg/L.	12
Loading Capacity (expressed as daily loads)	Flow regimes were determined for high, moist, mid-range, dry and low flow conditions. The mid-range flow value for each flow regime was then used to calculate the total daily loading capacity (TDLC). Thus, for the "high flow" regime, the TDLC is based on the daily flow value at the 5th percentile. How to convert flow and concentration to load: 1. Determine the median flow value for each regime. 2. Calculate the TSS surrogate equivalent of 25 NTU 3. For each flow regime, calculate the total liters per day Flow (cfs) x 28.31 (cubic feet per liter) x 86400 (sec. per day) 4. For each flow regime, calculate total mg of TSS: TSS surrogate (52 mg/L) x total liters 5. For each flow regime, calculate total tons TSS per day: Total mg TSS/907,184,740	20-21

Daily flows multiplied by the TSS surrogate value results in the load duration curve.

Zone	Loading capacity (tons/day)
High	101
Moist	38.2
Mid	18.0
Dry	7.9
Low	2.5

Turbidity levels are generally at their worst following significant storm events during the late spring and early summer months. See section 6.4 for a detailed description of seasonal variation of turbidity levels.

Wasteload allocation — 23-25

WWTF with discharge limits

Source	Permit#	Individual WLA	WLA with RC
Alberta	MNG580002	0.050	0.075
Appleton	MN0021890	0.055	0.083
Ashby	MNG580087	0.147	0.221
Barrett	MN0022713	0.171	0.256
Chokio	MNG580007	0.147	0.221
Chokio WTP	MNG640022	0.0015	0.002
Morris	MN0021318	1.425	2.175
Denco LLC	MN0060232	0.031	0.045
	Total (tons/day)	2.027	3.041

Construction Stormwater	Individual WLA (tons/day)
High	0.03
Moist	0.011
Mid	0.005
Dry	0.002
Low	*

Industrial Stormwater	Individual WLA (tons/day)
High	0.06
Moist	0.023
Mid	0.011
Dry	0.004
Low	*

Permitted MS4	Individual WLA (tons/day)
High	1.01
Moist	0.382
Mid	0.18
Dry	0.079
Low	*

* See section 5.8 for allocations for this specific category in this flow zone

Load allocation — 25

Flow condition	Load Allocation (tons/day)
High	86.76
Moist	30.93
Mid	12.97
Dry	3.99
Low	*

* See section 5.8 for allocations for this specific category in this flow zone

<table>
<tr><td>Margin of Safety</td><td>Because the allocations are a direct function of daily flow, accounting for potential flow variability is the appropriate way to address the MOS explicitly for the turbidity impairments. This is done within each of five flow zones. An explicit 10% MOS was applied
In the very lowest flow zone, the total daily loading capacity is very small due to the occurrence of very low flows in the long-term flow record. Consequently the MOS and WLA would exceed the allocation. To account for this unique situation, the WLA and LA are expressed as an equation rather than an absolute number. That equation is:

Allocation = (flow contribution from a given source) X (45 mg/L TSS)

In essence, this amounts to assigning a concentration-based limit to the sources in the low flow zone, with the concentration limit being 45 mg/L TSS from the MN Rules, Chapter 7050.
<table>
<tr><th>Flow Condition</th><th>MOS (tons/day)</th></tr>
<tr><td>High</td><td>10.1</td></tr>
<tr><td>Moist</td><td>3.8</td></tr>
<tr><td>Mid</td><td>1.8</td></tr>
<tr><td>Dry</td><td>.79</td></tr>
<tr><td>Low</td><td>*</td></tr>
</table>
* See section 5.8 for allocations for this specific category in this flow zone</td><td>22</td></tr>
<tr><td>Seasonal Variation</td><td>While the highest river flows occur in April, the highest turbidity and TSS levels occur in June, as this is the month with the highest average rainfall. During an average June, 3,000 tons of suspended solids are carried down the river. Combined, April, May and June account for 73% of the sediment load carried by the river during the April through September monitoring season.</td><td>31-34</td></tr>
<tr><td>Reasonable Assurance</td><td>The source reduction strategies detailed in the implementation plan section have been shown to be effective in reducing turbidity. Many of the goals outlined in this TMDL study run parallel to objectives outlined in the local Water Plans. Various programs and funding sources will be used to implement measures that will be detailed in an implementation plan to be completed.</td><td>40</td></tr>
<tr><td>Monitoring</td><td>A detailed monitoring plan will be included in the Implementation Plan to be completed. Currently there are monitoring efforts in the watershed.</td><td>34-35</td></tr>
<tr><td>Implementation</td><td>A summary of potential management measures was included. More detail will be provided in the implementation plan that will be completed following approval of the TMDL.</td><td>35-39</td></tr>
<tr><td>Public Participation</td><td>A public comment period was open from March 1 – March 31 2010 with a formal public meeting on 11/23/2009. There were four comment letters received and responded as a result of the public comment period. The PdT Watershed Project submitted monthly newspaper articles to watershed newspapers updating people on the TMDL process and progress. Public meetings were held in Sept. of 2008 to inform citizens of the impact of the turbidity TMDL on the PdT River. Invitations were mailed out to agricultural organizations and township board members and meeting notices were placed in watershed newspapers. The PdT Watershed Project developed a display board to be taken to county fairs, home and garden shows, and University Extension events. During the summer of 2008, this display was viewed by over 3,000 people.</td><td>40-42</td></tr>
</table>

Executive Summary

The Minnesota Pollution Control Agency (MPCA) listed one stream reach on the Pomme de Terre River, from Muddy Creek to Marsh Lake (HUC: 07020002-501), as impaired for the designated use of supporting aquatic life under Section 303(d) of the Clean Water Act. The pollutant of concern contributing to the impairment is excessive turbidity. This Total Maximum Daily Load (TMDL) report describes the magnitude of the problem and provides direction for improving water quality for the listed reach.

The Pomme de Terre River Watershed is located in the upper Minnesota River Basin. The Pomme de Terre (PdT) River originates in southern Otter Tail County and flows 105.9 miles to the south where it discharges into Marsh Lake on the Minnesota River. Land use in this area is dominated by agricultural cropping and animal production. Beef and swine production represent nearly half of the approximately 64,000 animal units (AUs) in the watershed.

This report uses a load duration curve approach to determine the loading capacity in the impaired reach under varying flow regimes. A total suspended solids (TSS) surrogate was calculated at a 52 mg/L and used to calculate each loading capacity. The report focuses on TSS loading capacity and general allocations necessary to meet water quality standards at the impaired reach, rather than on precise loading reductions that may be required from specific sources.

TSS loading capacities were calculated for the impaired reach and those capacities are allocated among point sources (wasteload allocation), nonpoint sources (load allocation), and margin of safety. A loading capacity is the product of stream flow at the impaired reach and the surrogate TSS water quality standard. Five flow zones, ranging from low flow to high flow, are utilized so that the entire ranges of conditions are accounted for in the report.

The turbidity impairment seems to be directly correlated with rainfall events during the months of June, July and August. While the highest flows in the river occur in April due to the snowmelt runoff, the highest turbidity and TSS readings occur in June, which is the month with the highest average precipitation. Using the duration curve approach, and noting the hydrologic conditions where most of the exceedances occur, it shows that the increased load may be the result of sediment delivery associated with rainfall and runoff from riparian areas and saturated soils in the upland areas under wetter conditions.

Section 1: Introduction

1.1 Purpose

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

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

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

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

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

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

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

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

The 2002 Minnesota TMDL Clean Water Act Section 303(d) list identified one impaired reach for the Pomme de Terre River Watershed. The reach was listed as impaired for failure to meet the aquatic life support designated beneficial use due to excessive turbidity concentrations.

1.2 Priority Ranking

The MPCA's projected schedule for TMDL completions, as indicated on Minnesota's 303(d) impaired waters list, implicitly reflects Minnesota's priority ranking of this TMDL. The project was scheduled to begin in 2007 and be completed in 2011. Ranking criteria for scheduling TMDL projects include, but are not limited to: impairment impacts on public health and aquatic life; public value of the impaired water resource; likelihood of completing the TMDL in an expedient manner, including a strong base of existing data and restorability of the waterbody; technical capability and willingness locally to assist with the TMDL; and appropriate sequencing of TMDLs within a watershed or basin.

1.3 Criteria Used for Listing

The protocol for this assessment is outlined in MPCA "Listing Methodology" publications found at http://www.pca.state.mn.us/water/tmdl/index.html#support. The applicable water body classifications and water quality standards are specified in Minnesota Rules Chapter 7050. Minn. R. ch. 7050.0222, subp. 5 lists applicable water quality standards for the impaired reach and Minn. R. ch. 7050.0407 lists water body classifications. Assessment summary information for the impaired reach is listed in Table 1.1. The assessment protocol states that there needs to be at least 20 independent observations over the previous 10-year period. The reach is listed as being impaired if at least three (3) observations and ten percent (10%) of observations exceed the water quality standard of 25 Nephelometric Turbidity Units (NTUs).

Table 1.1: Impaired Reach Description and Assessment Summary

Reach	Description	Year Listed	River Assessment Unit ID	# of observ. >25 NTU	% of observ. >25 NTU	Years of Data for Listing
Pomme de Terre River	Muddy Creek to Minnesota River (Marsh Lake Dam)	2002	07020002-501	12	44.4	91-01

1.4 Watershed Association

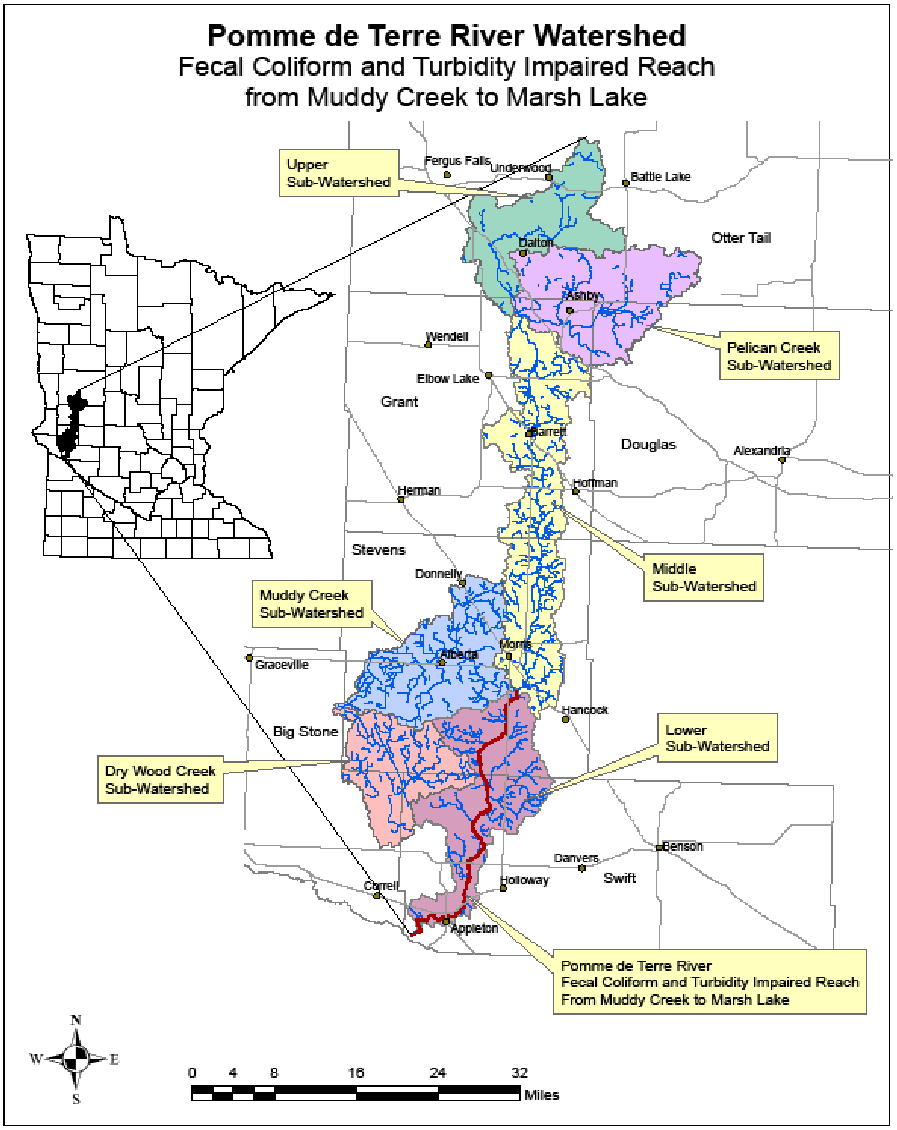
The Pomme de Terre River (PdT) Watershed has been studied since May, 1964 when it was included in the West Central Minnesota Resource Conservation and Development Area (WesMin RC&D) plan. In 1981 the Pomme de Terre River Association was organized and a Joint Powers Board (JPB) was created and signed by the six counties and soil and water conservation districts (SWCDs) in the watershed. The MPCA gave funding of $50,000 to the PdT Watershed Project at the end of June 2000 to compile all of the data that has been studied in the PdT River Watershed. The PdT River Association was awarded a grant in 2002 by the MPCA to investigate the water quality in the watershed. The Association was awarded a grant of $120,000 in 2008 by the MPCA to complete the turbidity TMDL and implementation plan. In addition, each of the six counties in the watershed contributed a total of $90,000 to the project. A Project Coordinator was hired in April of 2008 to complete the TMDL study and implementation plan.

Section 2: Background Information

2.1 Watershed Characteristics

The Pomme de Terre River Watershed is located in the upper Minnesota River Basin. It comprises nearly 560,000 acres or about 875 square miles. The majority of the watershed is in the Northern Glaciated Plains ecoregion with the northern tip in the North Central Hardwood Forest ecoregion. The counties and sub-watersheds are shown in Figure 2.1.

Figure 2.1: PdT Counties and Sub-watersheds



The average elevation in the watershed is 1198 feet above sea level. Precipitation in the watershed averages between 25 to 29 inches annually, with June being the month with the greatest average precipitation.

The majority of the Pomme de Terre Watershed is classified as rolling till prairie. Gently sloping to steep loamy glacial till soils with scattered sandy outwash soils and silty alluvial flood plain soils. This area is part of the prairie pothole region of the upper Midwest.

Drainage on the eastern side of the River is off the Big Stone Moraine, characterized by landscapes that are gently sloping to moderately steep (6-12%) and well drained silty and loamy soils. Water erosion potential within the Big Stone Moraine is generally classified as moderate. Waters falling on the western side of the basin drain the Fergus Falls Till Plain, an outwash plain of nearly level to moderately sloping (0-6%) composed of poorly drained clayey and loamy soils. Slight to high water erosion potential exists across this section of the basin and is reflected by the character of the River below the town of Morris. South of this point, flowing through southern Stevens and eastern Swift Counties, the River is bordered by eroding, muddy banks becoming increasingly turbid before discharging into the Minnesota River at Marsh Lake.

The total human population in the watershed is estimated to be about 18,400 (2002 census, and 2006 League of Minnesota Cities). Of the total, nearly 9,700 people live in urban areas while 8,700 people live in rural areas (54% and 47% respectively).

Of the six counties within the drainage basin of the Pomme de Terre River, only four actually have the river within their boundaries. The PdT flows from north to south, originating in Otter Tail County amid numerous lakes and wetlands. The river then flows through Grant, Stevens and Swift Counties where it reaches the Minnesota River at Appleton. Big Stone and Douglas Counties have land areas that drain into the Pomme de Terre River through a series of small streams and tributaries. The land area of each county in the watershed is listed in table 2.1.

Table 2.1: Acres and Percent of Watershed by County

County	**Acres of County in Watershed**	**% of Watershed Area**
Big Stone	18,116	3.2
Douglas	19,930	3.6
Grant	100,334	17.9
Otter Tail	128,829	23.0
Stevens	221,334	39.5
Swift	71,421	12.8
Total	**559,964**	**100**

There are about 104 Department of Natural Resources (DNR) protected lakes located in the watershed, 87 of which are located in Otter Tail and Grant Counties. These lakes act as buffers to the nutrient, sediment, and bacterial load to the river. Lakes, by virtue of their depth and volume, can slow the flow of a river, allow sediment to precipitate and dilute pollutants – sending cleaner water back to the river system.

There are four major tributaries that join the PdT River which are listed in Table 2.2. These tributaries connect the land use practices and their effects at the furthest reaches of the watershed to the main stem of the River, along with adding an additional volume of water.

Table 2.2: Streams in the Pomme de Terre River Watershed

STREAM NAME	Sub-Watershed	TOTAL STREAM MILES	TOTAL PERENNIAL STREAM MILES	TOTAL INTERMITTENT STREAM MILES
Artichoke Creek	Dry Wood Creek	2.7	0	2.7
Dry Wood Creek	Dry Wood Creek	10.1	3.2	6.9
Muddy Creek	Muddy Creek	31.5	11.1	20.4
Pelican Creek	Pelican Creek	12.4	12.4	0
Pomme de Terre River	Upper, Middle, Lower PdT	105.9	105.9	0
Unnamed streams and ditches	Watershed Wide	588.1	0	588.1
Totals		750.7	132.6	618.1

Minnesota River Basin Data Center, Minnesota State University, Mankato

The 52 minor watersheds within the Pomme de Terre River Watershed can be combined by drainage areas into the following six sub-watersheds:

- Upper Pomme de Terre River
- Pelican Creek
- Middle Pomme de Terre River
- Muddy Creek
- Dry Wood Creek
- Lower Pomme de Terre River

A U.S. Geological Survey (USGS) flow gage, number 0529400, is located in the Lower Pomme de Terre River sub-watershed on the Pomme de Terre River in Appleton. Data has been collected from this flow gage since 1931 and is in current operation as a real-time site. Information about this USGS flow gage and available data can be found on the internet at:
http://waterdata.usgs.gov/mn/nwis/nwisman/?site_no=05294000&agency_cd=USGS

2.2 Land Use

The Pomme de Terre River Watershed is largely rural. Cultivated land and grassland make up about 76% of the watershed, and urban land makes up nearly 2%. The cultivated land also includes pasture land in the watershed. Corn and soybeans make up about 50% of the crops grown in the watershed. The other 50% is made up mostly by smaller grains such as wheat, hay, and grasslands enrolled in the Conservation Reserve Program (table 2.3).

The majority of the cultivated land is in the lower three sub-watersheds (Dry Wood Creek, Muddy Creek, and Lower PdT) as seen in Table 2.4. These sub-watersheds also have the least amount of grassland and water/wetlands throughout the drainage area. The Middle PdT sub-watershed has a high percentage of cultivated land, but it also has one of the higher percentages of grassland. The majority of the water/wetlands are located in the two most northern sub-watersheds, Pelican Creek and Upper PdT.

Table 2.3: Land Use in the PdT River Watershed

Land Use	Number of Acres	% Of Watershed
Cultivated	386,362	68.9
Grassland	47,694	8.5
Forest	38,021	6.8
Water and Wetland	63,560	11.3
Urban/Residential	9,013	1.7
Other	15,314	2.8
Total	**559,964**	**100%**

1999 Land Use Inventory, Land Management Information Center

Table 2.4: PdT River Sub-Watershed Land Uses

		Land Use Percent of Sub-Watersheds					
Sub-Watershed	**Acres**	**Cultivated**	**Grassland**	**Forest**	**Water/ Wetland**	**Urban/ Residential**	**Other**
Dry Wood creek	61,778	82.5	5.2	2.2	8.0	0.1	2.0
Lower PdT	97,382	83.5	6.3	3.0	1.9	3.0	2.3
Middle PdT	137,733	72.4	9.4	3.9	9.5	2.3	2.5
Muddy Creek	92,350	85.0	4.1	1.3	5.1	1.3	3.2
Pelican Creek	84,939	42.2	15.5	14.7	22.7	1.4	3.5
Upper PdT	85,496	44.7	9.5	16.7	23.2	1.4	4.5

NRCS GIS Database

Section 3: Turbidity Standards and Assessment

3.1 Description of Turbidity

Turbidity is a measure of water clarity. Turbidity in water is caused by suspended sediment; organic material, dissolved salts, and stains that scatter light in the water column making the water appear cloudy. Excess turbidity can degrade aesthetic qualities of water bodies, increase the cost of treatment for drinking or food processing uses and can harm aquatic life. Aquatic organisms can have trouble finding food, gill function can be affected and spawning beds may become covered.

3.2 Applicable Water Quality Standards

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

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

According to MN Rules ch. 7050.0430, the impaired reach covered in this TMDL report is classified as Class 2B, 3B, 4A, 4B, 5 and 6 waters. This TMDL is written for class 2B waters as this is the most protective class. MN Rules ch. 7050.0222 describes the designated beneficial use for 2B waters is as follows:

The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water.

MN Rules ch. 7050.0222 subpart 5, turbidity water quality standard for class 2B waters, is **25 Nephelometric Turbidity Units (NTUs).**

As turbidity is a dimensionless unit, loading allocations, capacities and reductions are commonly based on a surrogate parameter that is concentration based. Total suspended solids (TSS) are the measurement of sediment and organic matter that is suspended in a sample of water and is reported in milligrams per liter (mg/L). The TSS equivalence to 25 NTU for the Pomme de Terre River was determined to be 52 mg/L. Section 5.5 details the calculation of the TSS surrogate value to 25 NTU for this reach of the river.

3.3 Assessment Procedures

Impairment assessment is based on the procedures contained in *The Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment* (MPCA, 2007a).

Transparency and TSS values reliably predict turbidity and can serve as surrogates at sites where there are an inadequate number of turbidity observations. Large sets of monitoring data have been used to develop transparency and TSS thresholds which will identify the large majority of waters with turbidity impairments while minimizing the number of waterbodies falsely identified. For transparency, a transparency tube measurement of less than 20 cm indicates a violation of the 25 NTU standard. For TSS, a measurement of more than 60 mg/L in the Western Corn Belt Plains and Northern Glaciated Plains ecoregions or more than 100 mg/L in the North Central Hardwood Forest ecoregion indicates a violation.

Turbidity is a highly variable water quality measure. Because of this variability, and the use of TSS and transparency as surrogates, a total of 20 independent observations (rather than 10) are now required for a turbidity assessment. If sufficient turbidity measurements exist, only turbidity measurements will be used to determine impairment. If there are insufficient turbidity measurements, any combination of independent turbidity, transparency, and total suspended solids observations may be combined to meet assessment criteria. If there are multiple observations of a single parameter in one day, the mean of the values will be used in the assessment process.

If there are observations of more than one of the three parameters in a single day, the hierarchy of consideration for assessment purposes will be turbidity, then transparency, then total suspended solids. For a water body to be listed as impaired for turbidity, at least 3 observations **and** 10% of observations must be in violation of the turbidity standard. This is an increase in the number of violations required, which was previously 10% of 10 required observations.

Section 4: Surface Water Quality Conditions

The turbidity and TSS dataset used for this TMDL was from 1997 to 2008 at the Appleton USGS monitoring station (STORET ID: S000-195). Transparency tube data was also collected at this site from 1997 to 2008, however, with the abundance of TSS data, the transparency tube data was not utilized. A summary of all the available data is provided in tables 4.1, 4.2 and 4.3.

Table 4.1 Summary of turbidity data for the PdT Watershed

	Appleton (S000-195)
Years sampled	1997-2008
Number of observations	115
Percent of observations > 25 NTU (state standard)	57%
Range, NTU	5.2-220
Mean, NTU	30.3

Although turbidity data was taken at the Appleton site from 1971-1976, no units of measurement were given for these samples, so these were not included in the data set. No turbidity data was taken from 1977-1996. The turbidity data used for this TMDL is from 1997-2008. It should be noted that this turbidity data was taken in three different measurement units, NTU, NTRU and FNMU. All the FNMU data was disregarded as the units of measurement were much different than the NTU and NTRU data. A statistical analysis was done by the MPCA and it was shown that the difference between the NTU readings and the NTRU readings was statistically insignificant, so turbidity readings with units of NTU and NTRUs were combined as one dataset (see appendix A). Only two turbidity and TSS samples were taken in both 1998 and 2000. In addition to 1998 and 2000, no TSS samples were taken in 2002, 1996 and 1978, so these years are not represented in tables 4.1 and 4.2, and figure 4.1.

TSS samples have been taken at the Appleton site since 1972, with the exception of the above noted years. From 1972-2003 the samples were taken approximately once a month, and from 2004 on, more frequent samples were taken. Stream transparency readings began to be taken in 1997 and continued through 2008. Although this data was not utilized in this assessment, the summary in table 4.3 produces another line of evidence towards the exeedence of the turbidity standard.

Table 4.2 Summary of TSS data for the PdT Watershed

	Appleton (S000-195)
Years Sampled	1972-2008
Number of Observations	352
Percent of observations > 52 mg/L (Surrogate value for the 25 NTU standard)*	41%
Range of TSS concentrations (mg/L)	.6 - 400
Mean TSS concentration (mg/L)	51

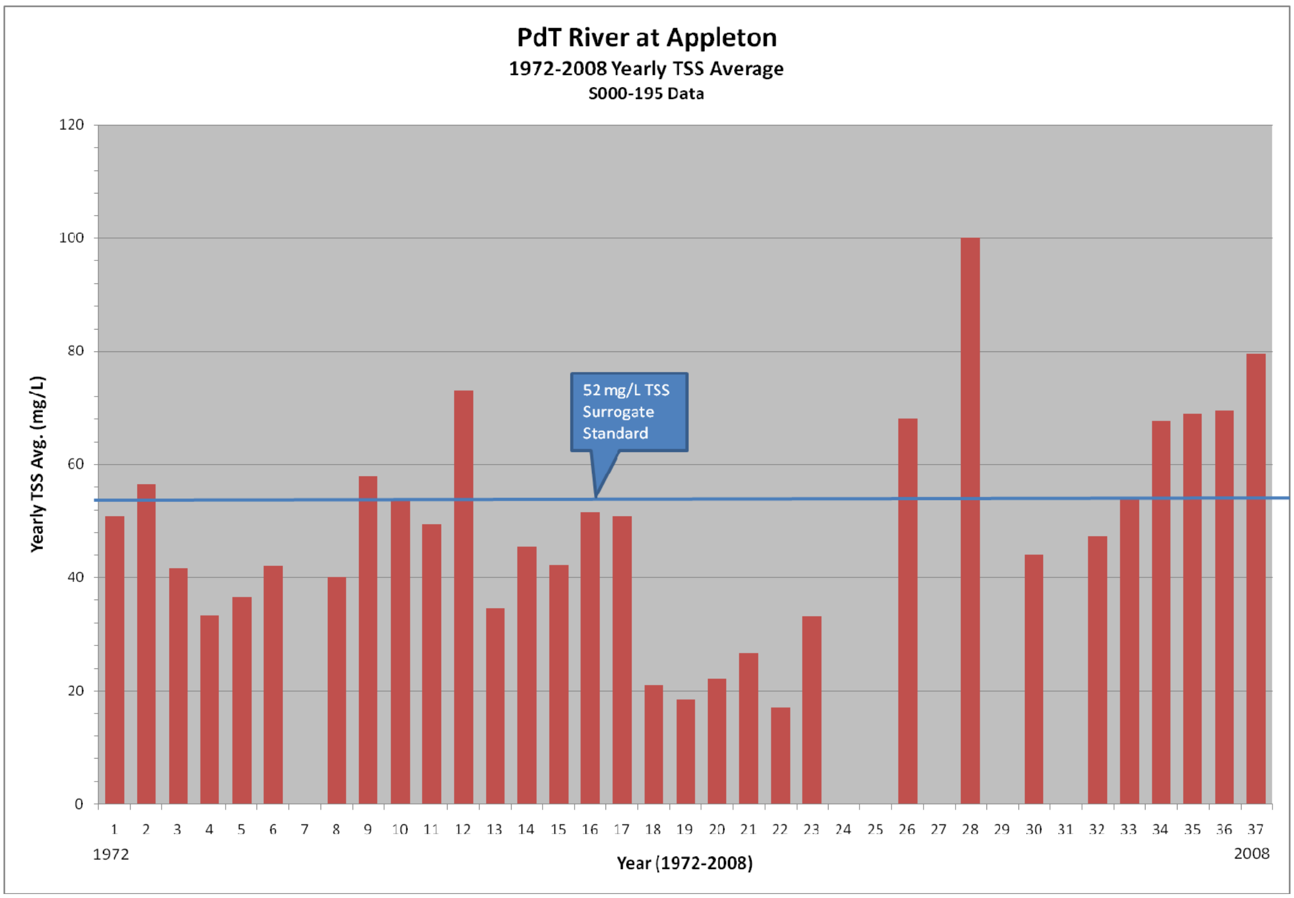
*****See appendix A for description of TSS surrogate standard

Table 4.3 Summary of Transparency data for the PdT Watershed

	Appleton (S000-195)
Years Sampled	1997-2008
Number of Observations	119
Percent of observations < 20 cm (Surrogate value for the 25 NTU standard)	54%
Range of Transparency readings (cm)	3->100
Mean transparency reading (cm)	23.4

Figure 4.1 shows the 1972-2008 yearly TSS concentration averages for the Pomme de Terre River at the S000-195 gauge in Appleton, MN. From 1972-1999 there were only 5 years where the yearly TSS average was above the 52 mg/L surrogate standard. From 2000-2008, there were 4 years where the yearly average was above the surrogate standard.

Figure 4.1: 1972-2008 Yearly Average TSS concentrations (the corresponding TSS surrogate value for the 25 NTU standard is shown.)



Section 5: Turbidity TMDL Development

The following describes the development process for the turbidity TMDL in the Pomme de Terre River Watershed.

5.1 Description of Impaired Reach

The Pomme de Terre River, from Muddy Creek located 7 miles south of Morris, MN down to Marsh Lake, just southwest of Appleton, MN was placed on the 303(d) impaired waters list in 2002 for excess turbidity. The impaired reach is the last 31 miles of the River, and is the last reach before the River empties into Marsh Lake and the confluence with the Minnesota River. Figure 2.1 displays the location of this impairment and its contributing 560,000 acre drainage area.

5.2 Components of Turbidity TMDL

Turbidity TMDLs consist of four components: Wasteload Allocation (WLA), Load Allocation (LA), Margin of Safety (MOS), and Reserve Capacity (RC).

WLA = Waste Load Allocation, which is the sum of all point sources, including:

- Permitted Wastewater Treatment Facilities (NPDES)
- Construction Stormwater (NPDES)
- Industrial Stormwater (NPDES)
- Permitted Municipal Separate Storm Sewer Systems (MS4) Communities

LA = Load Allocation, which is the sum of all nonpoint sources, including:

- Runoff from row cropland
- Feedlots with pollution hazards
- Livestock in riparian zone
- Impervious surface
- In-stream sources

MOS = Margin of Safety, a factor that accounts for any lack of knowledge concerning the effluent limitations and water quality. May be implicit and factored into conservative WLA or LA, or explicit

RC = Reserve Capacity (allocation for future growth)

The “Duration Curve” approach was utilized to address the turbidity TMDL. This process involved the following steps: compiling the flow data, producing a flow duration curve, calculating the TSS surrogate for the Pomme de Terre River, and determine loading capacity and allocations.

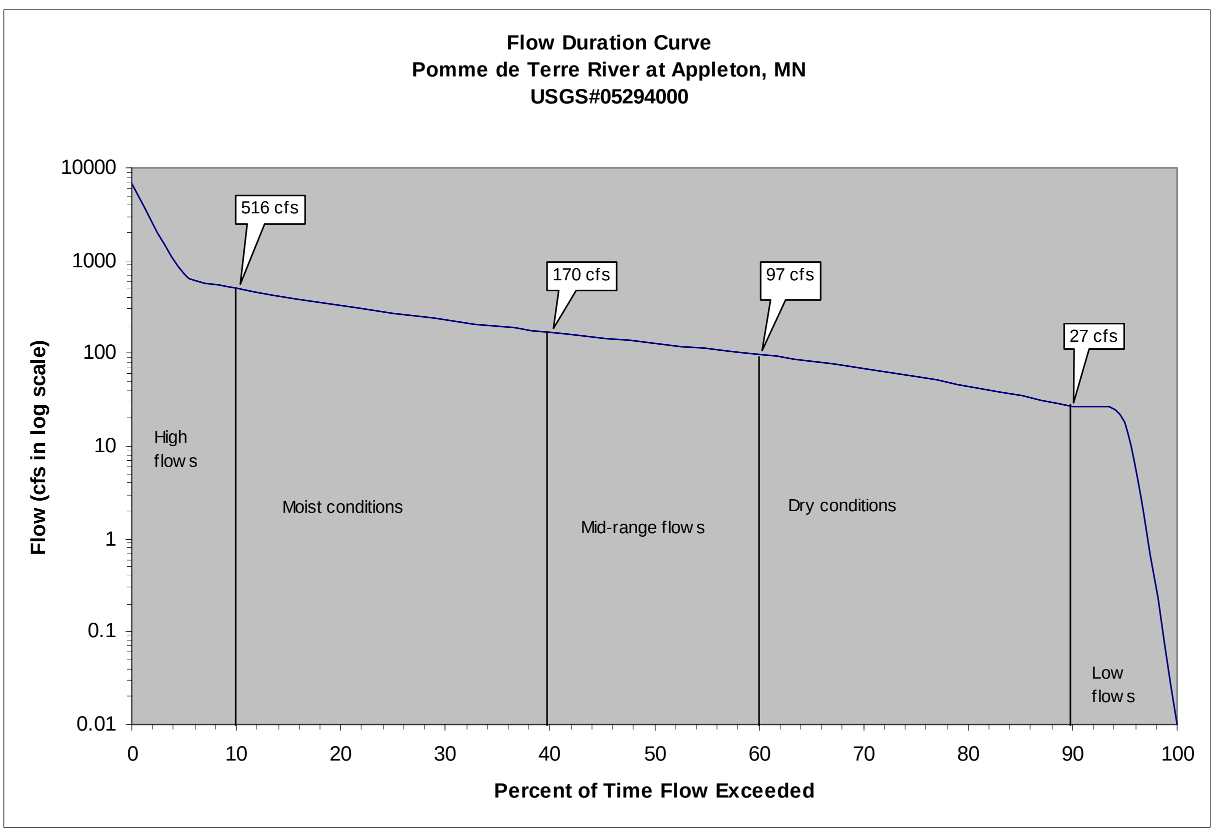
5.3 Compilation of Flow Data

The duration curve approach for turbidity involved using flow monitoring data from the Pomme de Terre River USGS gauging site (#05294000) located at Appleton, MN. The turbidity TMDL duration curve required daily mean flow values. A total of 7,012 daily flow values were compiled for the flow record, which spanned from 1977-2007. Flow data was available from 1931, but the last thirty years were used to better reflect current watershed conditions.

5.4 Development of the Flow Duration Curve

The daily flow values were sorted by flow volume, from highest to lowest, to develop a flow duration curve, shown in figure 5.1.The duration curve relates flow values to the percent of time those values have been met or exceeded. Thus, the full range of stream flows is considered. The cumulative flows are broken into five hydrologic conditions (low flows, dry conditions, mid-range flows, moist conditions and high flows). Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently. Using this convention, flow duration intervals are expressed as a percentage, with zero corresponding to the highest stream discharge on record (flood conditions) and 100 to the lowest (drought). A flow duration of sixty associated with a stream discharge of 97 cfs implies that sixty percent of all observed stream discharge values equal or exceed 97 cfs.

Figure 5.1: Flow Duration Curve for the PdT at Appleton, MN



5.5 Calculation of TSS Equivalent for Turbidity Standard

As turbidity is a dimensionless unit, loading allocations, capacities and reductions are commonly based on a surrogate parameter that is concentration based. Total suspended solids (TSS) are the measurement of sediment and organic matter that is suspended in a sample of water and is reported in milligrams per liter (mg/L). TSS is often used as a surrogate to calculate loading allocations and capacities for turbidity impairments.

MPCA protocol used for listed streams allows for the use of TSS data when adequate turbidity data is not available. The protocol suggests TSS values of 60 mg/L in the Western Corn Belt Plains Ecoregion and Northern Glaciated Plains Ecoregion is a violation of the standard. Most of the Pomme de Terre River is located in the Northern Glaciated Plains Ecoregion.

In reality, the relationship between turbidity and TSS varies in streams across Minnesota. Even different segments of the same stream can have varying relationships of TSS to turbidity. The relationship of turbidity and TSS will depend on contributing water sources and landscape features. Sediment particle size and type will also often change from one portion of a stream to another, which can have an impact on this relationship. To account for this issue, the MPCA recommends that stream specific relationships of turbidity and TSS be made for each stream undergoing a TMDL (when adequate data exists). There was ample data to use the stream specific relationship for this TMDL.

To determine the TSS equivalent to the turbidity standard of 25 NTU, paired turbidity and TSS samples collected from the Appleton monitoring station (STORET ID S000-195) were compiled using data from 1997-2007. Based on criteria recommended by the MPCA (2007b), only sample sets with a turbidity value of 40 NTU or below and TSS values of 10 mg/L or above were used for the analysis. Review of turbidity data revealed varying methods of laboratory and field turbidity analysis. Following MPCA criteria, only accepted turbidity methods and types were used for the analysis. A total of 39 paired turbidity/TSS samples met these criteria. Of these 39 samples, 27 were NTRU samples and 12 were NTU samples. A regression analysis was completed on each as shown in figures 5.2 and 5.3. Using the regression line equation, a TSS concentration of 52 mg/L was determined to be the surrogate value to the 25 NTU standard. The complete write up and data set used for this analysis is in appendix A.

Figure 5.2: Paired Turbidity (NTRU)/TSS samples

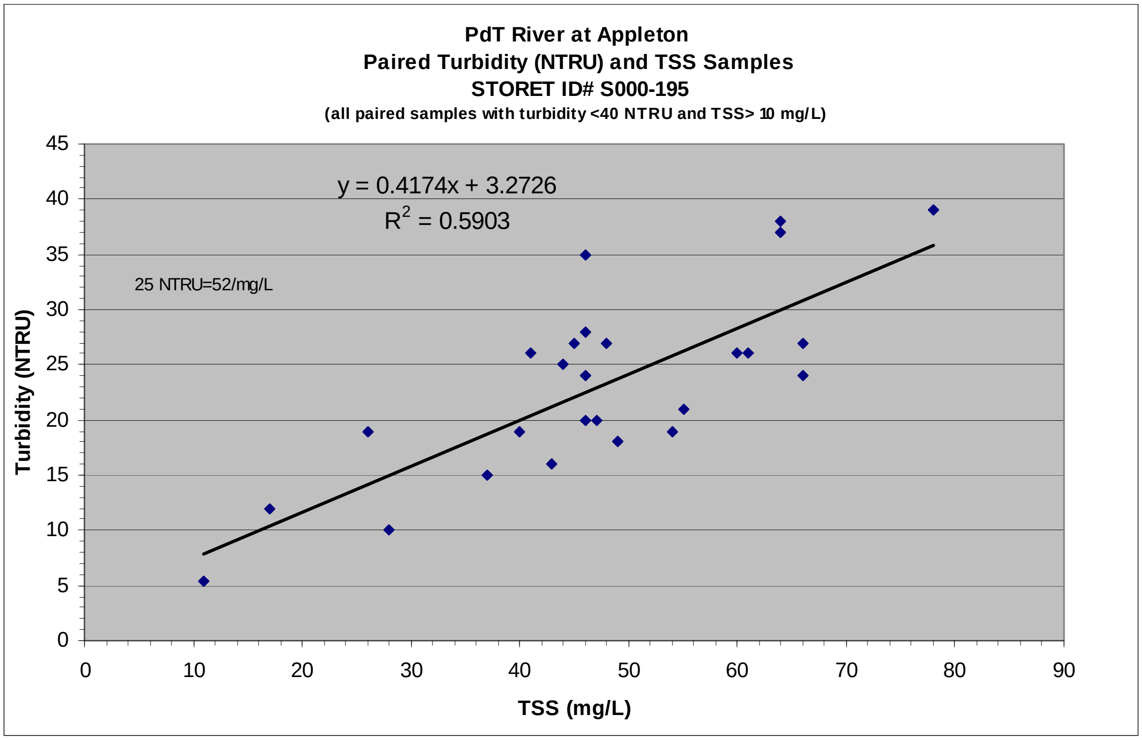
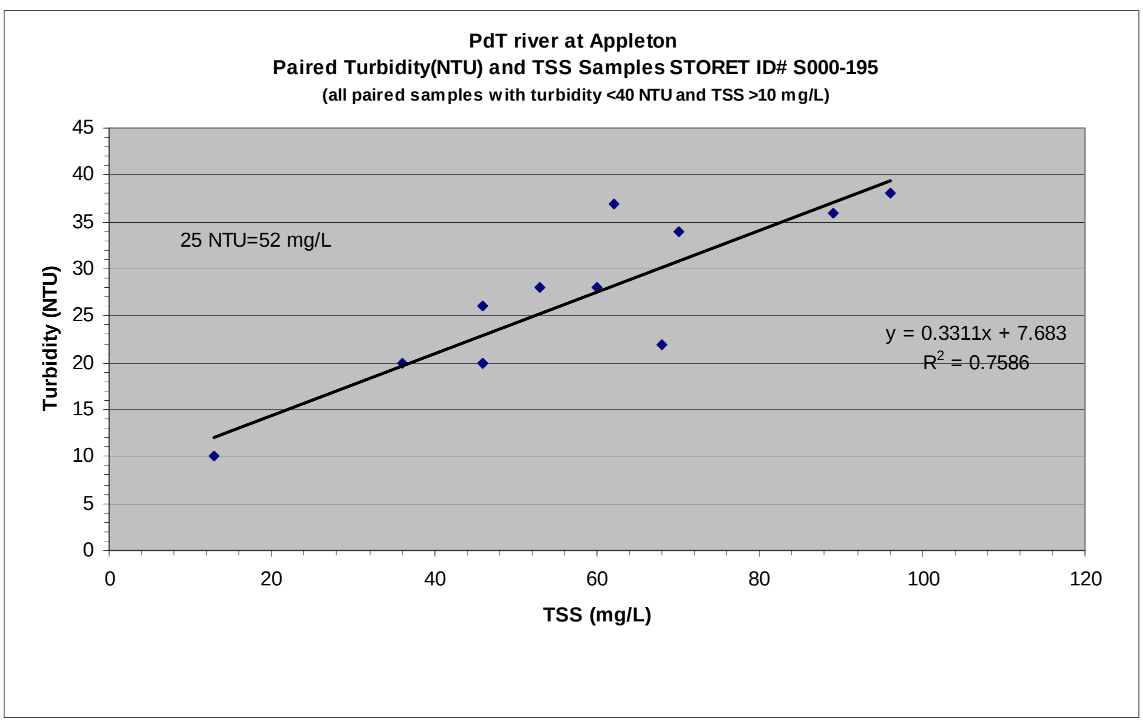


Figure 5.3: Paired Turbidity (NTU)/TSS samples



5.6 Determining Loading Capacity (Maximum Amount of Pollutant)

Flow regimes were determined for high, moist, mid-range, dry and low flow conditions. The mid-range flow value for each flow regime was then used to calculate the total daily loading capacity (TDLC). Thus, for the "high flow" regime, the TDLC is based on the monthly flow value at the 5th percentile. Table 5.1 presents the flow regimes and the flow value used to calculate the TDLC.

Table 5.1: Flow Categories for the PdT River

Flow Condition	Percent of Time Flow Exceeded	Flow Range (cfs)	Flow Used to Calculate Total Daily Loading Capacity (cfs)
High	0-10%	>516	721
Moist	10-40%	170-516	273
Mid	40-60%	97-170	129
Dry	60-90%	27-97	56
Low	90-100%	<27	18

Next, the TDLC for each flow regime was multiplied by the TSS surrogate standard of 52 mg/L, which is converted into tons of TSS per day using the following equation:

How to convert flow and concentration into sediment load

1. Determine the median flow value for each flow regime.

2. Calculate the TSS equivalent of 25 NTU (=52 mg/L)

3. For each flow regime, calculate the total liters per day:
    a. Flow (cfs) x 28.31 (cf/L) x 86,400 (sec./day)

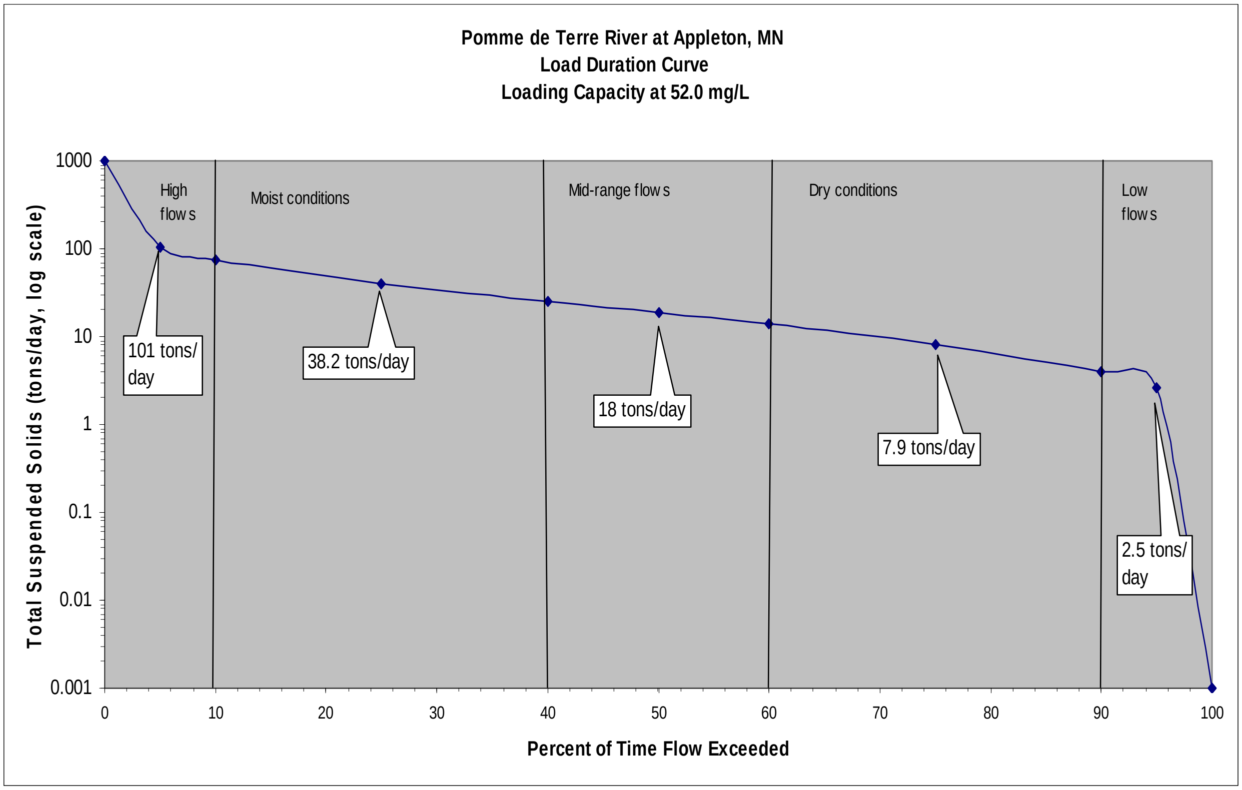
4. For each flow regime, calculate total mg of TSS:
    a. TSS surrogate (52 mg/L) x total liters.

5. For each flow regime, calculate total tons of TSS per day:
    a. Total mg TSS/907,184,740 (mg/ton)

$$\frac{\text{Flow x TSS surrogate x 28.31 x 86,400}}{907{,}184{,}740}$$

Daily flows multiplied by the TSS surrogate value results in a load duration curve. Figure 5.4 presents the load duration curve for the Pomme de Terre River near Appleton with the TDLC for each of the five flow regimes. The loading capacity varies from 2.5 tons per day during low flow conditions, up to 101 tons per day during high flow conditions.

Figure 5.4: TDLC by Flow Regime



5.7 Determining Margin of Safety

Next, a Margin of Safety (MOS) was determined for each flow regime. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. For this TMDL, an explicit 10% MOS is applied. This is expected to provide an adequate accounting of uncertainty.

In the low flow zone, where the allocation required use of an alternative method of calculation, i.e., a concentration-based limit, an implicit MOS was used. An implicit MOS means that conservative assumptions were built in to the TMDL and\or allocations. In this instance the river is expected to meet the TMDL because the permitted point source dischargers are limited to discharge concentrations below the TSS target, thereby providing additional capacity.

5.8 TDLC, MOS and TMDL Allocations

Table 5.2 presents the TDLC, MOS and TMDL allocations for the Pomme de Terre River near Appleton. The TDLC minus the MOS results in the available wasteload and load allocations. The values expressed are in tons of TSS per day.

Table 5.2: TMDL, MOS and TDLC for the PdT River near Appleton

Flow Condition	TDLC (tons TSS/day)	MOS (tons TSS/day)	Allocation (tons TSS/day)
High	101	10.1	90.9
Moist	38.2	3.8	34.38
Mid	18.0	1.8	16.2
Dry	7.9	.79	7.11
Low	2.5	*	*

In the very lowest flow zone, the total daily loading capacity is very small due to the occurrence of very low flows in the long-term flow record. Consequently the MOS would take up most of the loading capacity. To account for this unique situation, the WLA and LA are expressed as an equation rather than an absolute number. That equation is:

Allocation = (flow contribution from a given source) X (45 mg/L TSS)

In essence, this amounts to assigning a concentration-based limit to the sources in the low flow zone, with the concentration limit being 45 mg/L TSS from the MN Rules, Chapter 7050.

5.9 Split the TMDL into a Wasteload Allocation and Load Allocation

WASTELOAD ALLOCATION

NPDES Industrial and Municipal Wastewater Treatment Facilities (WWTF)

Through permit requirements, WWTFs may be allocated a concentration and or load based TSS effluent discharge limit. This TSS limit was then converted into tons per day of TSS. Table 5.3 provides the tons per day TSS discharge permitted to each of the facilities in the Pomme de Terre River Watershed. To account for potential future growth/expansion impacts, a reserve capacity of an additional 50 percent was added to each NPDES wasteload allocation.

Table 5.3: Wastewater Treatment Facilities and Industrial Facilities with Numeric Discharge Limits for TSS

Name	Permit Number	Wasteload Allocation (Standard Tons TSS/day)	Wasteload Allocation with Reserve Capacity (Standard Tons TSS/day)
Alberta	**MNG580002**	0.050	0.075
Appleton	**MN0021890**	0.055	0.0825
Del Dee Foods[1]	**MNG960027**	0	0
Ashby	**MNG580087**	0.147	0.221
Barrett	**MN0022713**	0.171	0.256
TWF Industries[2]	**MNG960027**	0	0
Chokio	**MNG580007**	0.147	0.221
Chokio WTP	**MNG640022**	0.0015	0.0022
Dalton[1]	**MN0023141**	0	0
Morris	**MN0021318**	1.425	2.175

Underwood[1]	**MN0025071**	0	0
Denco LLC	**MN0060232**	0.031	0.045
	Totals	**2.027**	**3.041**

[1]No discharge to surface water
[2]Discharges to Barrett WWTF

Six of the eight municipalities with WWTFs discharge to surface water, while two WWTFs, Dalton and Underwood, do not discharge to surface water, but discharge by spray irrigation and groundwater infiltration respectively. Alberta, Ashby, Barrett, Chokio, and Morris are all pond systems. Chokio also has a water treatment plant that has a filter backwash discharge TSS limit. Appleton is the only community with a mechanical system. TWF Industries Inc. is a metal finisher in Barrett. It discharges to the Barrett WWTF and no WLA is required. Del Dee Foods in Appleton has a land application of industrial byproducts pretreatment permit. There is no surface discharge and no WLA is required.

Denco LLC, an ethanol plant located in Morris, was the only industrial facility with a TSS effluent limit (table 5.3). The facility has a TSS concentration limit of 30 mg/L and a maximum design flow of .250 million gallons per day. This equates to a limit of .03 tons per day. This industrial wasteload allocation was utilized with the municipal WWTF allocations in table 5.4.

Municipal, Industrial and Construction Stormwater

In addition to the NPDES industrial TSS effluent limit, Denco LLC also has a stormwater outfall. This outfall also has a 30 mg/L TSS effluent limit but no design flow upon which an allocation could be based. This discharge will be handled with the industrial stormwater discharge WLA. If the facility is in compliance with its NPDES industrial stormwater permit requirements it will also be considered to be in compliance with the wasteload allocation.

APEC LLC has a permit to build an ethanol plant in Alberta. The permit authorizes the discharge of stormwater from outfall SD001. There is a TSS limit of 30 mg/L but no design flow value to calculate a load or allocation. Currently this project is on hold due to failure to obtain a permit from the DNR because of issues with the capacity of the aquifer to be able to supply the water needed for plant operation.

When applicable, permitted MS4 communities are also allocated a portion of the loading capacity based on percentage of land coverage in the impaired watershed. The City of Morris is designated for permit coverage because their population exceeds 5000 and they are within a half mile of an impaired water body (HUC: 07020002-502, biotic impairment for fish). The City of Morris currently covers about 0.79 percent of the watershed and thus receives 0.79 percent of the loading capacity. To account for future growth (reserve capacity), allocations in the TMDL for Morris as an MS4 community were rounded to 1% of the loading capacity to calculate the wasteload allocation.

The wasteload allocation for construction and industrial stormwater was determined based on percentage of land in the watershed affected by these uses. These uses primarily involve road construction projects, sand and gravel operations and new construction projects. The estimates are determined by the average number of acres per year in the last 4.5 years disturbed by these activities, divided by the total acreage in the watershed. Estimates as of 2007 are that 0.03% of the watershed has land disturbed by construction activities, and 0.06% of land disturbed by industrial activities.

Construction stormwater activities are considered in compliance with provisions of the 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.

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.

Load Allocation

Once the WLA and MOS were determined for the given reach and flow zone, the remaining loading capacity was considered the load allocation. The load allocation includes nonpoint pollution sources that are not subject to NPDES permit requirement, as well as “background” sources, such as natural soil erosion from stream channel and upland areas.

5.10 Turbidity TMDL for the Pomme de Terre Watershed

Table 5.4 presents the Wasteload and Load Allocations for the impaired reach. The table provides allocations in tons per day and also in percent of total loading capacity.

Table 5.4: TSS Total Daily Loading Capacities and Allocations

Pomme de Terre River: Muddy Creek to Marsh Lake AU ID: 07020003-501 Watershed area: 560,000 acres 855 sq. mi.	Flow Zone				
	High	**Moist**	**Mid-Range**	**Dry**	**Low**
	Values expressed as tons TSS/day				
Total Daily Loading Capacity	101	38.2	18.0	7.9	2.5
Wasteload Allocation					
Wastewater Treatment Facilities and Industrial Facilities with Numeric Discharge Limits for TSS (NPDES)	3.041	3.041	3.041	3.041	*
Communities Subject to MS4 NPDES Permit Requirements	1.01	0.382	0.18	0.079	*
Construction Stormwater (NPDES)	0.03	0.011	0.005	0.002	*
Industrial Stormwater (NPDES)	0.06	0.023	0.011	0.004	*
Wasteload Allocation Total	4.14	3.45	3.23	3.12	*
Load Allocation	86.76	30.93	12.97	3.99	*
MOS	10.1	3.82	1.8	.79	Implicit
	Value expressed as percentage of total daily loading capacity				
Total Daily Loading Capacity	100%	100%	100%	100%	100%
Wasteload Allocation					
Wastewater Treatment Facilities and Industrial Facilities with Numeric Discharge Limits for TSS (NPDES)	3.0%	7.9%	16.9%	38.5%	*
Communities Subject to MS4 NPDES Permit Requirements	1.0%	1.0%	1.0%	1.0%	*
Construction Stormwater (NPDES)	0.03%	0.028%	0.029%	0.025%	
Industrial Stormwater (NPDES)	0.06%	0.06%	0.06%	0.051%	*
Wasteload Allocation Total	4.09%	8.99%	17.99%	39.57%	*
Load Allocation	85.91%	81.01%	72.01%	50.43%	*
MOS	10%	10%	10%	10%	Implicit

***** See section 5.8 for allocations for this specific category in this flow zone

5.11 Impacts of Growth on Allocations

Potential changes in population and land use over time in the Pomme de Terre River Watershed could result in changing sources of excess turbidity. Discussion on how these changes may impact TMDL allocations are discussed below.

Wasteload Allocations

Monthly TSS discharge limits for facilities with NPDES permits typically are from 30 to 45 mg/L. As discussed previously, the TSS equivalent to 25 NTU in the Pomme de Terre River is approximately 52 mg/L. While new facilities may add increased sediment loading to the system, they would also add additional water. As long as facilities continue to meet existing and new effluent limits, point sources would continue to have a minimal impact on the turbidity of receiving waters. There are no un-sewered communities in the watershed that would be building new WWTFs.

Load Allocations
The amount of land in agricultural land use in the Pomme de Terre River Watershed is likely to remain fairly consistent over the next two decades. The watershed is comprised primarily of row crops (corn and soybeans) and pasture and hay land. While the majority of the landscape is likely to remain in an agricultural land use, it is possible a shift from pasture/hay land to row crops could occur. While this could occur, this shift would likely not affect the loading capacity of the stream. This is due to the loading capacity being based on long-term flow value, and slight shifts in land use would likely not substantially increase or decrease annual flows.

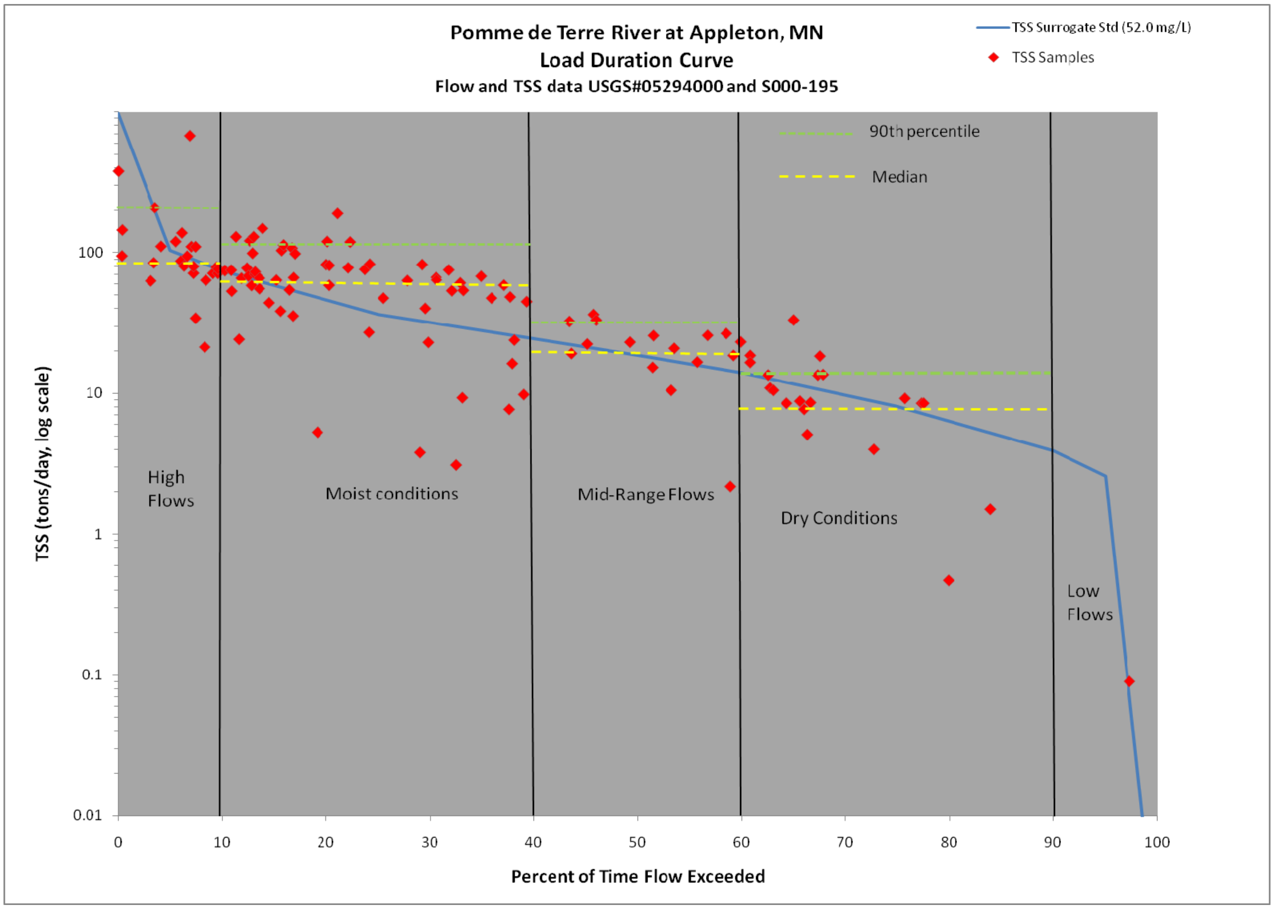
Section 6: Turbidity Assessment

The following section details the most recent ten-year period of TSS loading and necessary reductions by varying flow conditions. The presentation of data also attempts to provide a general sense of the magnitude, timing and sources of TSS.

6.1 TSS Loading

Figure 6.1 presents TSS samples plotted on a load duration curve using flow data from the USGS gauging station # 05294000 at Appleton and water quality data from the Appleton monitoring station (STORET ID# S000-195). Figure 6.1 shows the loading capacity over the flow record (1977-2008) along with the 126 samples collected in the last eleven year period. For each sample, the TSS concentration was multiplied by the daily flow value to compute a daily load in tons of TSS. Values that lie above the load duration curve represent samples that exceed 52 mg/L. In addition, the 90^{th} percentile values, and the median values are shown for each flow regime. The 90^{th} percentile value is that reading that is only exceeded by 10% of the data points. The median value is the reading in the middle of the data set. 50% of the readings are greater than the median value and 50% are less than the median value. The data show that exceedances of the TSS surrogate of 52 mg/L is more likely to occur at higher flow rates. When flows were less than the 50^{th} percentile flow value (129 cfs), 53% of the samples exceeded the standard. When flow values are above 129 cfs, 61% of the samples exceeded the standard.

Figure 6.1: Loading Duration Curve for PdT River



6.2 Necessary Load Reductions

An estimate for an overall load reduction percentage can be made using the existing dataset. To do so, it makes sense to consider the listing/delisting criteria for TSS, which is based on whether or not 10 percent of the data points within a dataset exceed the 52 mg/L TSS surrogate standard. Therefore, to meet the standard 90 percent of the time would mean reducing the 90th percentile value from the dataset down to 52 mg/L. The watershed-wide 90th percentile for TSS is 110 mg/L. And to reduce that to 52 mg/L would mean a reduction of:

$$[(110-52) /110] \times 100=53\%$$

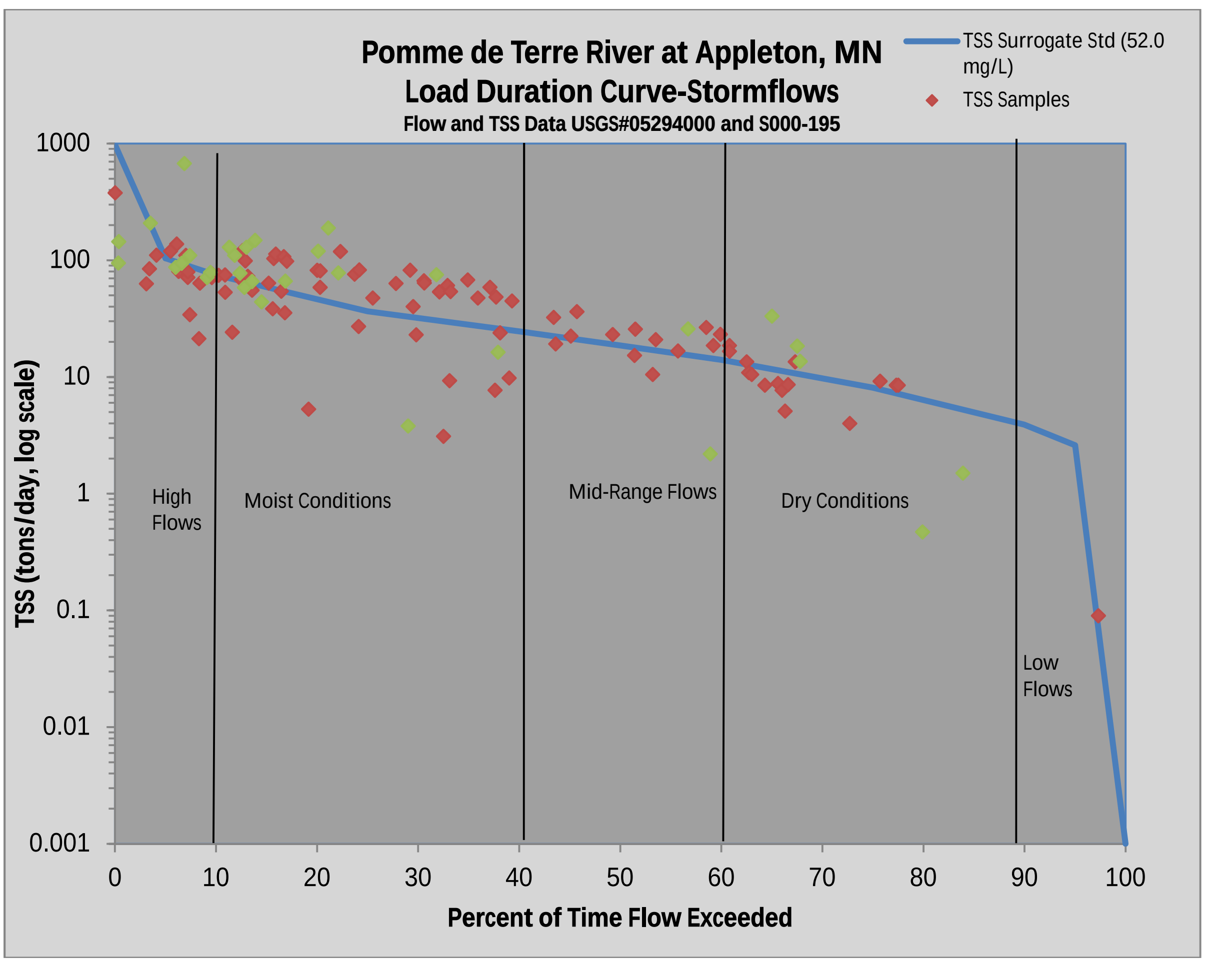
This reduction percentage is only intended as a rough approximation, as it does not account for flow, and is not a required element of a TMDL. It serves to provide a starting point based on available water quality data for assessing the magnitude of the effort needed in the watershed to achieve the standard. This reduction percentage does not supersede the allocations provided in section 5.10 in which the loading capacity will be meeting the standard 100% of the time.

6.3 Potential Sources of TSS

Sources of TSS and turbidity in stream settings are often categorized as external and internal sources. External sources include point and non-point contributors. External point contributors would include municipal and industrial wastewater facility discharges. Examples of external non-point sources would include runoff from rural and urban landscapes. Internal sources would include streambed load movement and bank slumping. Internal processes can also include growth and decay of algae and other plant material in the channel or water column.

To help assess the sources of TSS loading, the duration curve was further enhanced to characterize wet weather concerns. Average daily stream discharge measurements on days preceding the collection of the ambient water quality sample were examined. Flow data on the day the sample was collected was compared with the flow the preceding day. Any one-day increase in flow is assumed to be the result of surface runoff (Cleland, 2003). In figure 6.2 these samples are identified with a green diamond.

Figure 6.2: Load Duration Curve with Stormflow Samples



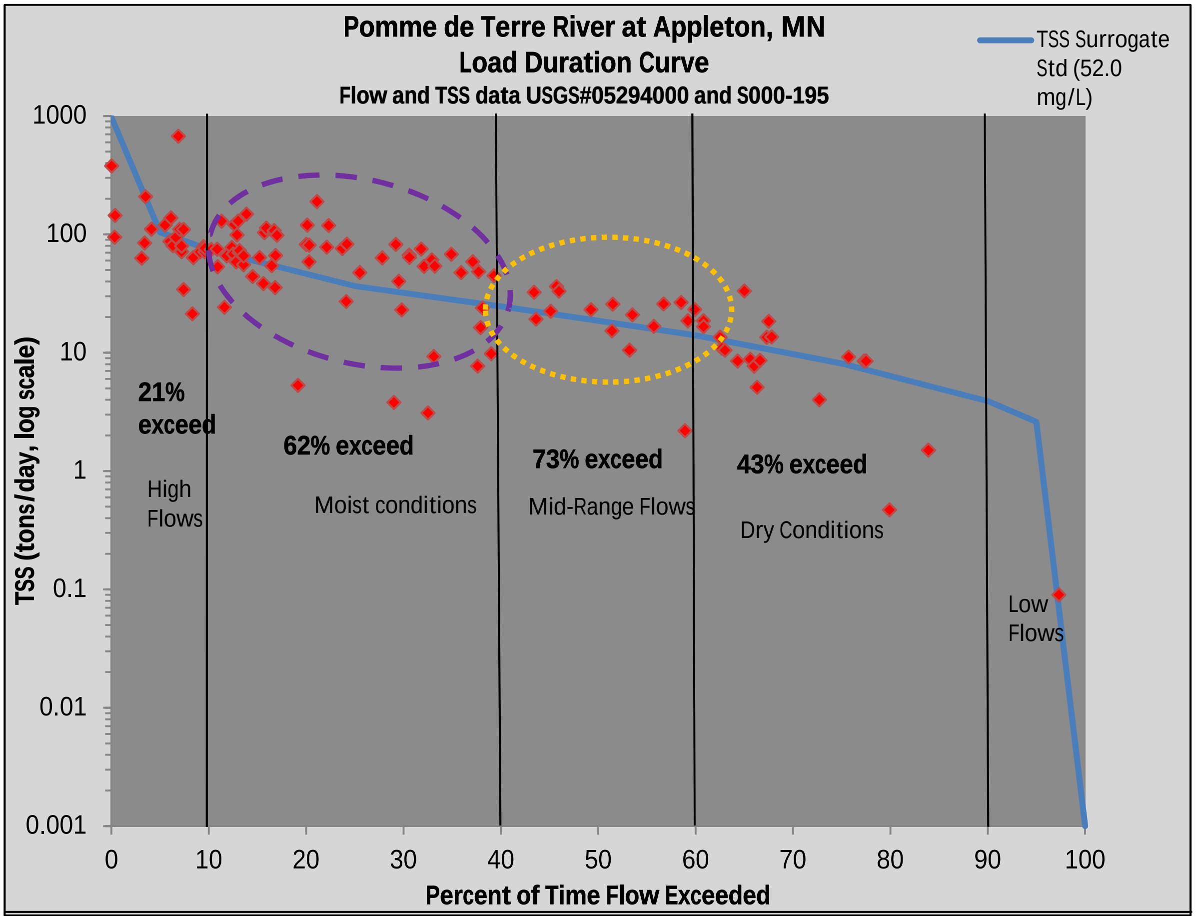
Bruce Cleland of the US EPA (2002) has indicated that a weight of evidence relationship between the load duration curve intervals (Low Flows, Dry Conditions, Mid-Range Flows, Moist Conditions, High Flows) and the proximity or energy required by types of sources to be significant loaders may be use to support targeting implementation measures. To use the weight of evidence process, the relationships that exist for any one source between proximity (transport) and the ratio of stream loading must be better understood. Not all of the sources will dominate the conditions of a river during all duration curve intervals. The understanding of when the source is expected to be a dominant factor is used.

The percentage of TSS samples that violate the 52 mg/L TSS standard is greatest in the Mid-Range Flows (72% of samples exceed the standard) and in the Moist Conditions (62% of samples exceed the standard). Figure 6.3 is the load duration curve with the addition of two key transport discussions. The discussions are developed as a weight of evidence application for known sources and expected occurrence in the watershed.

1. The orange small dashed oval indicates the area where materials are typically transported from close proximity erosion areas in the watershed. Mid-Range flows usually represent the rise of a hydrograph as it progresses out of the dry condition range and enters into wetter conditions. The zone of land use that is most likely to contribute during this period would be the riparian corridor of the river. This is because limited upland soil saturation and quite possibly soil erosion has yet to take place during the early period of storm events or in smaller events that can only deliver localized eroded soils. In agricultural areas, targeted programs for mid-range flow exceedances should focus on riparian protection. The targeted activities would be riparian buffers like the Conservation Reserve Program (CRP) or Conservation Reserve Enhancement Program (CREP).

2. The purple dashed oval indicates the area where material loading typically originates from both upland soils which under these wetter conditions are now saturated and begin contributing to the more effective transport of eroded materials and continuing to move riparian corridor eroded materials. In agricultural areas, target programs should also focus on saturated upland soils. Targeted activities could include conservation tillage techniques, contour strips and grassed waterways.

Figure 6.3: Using the Load Duration Curve to Discuss Contributing Erosion Zones



6.4 Critical Condition and Seasonal Variation

The Environmental Protection Agency (EPA) states that the critical condition *"…can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence"* (USEPA, 1999). Turbidity levels are generally at their worst following significant storm events during the late spring and early summer months.

While the highest flow levels in the Pomme de Terre River occur in April and May due to snowmelt runoff (figure 6.4). The highest turbidity and TSS levels occur in June-September. There is a strong correlation when the turbidity and TSS levels are graphed with average monthly rainfall amounts (figures 6.5 and 6.6). This shows that high turbidity and TSS levels on the Pomme de Terre River are linked with rainfall events rather than snowmelt runoff. This is most likely due to the erosive power of raindrops on the soil before agricultural crop cover is fully developed.

Figure 6.4: Average Monthly flow

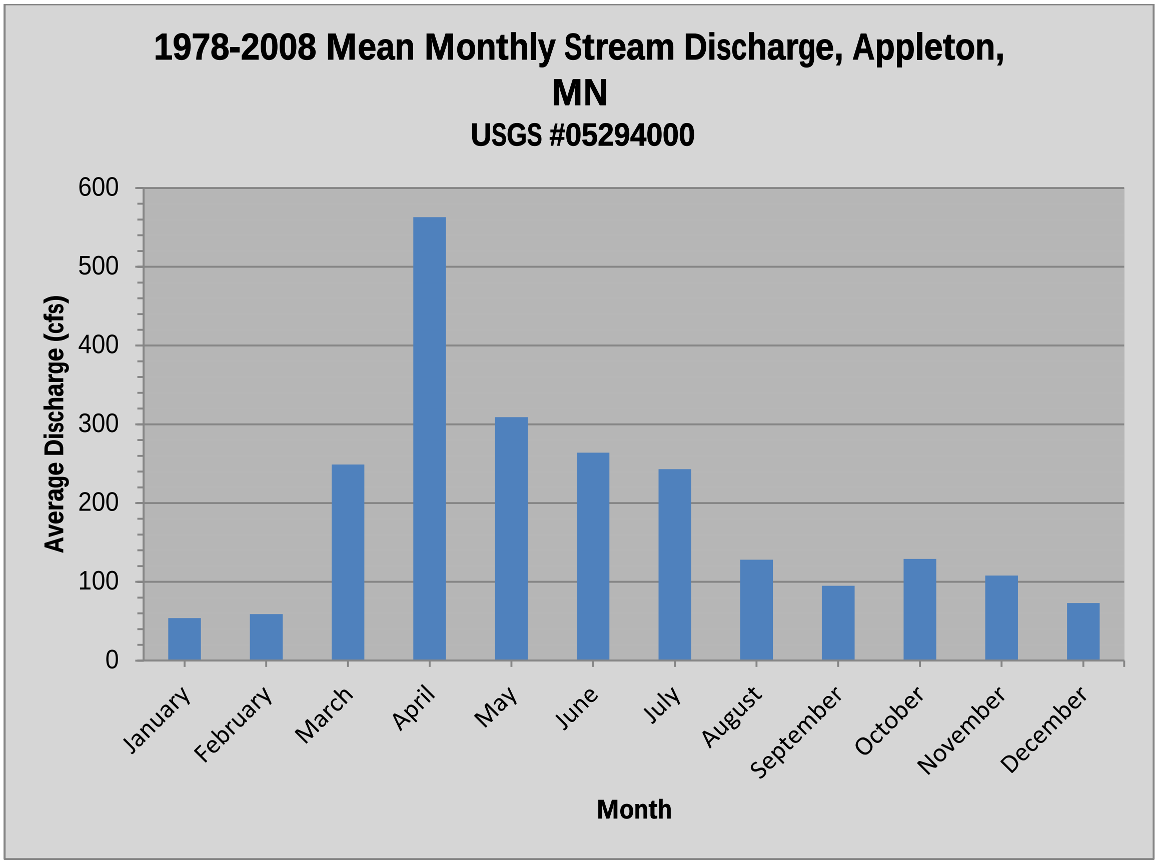


Figure 6.5: Monthly Turbidity and Rainfall Averages

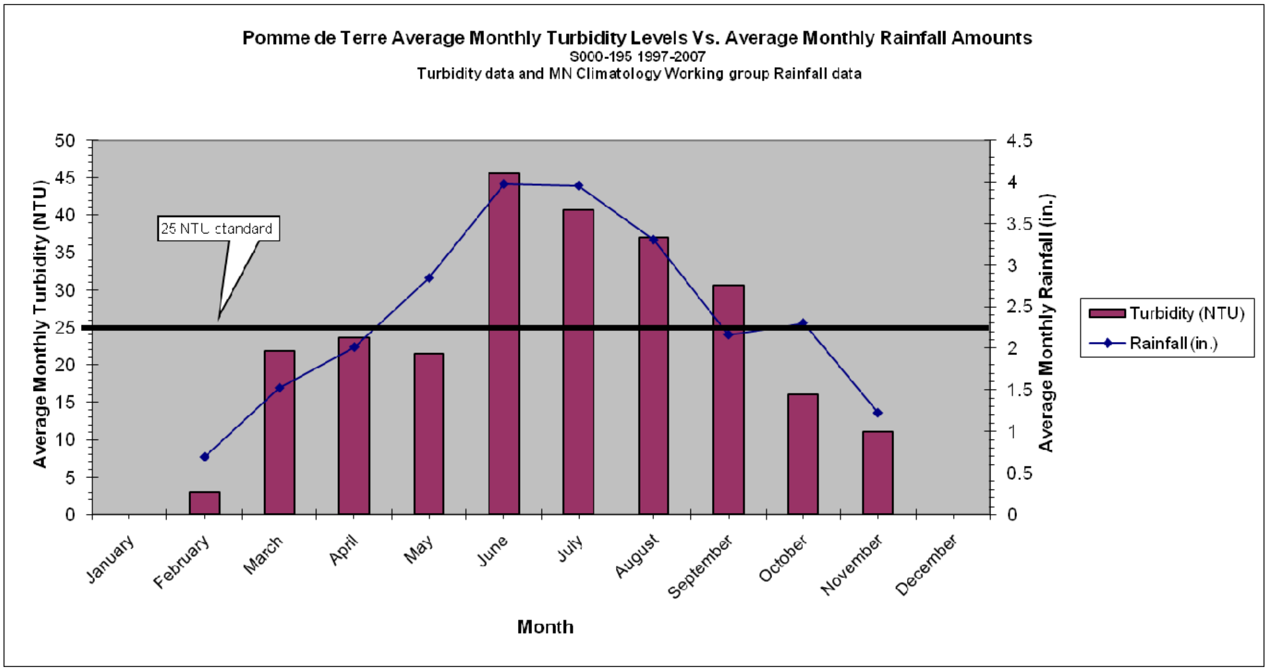
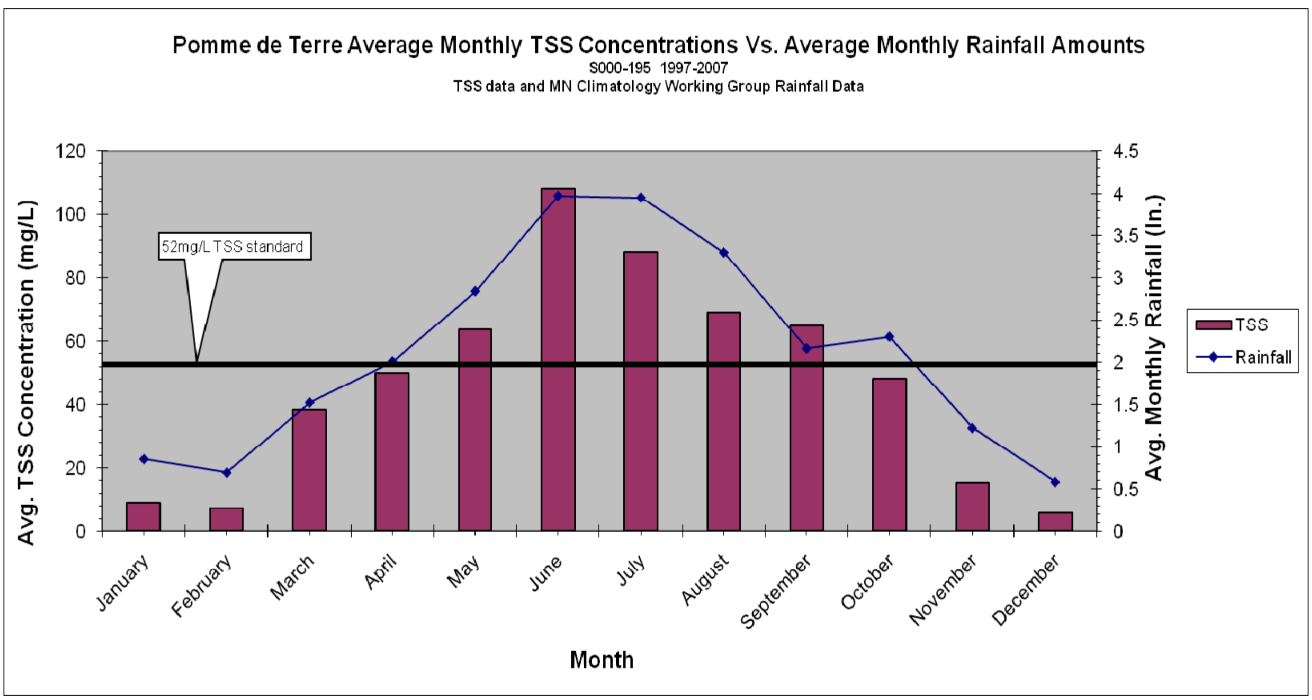


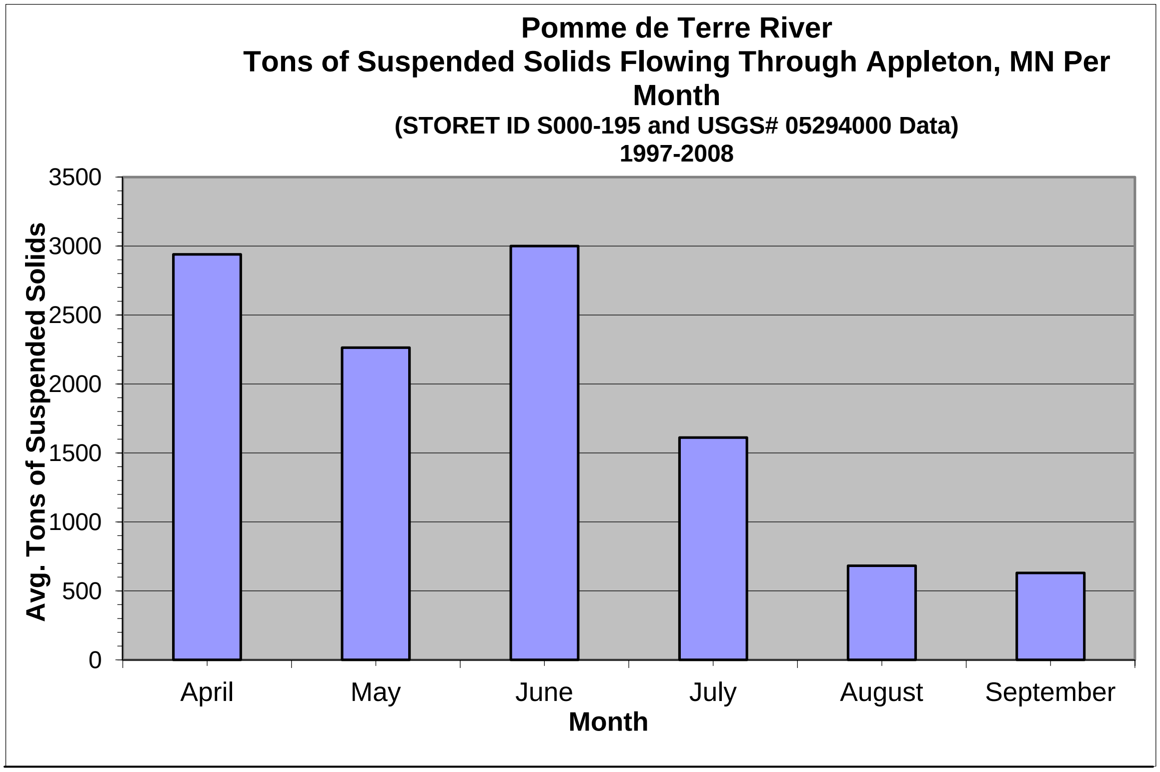
Figure 6.6: Monthly TSS and Rainfall Averages



When the USGS flow data is compared with TSS readings taken in Appleton, the amount of suspended solids flowing past the gauge can be computed as a monthly average (figure 6.7). The greatest amount of suspended solids occurs in June with a monthly average of 3,000 tons. The next highest month is April with a monthly average of 2,940 tons per month. While the average Turbidity and TSS levels in April are below the 25 NTU standard and 52 mg/L TSS surrogate, the sheer volume of water flowing in the river during the month of April means a large volume of sediment is being transported down the river.

June is the month with the highest precipitation average, but with much less flow compared to April, indicating that rainfall runoff is the driving force. When combined, April, May, and June account for 73% of the sediment load in the river during the April through September monitoring season.

Figure 6.7: Average Tons of Suspended Solids per Month



Section 7: Monitoring Plan

Water quality monitoring of the Pomme de Terre River will be needed to assess if reductions in turbidity are being achieved. A detailed monitoring plan will be included in the implementation plan which will be completed within one year of approval of this TMDL. Monitoring will be conducted by the Pomme de Terre River Watershed Association and the MPCA.

Currently, the S000-195 site in Appleton is part of the MPCA's Major Watershed Pollutant Load Network Program. The purpose of this long term monitoring is to monitor nutrient and sediment loads at the mouths of 81 major watersheds in Minnesota (MN) based on the 8 digit HUC. It is also part of the MN Milestone River Monitoring Program. The purpose of this monitoring is to monitor site specific long term trends, at a fixed set of more than 80 stream locations with sufficient length of data record, for a limited list of parameters that measure an aspect of stream health.

The Pomme de Terre River Watershed is also part of the MPCA's intensive watershed monitoring program. This project is a problem investigation of water quality and biological impairments throughout the watershed. It is completed in two phases with phase I testing random sites throughout the watershed to determine the health of the stream system. Phase II identifies problem areas and focuses additional research to finding the sources of the problems. This project is funded through MPCA and is on a 10 year cycle. The Pomme de Terre River Watershed was the subject of phase I monitoring in 2007 and phase II starting in 2009. The results from this monitoring effort will provide more information for future restoration activities which will help meet the goals of this TMDL. The data collected in 2009 and 2010 includes fluvial geomorphology surveying, field turbidity measurements in the Middle sub-watershed, and the installation of bank pins in Dry Wood Creek and the Pomme de Terre River. Over time, this data will help determine the amount of sediment coming from in-stream sources. This watershed is scheduled to be re-tested in 2017.

Section 8: Implementation Activities

This section provides general implementation strategies targeted towards reduction of turbidity. Following approval of the Pomme de Terre turbidity TMDL study, a more detailed implementation plan will be developed. The implementation plan will use the potential source assessment, potential erosion factors, land use, public input, and other sources of information to determine which implementation strategies will best reduce turbidity. Implementation activities should focus on the priority areas of Muddy Creek, Dry Wood Creek and Lower Pomme de Terre sub basins.

8.1 Pasture Management

Livestock with access to streams pose a risk to contaminating waters in the stream or along the banks. Unmanaged grazing can cause instability of stream banks, which leads to greater turbidity during higher flows. The negative impacts of grazing riparian areas can be prevented, minimized, or improved by controlling the timing, duration and intensity of grazing in the riparian area. A suite of practices have been identified which can help reduce turbidity, including providing an alternative livestock water supply, installation of stream crossings, limiting livestock access to streams in sensitive areas, and preventing over grazing.

8.2 Conservation Tillage

Excessive tillage has the potential to increase sediment delivery to streams. Tillage systems that maintain ground cover with less soil disturbance than traditional cultivation, can reduce soil loss and energy use while maintaining crop yields and quality.

The negative impacts of excessive tillage can be prevented or minimized by avoiding tillage in areas prone to higher sediment delivery due to soil type, slope or proximity to water. In some cases, this can be accomplished by developing an appropriate system of tillage, buffer strips, filter strips, or grassed water ways.

Conservation on cropped areas can be accomplished by coordinating crop selection, management and growing conditions specific to each farm. Management considerations include proper nutrient, pest, and tillage management. Growing conditions include the soils, topography, and expected growing season and rainfall patterns.

8.3 Vegetative Practices

Vegetative practices include wetland restorations, filter strips, riparian buffers and grassed waterways. These practices minimize sediment runoff from agricultural lands through increased infiltration and decreased pollutant transport.

Wetland Restorations

Wetlands are natural swamps, bogs, sloughs, potholes or marshes that have saturated soils and water loving plants. Wetlands are important as they provide wildlife habitat and serve as a natural filter for agricultural and urban runoff. They also remove nutrients, pesticides and bacteria from surface waters. Wetlands slow overland flow and store runoff water, which reduces both soil erosion and flooding downstream.

Filter Strips

Filter strips are strips of grass and trees and/or shrubs that slow water and cause contaminants like sediment, chemical, and nutrients to collect in the vegetation. The nutrients and chemicals are then used by the vegetated filter strips, rather than entering water supplies and water bodies. Filter strips are often constructed along ditches, thus moving row crop operations farther from the stream.

Riparian Buffers

Riparian buffers are also strips of grass, trees and/or shrubs that slow water flow and prevent contaminants like sediment, chemical and nutrients from reaching streams and lakes. Riparian buffers are created in and along the cultivated floodplain and along the main stem of streams.

Grassed Waterways

A grassed waterway is where a natural drainage way is graded and shaped to form a smooth, bowl shaped channel. This area is seeded to sod-forming grasses. Runoff water flows down the drainage way, across the grass rather than tearing away soil and forming a larger gully. An outlet is often installed to stabilize the waterway and prevent a new gully from forming. The grass cover protects the drainage way from gully erosion and can act as a filter to absorb some of the chemicals and nutrients in runoff water.

8.4 Structural Practices

Water and sediment control basins, terraces, diversions, grade control structures, and channel restoration measures are all structural practices that help reduce runoff, reduce soil erosion, and reduce in channel erosion.

Terraces

Terraces break long slopes into shorter ones. As water makes its way down a hill, terraces serve as small dams to intercept water and guide it to an outlet. There are two types of terraces; storage terraces and gradient terraces. Storage terraces collect water and store it until it can infiltrate into the ground or be released through a stable outlet. Gradient terraces are designed as a channel to slow runoff water and carry it to a stable outlet like a grassed waterway.

Water and Sediment Control Basins

A water and sediment control basin is an embankment that is built across a depressional area of concentrated water runoff to act similar to a terrace. These basins trap sediment and water running off farmland above the structure. These structures help reduce gully erosion by controlling water flow within a drainage area. Spacing for water and sediment control basins depends on the land slope, tillage, and management system.

Diversions

A diversion is much like a terrace, but its purpose is to direct or divert runoff from an area. A diversion is often built at the base of a slope to divert runoff away from bottom lands. A diversion may also be used to divert runoff flows away from a feedlot, or to collect and direct water to a pond. Diversions help reduce soil erosion on lowlands by catching runoff water and preventing it from reaching farmland below.

Grade Control Structures

A grade control structure prevents gully formation by safely dropping water from one height to another. A recommended grade control structure is a field stone riffle, or series of riffles that step water down steeper grassed waterways. This provides grade control and prevents headcuts from advancing up a steep slope. Grassed, non-eroding waterways with grade control riffles reduce gully erosion, yield better water quality, and can be crossed with equipment.

Open Tile Inlet Removal
Traditional open surface tile intakes can be a significant contributor of sediment to ditches, streams and rivers. Replacing open tile intakes with alternative designs like rock intakes, pattern tile with open inlets removed, and Hickenbottom intakes have the potential to reduce sediment while still providing adequate drainage.

Channel Restoration Practices
Where appropriate, natural channel design practices could be used to restore the river to a more stable and natural dimension, pattern, and profile. For example, toe-wood brush-mat techniques could be used to greatly reduce accelerated bank erosion rates while providing roughness and pool habitat without increasing velocities downstream. Riffles, rock veins and weirs, and root wads could be used for grade control, thalweg management, or erosion control and artificially cut off meanders could be reconnected. These techniques should be part of a larger effort to restore natural river functions including access to a working flood plain and diverse natural habitat including a variety of substrates including riffles, runs, pools, and glides.

8.5 Municipal Stormwater Management

The city of Morris will be required to apply for an MS4 permit which includes BMP implementation and education. Active enforcement of MS4 permit requirements and application of the required Storm Water Pollution Prevention Plans (SWPPP) will be required. Other communities in the watershed not required to obtain MS4 permits will be encouraged to implement BMPs. Educational efforts will also be conducted to inform residents about stormwater pollution. Urban stormwater BMPs such as street sweeping, raingardens, and stormwater conscious development will be promoted.

8.6 NPDES Permit Management

Municipal and Industrial NPDES permit holders are given discharge limits for TSS as part of their permit. The wasteload allocations assigned to these facilities are based upon their current permit limits and thus no reduction activities will be required. Construction and industrial stormwater activities following BMPs stated in a permit obtained from the NPDES program will not require further implementation activities.

8.7 Locally Targeted Implementation

Stevens County: The NRCS has 54 Wetlands Reserve Program (WRP) easements totaling about 5,000 acres. There are 52 Conservation Reserve Enhancement Program (CREP)/Reinvest in MN (RIM) easements covering 1,635.2 acres

Muddy Creek Sub-Watershed: Located in Stevens County, has been identified as a high priority in the Local Water Management Plan (LWMP). It is listed as a priority for Continuous Conservation Reserve Program (CCRP) filter/buffer strips and wetland restoration. Reducing the turbidity and fecal coliform bacteria levels in Muddy Creek is identified as a priority action item in the Plan. Fencing and livestock exclusion practices are also targeted for this sub-watershed.

Dry Wood Creek Sub-Watershed: The area that lies within Stevens County has been identified as a priority in the LWMP. It is targeted for buffer strips, pasture practices, non-compliant feedlot upgrades, and failing septic system upgrades.

Swift County: Focus in Swift County has been on CRP wetland restoration and buffers to decrease the flash flows on the Pomme de Terre River. The Farmed Wetland Program has been successful for low areas in fields

Dry Wood Creek Sub-Watershed: Dry Wood Creek itself lies mostly in the Swift County boundaries, but the watershed is split between Swift, Stevens and Big Stone Counties. Monitoring has placed this sub-watershed in the high priority category.

Grant County: Grant County has utilized accelerated state cost-share programs to enroll buffers along waterways through a BWSR challenge grant. Buffers and wetland restoration remain a top priority in the Grant County LWMP.

Otter Tail County: At the top of the Watershed, Otter Tail County has focused their annual state cost-share dollars on sediment basins, funding six within the Pomme de Terre.

Douglas County: Over 400 acres have been set aside in CRP grass easements within this watershed. A very small portion of the Watershed is located in Douglas County and Lake Christina covers about one-fourth of it. A large portion of the remaining land is grassed due to wetness and poor cropping use.

Big Stone County: Even though a minimal amount of the watershed is in this County, they have four CREP easements totaling 205 acres, 40 acres in RIM, and a 133 acre WRP easement.

8.8 Cost Estimate

After approval of this TMDL, a detailed implementation plan will be created with extensive stakeholder involvement. This plan will spell out management practices and costs of implementing the recommendations of this TMDL. While payment rates and cost share amounts have not yet been set, it is estimated that over ten years, the cost to implement the management strategies to decrease turbidity in the Pomme de Terre River Watershed will be between $5.5 and $6 million dollars.

Section 9: Reasonable Assurance

As a requirement of TMDL studies, reasonable assurance must be provided demonstrating the ability to reach and maintain water quality endpoints. The source reduction strategies described in section 8.0 have been shown to be effective in reducing sediment load and turbidity. These strategies are capable of widespread adoption by landowners and local resource managers.

Many of the goals outlined in this TMDL study run parallel to objectives outlined in the six watershed counties' Local Water Plans. These plans have the same goal of removing streams from the 303(d) Impaired Waters List. These plans provide watershed specific strategies for addressing water quality issues.

Various program and funding sources will be used to implement measures that will be detailed in an implementation plan to be completed in the year following approval of this TMDL. Funding sources include a mixture of state and federal programs, such as the Environmental Quality Incentive Program (EQUIP), Conservation Reserve Program (CRP), and Clean Water Legacy funding. Local officials agree there is a need for additional BMP's and through implementation, water quality improvement can be realized.

Section 10: Public Participation

Public participation opportunities were provided during the project in the form of public meetings held in September of 2008, March of 2009, and November of 2009, monthly newspaper articles about the watershed and its impairments, and project informational handouts. The public participation materials can be found in Appendix B. At the onset of the project, a Technical Advisory Committee (TAC) was formed that served as an advisory and review role for the project. This group was comprised of staff from the following groups:

- Ottertail County SWCD
- Douglas County SWCD and Planning and Zoning
- Grant County SWCD and Planning and Zoning
- Stevens County SWCD and Environmental Services
- Swift County NRCS and Planning and Zoning
- Big Stone County SWCD and Planning and Zoning
- WesMin RC&D
- MN Board of Water and Soil Resources (BWSR)
- MN DNR
- West Central Environmental Consultants

The technical committee met quarterly. The committee assisted with reviewing the project workplan, outreach materials and the draft TMDL report. Key findings were discussed and input was gathered from the group.
Public outreach for this project also included the following activities:

May 2008	Project coordinator gave a presentation about the TMDL project to Morris Area High School Environmental Science Class.
May 2008	Project coordinator gave a radio interview about the Pomme de Terre TMDL project
May 2008	Project coordinator and Stevens SWCD participated in a joint DNR MAHS shoreline restoration project at PdT Park in Morris, MN. Coordinator talked about the project to school children assisting with the project, and a newspaper article was written about the project.
May 2008	Article about the TMDL projects was submitted to the Pomme de Terre Lake Association annual newsletter.
May 2008	PdT Watershed Project submitted newspaper article one to five watershed newspapers.
June 2008	PdT TMDL display board displayed at MN DNR shore lands meeting in Alexandria, MN.
July 2008	PdT Watershed Project submitted newspaper article two to five watershed newspapers.
July 2008	PdT TMDL display board displayed at the University of Minnesota, West Central Research and Outreach Center annual field day.
July 2008	PdT coordinator attended a meeting with Stevens County Farm Bureau members and the MN Ag Waters Resource Coalition. Topic of this meeting was the TMDL process and the importance of producer stakeholder involvement.
July 2008	PdT display board displayed at the University of Minnesota, West Central Research and Outreach Center annual Horticulture Night.
Aug. 2008	PdT Watershed Project submitted newspaper article three to five watershed newspapers.
Aug. 2008	PdT Watershed Project displayed at the Stevens County Fair, TMDL materials handed out at Swift County Fair.
Sept. 2008	PdT Watershed Project submitted newspaper article four to five watershed newspapers
Sept 2008	Watershed Public Meeting held in Morris

Sept 2008 PdT canoe trip with C.U.R.E. in Appleton, MN

Oct. 2008 PdT Watershed Project submitted newspaper article five to five watershed newspapers.

March. 2009 Combined JPB, TAC, Turbidity stakeholder group meeting held in Morris.

A formal public comment period was open from March 1 to March 31, 2010 at which time comments were being accepted regarding the draft TMDL report. A meeting was held on November 23, 2009 to present the draft TMDL report to the public. There were four comment letters received and responded to as a result from the public comment period and are included in Appendix C.

Section 11: References

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Turbidity TMDL Assessment for the Pomme de Terre River

Appendix

Appendix A: Development of Total Suspended Solids Surrogate

Development of Total Suspended Solids (TSS) Surrogate for Turbidity in the Pomme de Terre River Watershed

April 2009
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Minnesota Pollution Control Agency

1. Background

The Pomme de Terre River Watershed is in the Minnesota River Basin and has one reach impaired for turbidity. This impaired reach, AUID 07020002-501, is located on the Pomme de Terre River and starts from where Muddy Creek enters and ends at Marsh Lake where the Pomme de Terre River enters the Minnesota River. While this watershed is within the Minnesota River Basin, this impaired reach was not included in the Minnesota River Turbidity TMDL. A map of the project area is shown in Figure 1.

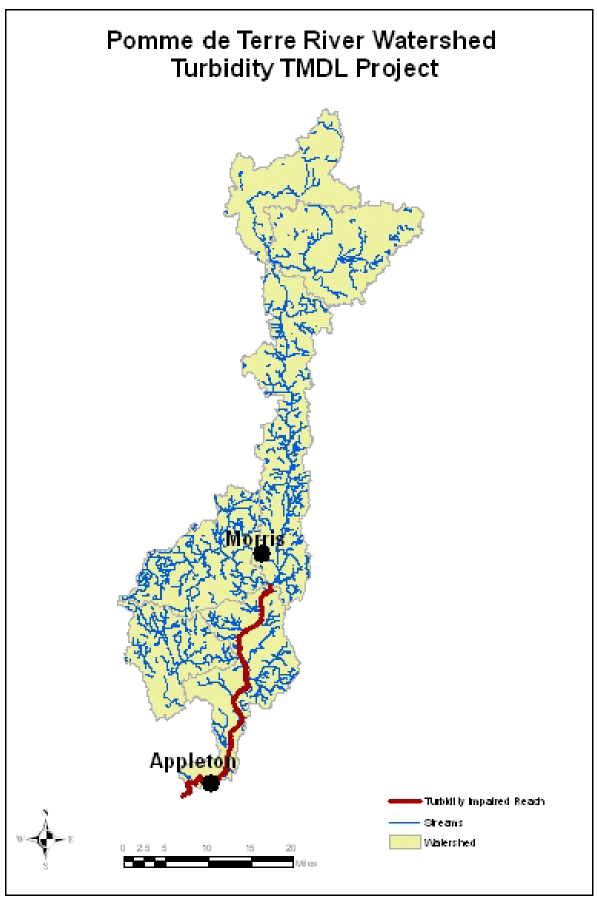

Figure 1: Pomme de Terre River Watershed

Turbidity is a means of measuring the clarity of water by measuring how much light is absorbed or scattered in a sample of water (Johnson, 2007). This light can be scattered or absorbed by suspended sediments, algae, organic matter, and color. TMDL allocations are calculated as concentrations of a specific pollutant. To determine a concentration, the mass of that pollutant is needed. Turbidity is an optical measurement, not one of mass. For this reason, turbidity is not used directly in a TMDL, but rather a surrogate is developed from the turbidity data.

Research has been compiled to correlate Total Suspended Solids (TSS) to turbidity, making it a viable surrogate. The MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters states 60 mg/L and 100 mg/L of TSS in Western Corn Belt Plains and North Central Hardwood Forest ecoregions respectively equal the turbidity water quality standard (MPCA, 2007a). Often referred to as surrogates, these concentrations will identify the majority of turbidity-impaired waters while keeping falsely identified waters to a minimum. It should be noted that there are enough differences between sites, streams, and watersheds that an individual correlation should be made for each monitoring site.

2. Methods

2a. Data Utilized

The data used in this analysis was collected from one site in Appleton. The STORET station identification number is S000-195 and is located on the Pomme de Terre River upstream of MN Highway 119 and US Highway 59. Although data has been collected at this station since 1971, only data from 1996 and later was used in this analysis.

Turbidity data can be reported in a number of units, depending upon the meter and method used for testing. For site S000-195, the turbidity data was reported in units of NTU, NTRU, FNMU, FNU, and NONE in STORET. The units of FNMU and FNU are field measurements and do not have laboratory paired data for comparisons. Given potential variation in values between reporting units, a comparison is needed to correlate the field measurement with the turbidity water quality standard in units of NTU (MPCA, 2007). This data, therefore, will not be used since it does not have paired laboratory data and cannot be correlated to the standard. The units of NONE are from field testing and laboratory testing. It was determined that the field units were FNMU and thus not used. The laboratory testing was conducted from 1971 to 1981 and may have been in units of NTU. However, through unit conversions and with insufficient information about the data, this data was not used due to a lack of certainty in reporting units. Of the remaining data points, five observations were not used as a result of the Stearns DHIA Laboratory not being certified for testing turbidity. The remaining data for analysis are summarized in Table 1 for each unit. A complete list of the data used is at the end of this Appendix.

Table 1: Units, years of data, and the number of observations possible to utilize in the analysis

Units	Years of Data	Number of Observations	Lab

NTU	2004-2007	40	ERA
NTRU	1996-1997, 1999-2001, 2006-2007	44	MDH

2b. Comparing NTU and NTRU

There are different methods and different equipment that can measure turbidity and these can produce different units. These units of raw data should not be considered directly interchangeable since they can differ by factors of two or more (MPCA, 2007b). The two units in this analysis were found to be from the same type of meter, Hach 2100AN. The Hach 2100AN meter can report in units of NTU and NTRU, depending if the ratio compensation is used. ERA Laboratories reported in NTU by using the Hach 2100AN with the ratio compensation "off" (Magnuson, personal communication, 2008). With the ratio compensation "off", the meter uses a single white light source with a single light detector located at 90 degrees to the light source. The Minnesota Department of Health (MDH) laboratory reported in NTRU by using the Hach 2100AN with the ratio compensation "on" (Johnson, 2007). The meter, when the ratio compensation is "on", uses a single white light source and multiple light detectors. The first detector is located at 90 degrees to the light source and the other light detector is located at a wider angle with a "ratio" being made between the two.

Since two different methods were used, a comparison was needed. Of the data set that is available for comparing NTUs and NTRUs, only data from 2006 to 2007 overlap. This gives 21 NTU and 25 NTRU sampling occasions. After an overview of the data, there were two occasions of paired data and three occasions of "nearly paired" data where the samples were taken within a day of each other. All of the data were plotted by date (Fig. 2) and with flow (Fig. 3) to visually see if there are any apparent differences. These visual comparisons do not show any apparent differences between NTU and NTRU.

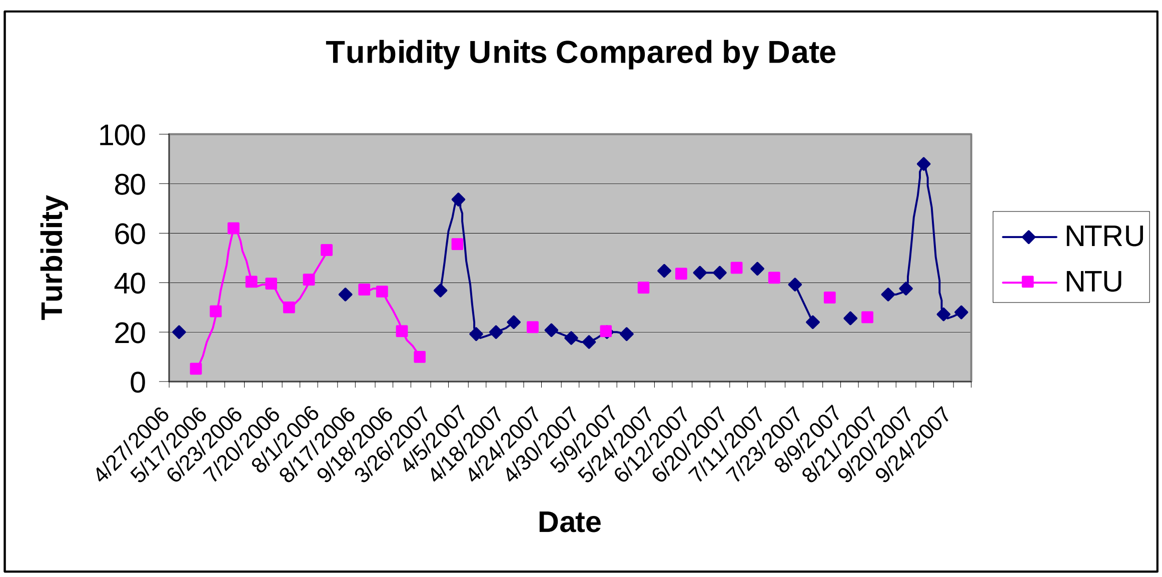

Figure 2: NTU and NTRU Turbidity units compared by date

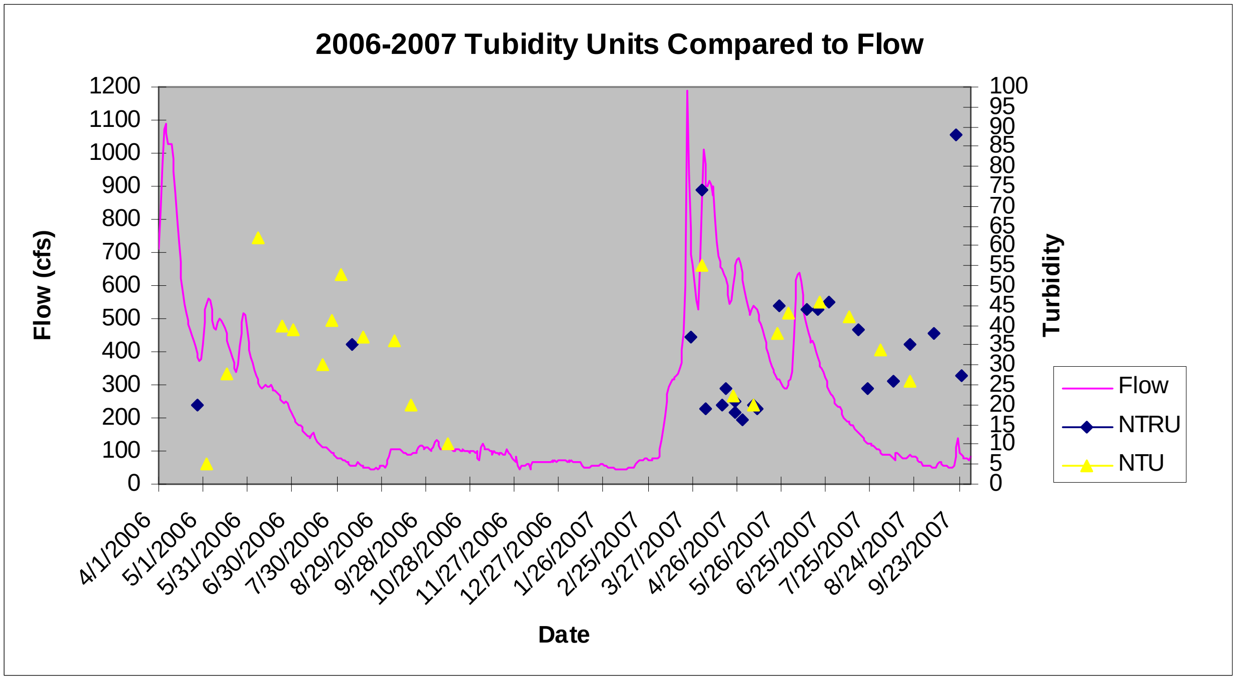

Figure 3: NTU and NTRU Turbidity units compared by date and correlated to flow

With no apparent difference between the two data sets, further analysis was completed. Assuming normality with skewness and kurtosis values, a t-test was run. The results of the t-test indicate that there is no significant difference between the means of the NTU and NTRU data. However, with the assumption of normality, a decision was not made on this result alone.

The raw turbidity data was then compared to the TSS data for the purpose of checking the validity of the turbidity data. A linear regression was completed and TSS concentrations were calculated from 25 NTU and 25 NTRU. The difference between the two TSS values was within ten percent of each other. The differences between the slopes and intercepts were not calculated, but could be in the future if needed.

To see how the NTU and NTRU data relates more directly, a regression analysis was completed with the paired and "nearly paired" data. It is important to note that with only 5 data sets, there is limited confidence in the results. Using the regression equation, a 25 NTRU value produced a 24.5 estimated NTU value.

Recent work completed by MPCA staff compared the two units and developed a conversion factor. This was completed by using paired data from a river remote sensing study in 2004 by MPCA staff and was developed for the Minnesota River, West Fork Des Moines River, and Pipestone Creek (Johnson, 2007). However, as stated earlier, there is variability and uncertainty with turbidity and work should be completed for each individual site. A regression analysis was run to compare NTU values and the values of

NTRU after being converted to NTU to TSS. The TSS values calculated from the regression equation produced two TSS values that have a difference of over 30 mg/L. Therefore, the conversion factor that was developed through this work was not utilized for the Pomme de Terre River data due to a lack of supporting evidence that a difference in NTU and NTRU values was present.

A determination was made that NTU units and NTRU units would be compared separately to TSS. However, with the amount of evidence provided, a TSS surrogate should be developed for 25 NTU and 25 NTRU assuming that the turbidity data is similar.

2c. Developing a TSS Surrogate

TSS was compared with turbidity by following the "Turbidity TMDL Protocol and Submittal Requirements" (MPCA, 2007b). This included filtering the data set so that the turbidity was less than 40 NTU and the TSS was greater than 10 mg/L. TSS was plotted as the independent variable (x-axis) and turbidity as the dependent variable (y-axis). Excel and Minitab were used to run the regression analysis.

In order to use regression analysis to calculate a TSS surrogate, paired data between TSS and turbidity is needed. Of the possible 84 turbidity observations, 58 were paired with a TSS observation. After the data was filtered, there were 41 TSS samples (Table 2).

Table 2: Amount of data used in TSS surrogate regressions

Data Set	# of TSS Observations	# of NTU Observations	# of NTRU Observations
All Data	58	20	39
Filtered Data	41	13	29

A regression analysis was performed for individual turbidity units and the TSS surrogate value was correlated to 25 NTU and 25 NTRU as indicated in Section 2b.

The datasets were tested for normality and found to have reasonably normal distributions. Since there are normal distributions, linear equations were able to be produced without having to transform the data. There was one data point that had been removed as an outlier since it had obviously skewed the regression (Table 3). No statistical calculation was performed to prove this assumption, but may be performed in the future if needed.

Table 3: Outliers removed from data set

Date	TSS (mg/L)	Turbidity (NTU)
5-3-2006	57	5.2

3. Results

The following TSS-turbidity regression plots, Figures 4 and 5, are for each turbidity unit. Figure 4 shows a fairly strong correlation (r^2: 0.76) of NTU data to TSS data. Figure 5 displays the NTRU and TSS data, although the correlation is not a strong as Figure 4 (r^2: 0.62), data still indicates a positive relationship.

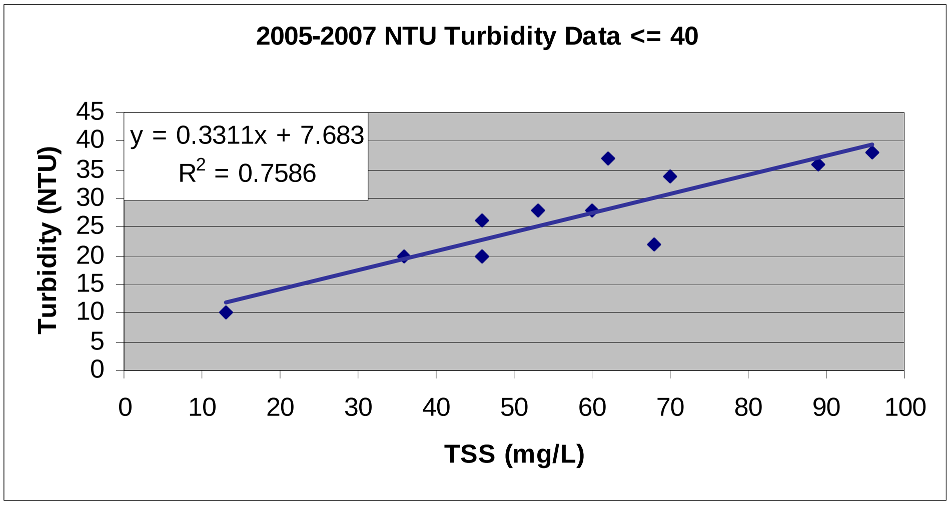

Figure 4: Regression analysis for TSS and NTU Turbidity units

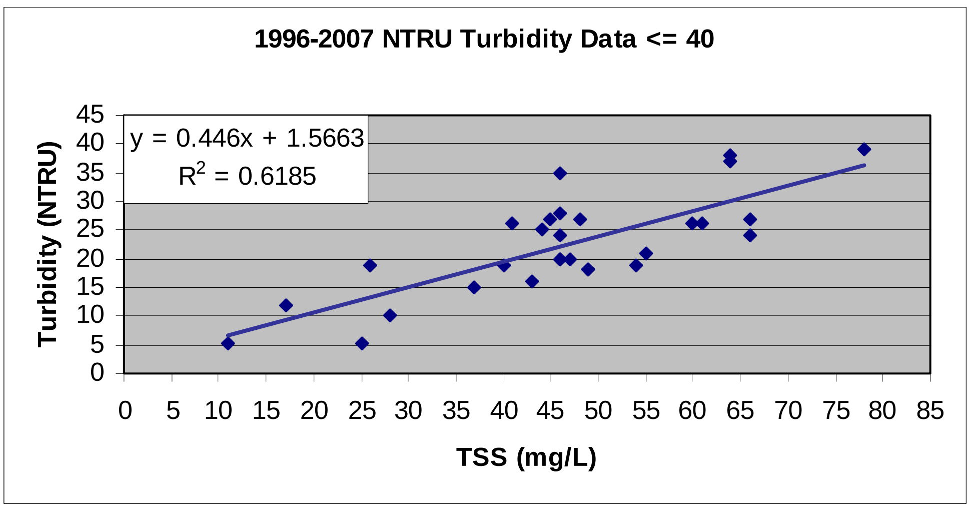

Figure 5: Regression analysis for TSS and NTRU Turbidity units

The TSS surrogate values for 25 NTU and 25 NTRU are summarized in Table 4 with the corresponding r-squared value. These values are estimates for the given data and conditions during data collection. For the purposes of the Pomme de Terre Turbidity Assessment, the TSS concentration of 52 mg/L will be used for determining allocations.

Table 4: TSS surrogate value for each turbidity unit

Turbidity Unit	TSS Surrogate (mg/L) value of 25	r^2
NTU	52	0.76
NTRU	52	0.62

Water Quality Dataset at STORET Site S000-195

SAMPLE DATE	TSS (mg/l)	Turbidity (NTRU)	Turbidity (NTU)
10/16/1996		22	
11/6/1996	17	12	
3/31/1997	49	18	
4/14/1997	44	25	
5/28/1997	37	15	
6/17/1997	94	43	
7/22/1997	120	58	
8/4/1997	92	45	
9/24/1997	40	19	
2/2/1999		3	
3/25/1999	66	27	
4/28/1999		15	
9/13/1999	130	50	
11/20/2000	28	10	
3/28/2001	11	5.4	
5/15/2001	25	5.2	
6/6/2001	61	26	
8/28/2001	60	26	
9/19/2001	48	27	
5/9/2004			18
5/12/2004			18
5/25/2004			20
6/1/2004			56
6/9/2004			80
7/1/2004			46
7/8/2004			51
8/3/2004			39
8/23/2004			18
9/7/2004			22
9/16/2004			43
10/13/2004			12
10/29/2004			14
4/4/2005			13
5/3/2005			7.2
5/9/2005			14
5/18/2005			10
6/7/2005			51
6/15/2005			16
7/21/2005	106		42
8/3/2005	94		47
8/17/2005	46		20
8/26/2005	114		73
10/12/2005	53		28
4/27/2006		20	
5/3/2006	57		5.2
5/17/2006	60		28

SAMPLE DATE	TSS (mg/l)	Turbidity (NTRU)	Turbidity (NTU)
6/6/2006	141		62
8/9/2006		35	
8/17/2006	62		37
9/6/2006	89		36
9/18/2006	36		20
10/12/2006	13		10
3/26/2007	64	37	
4/2/2007	87	74	55
4/5/2007	26	19	
4/16/2007	46	20	
4/16/2007	47	20	
4/18/2007	66	24	
4/23/2007	68		22
4/24/2007	55	21	
4/25/2007	49	18	
4/30/2007	43	16	
5/7/2007	46	20	20
5/9/2007	54	19	
5/23/2007	96		38
5/24/2007	96	45	
5/30/2007	94		43
6/12/2007	100	44	
6/19/2007	100	44	
6/20/2007	108		46
6/27/2007	100	46	
7/11/2007	92		42
7/17/2007	78	39	
7/23/2007	46	24	
7/31/2007	70		34
8/9/2007	41	26	
8/20/2007	46		26
8/21/2007	46	35	
9/6/2007	64	38	
9/20/2007	150	88	
9/24/2007	45	27	
9/24/2007	46	28	
Total Count:	58	44	40

References

Johnson, Greg. 2007. Evaluation of "Paired" Turbidity Measurements from Two Turbidimeters for Use in Two TMDL Projects. December 13, 2007. Appendix to the Draft West Fork Des Moines River Watershed Total Maximum Daily Load Report: Excess Nutrients (North and South Heron Lake), Turbidity and Fecal Coliform Bacteria Impairments. Minnesota Pollution Control Agency.

Magnuson, Bob. Personal communication. 2008. ERA Laboratories, Duluth, MN.

[MPCA] Minnesota Pollution Control Agency. 2007a. Guidance Manual for Assessing the Quality of Minnesota Surface Waters.

[MPCA] Minnesota Pollution Control Agency. 2007b. Turbidity TMDL Protocol and Submittal Requirements.

Appendix B: Public Participation Materials

Turbidity Brochure

What Happens After the TMDL is Developed?

*Once the TMDL is approved by the EPA, and implementation plan will be developed. The plan will identify sources and causes of each pollutant and provide a strategy for implementation of **practical** management measures needed for the water body to meet water quality standards.*

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

A grassed conveyance can protect against erosion and helps to filter sediment and pollutants carried in runoff.

One example of a best management practice to reduce sediment entering the river.

"Our mission is to protect and improve the surface and ground water resources of the Pomme de Terre River Watershed by addressing water quality and quantity issues while also promoting healthy and sustainable agricultural, industrial and recreational based economy for the region."

For More Information
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Pomme de Terre River Watershed Project
www.pdtriver.org

Pomme de Terre River Watershed TMDL for Turbidity.

Questions and Answers

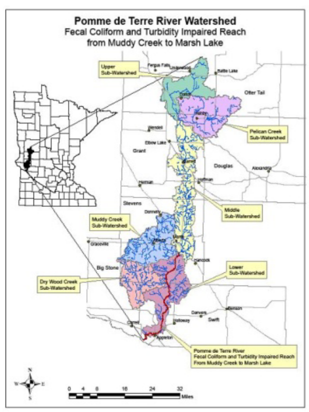
What is Turbidity?

Turbid water is usually described as "muddy" or "murky"

Turbidity is a measurement of water clarity. A decrease in water clarity is caused by suspended and dissolved matter such as clay, silt, organic matter, and algae. Turbidity is recognized as an indicator of water quality. Increased turbidity levels limit light penetration and inhibit healthy plant growth. High turbidity can make it difficult for aquatic organisms to find food, affect gill functions and cause spawning habitat to become covered in silt.

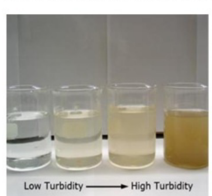
What are the sources of high turbidity?

Sources of increased turbidity levels include erosion from agricultural fields or construction sites, urban runoff from precipitation, eroding streambanks, and excessive algal growth.



Is the Pomme de Terre Polluted?

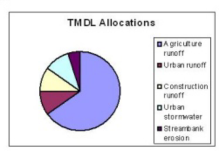
According to the Minnesota Pollution control Agency (MPCA) the lower reaches of the Pomme de Terre from Muddy Creek down to Marsh lake, exceeds the limits for stream turbidity, The turbidity standard is 25 NTU.



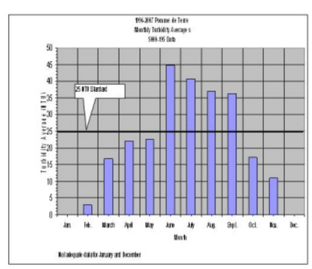
What is a TMDL?

According to the Environmental Protection Agency, a "**T**otal **M**aximum **D**aily **L**oad" is a calculation of the maximum amount of pollutant a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutants sources.

A TMDL identifies sources of each pollutant that fails to meet water quality standards. Water quality sampling and computer modeling determine how much each pollutant source must reduce its contribution to assure the water quality standard is met.



The TMDL is the pie, while the individual load allocations are the pieces of the pie.



Display Booth

Outdoors

Pomme de Terre Watershed Project: Watersheds 101

The following is the first in a series of articles about the Pomme de Terre Watershed and the TMDL studies that are now underway studying the pollution problem in the watershed.

By Shaun McNally, Coordinator Pomme de Terre Watershed Project

As most of us who live in the area know, the Pomme de Terre is a local river. But the Pomme de Terre is also a watershed. What exactly is a watershed and how big is it?

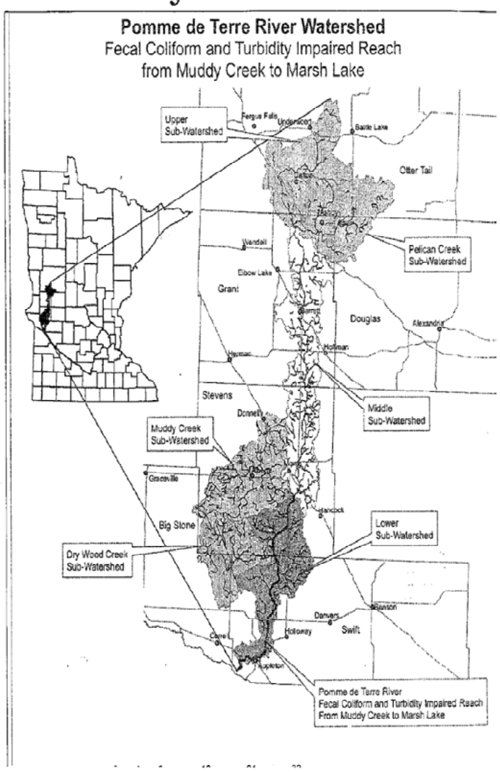
A watershed is essentially an enormous precipitation collecting, storing and routing device. It's an area of land that drains water to a common point – the Pomme de Terre River. Watershed boundaries are set by nature, not by the legislature. Wherever the water runs determines the watershed an area is in. For example, Stevens County is part of three watersheds. The west-northwest area of the county is in the Bois de Sioux Watershed. The very eastern portion of the county is in the Chippewa Watershed. And, the center and most of the southern part of the county is in the Pomme de Terre Watershed.

The Pomme de Terre begins its journey from Stalker Lake in Otter Tail County just south of Underwood. In its upper course, the river flows through a morainic region of numerous lakes, with well drained silty and loamy soils, its course characterized by meadow, woody hills and marshy stretches near areas where the river passes through Morris, Chokio, Alberta and Appleton.

The watershed is divided into six sub-watersheds. The upper sub-watershed is the headwaters region south of Underwood. The Pelican Creek sub-watershed is located around the Ashby area. The middle sub-watershed is a narrow band starting just north of Barrett and follows Highway 59 down to Morris. The lower sub-watershed follows Highway 59 south of Morris down to Appleton. The Muddy Creek sub-watershed includes Chokio and Alberta, and the Dry Wood Creek sub-watershed includes the areas around Artichoke Lake and east.

The Pomme de Terre watershed is one of 12 watersheds in the Minnesota River Basin. Water from the Pomme flows into the Minnesota, which flows into the Mississippi, which flows into the Gulf of Mexico. So in theory, what goes into the Pomme de Terre can have an effect on the Gulf.

For decades, people living on the river have been noticing a decline in water quality. The river becomes increasingly murky during high flow periods and green with algae during low flow periods. This phenomenon seems to be a more recent one, as Eric Sevarcid, canoeing up the Minnesota River during the summer of 1930 wrote; "We paddled on, nagging at the heat and flies, until we came to the Pomme de Terre, or Potato River, clear as crystal, flowing into the muddy Minnesota."



Chokio Review 7/8/08

Impaired waters topic of Farm Bureau meeting

Stevens County Farm Bureau is hosting an informational meeting for local producers on July 15 at 7:30 p.m. in the AgCountry Conference Room.

Warren Formo, director of the Minnesota Agricultural Water Resources Coalition (MAWRC), will provide background information on the TMDL process and the importance of farmer involvement at the local level. The MAWRC is a recently formed coalition consisting of Minnesota's Farm Bureau, Corn Growers, Soybean Growers, Milk Producers, Pork Producers, and Wheat Growers organizations. Shaun McNally, Pomme de Terre River Watershed Project Coordinator will also be there to explain the process of developing and implementing a TMDL reduction plan.

Recently, the MPCA has placed a stretch of the Pomme de Terre River from Muddy Creek just south of Morris, down to Marsh Lake just south of Appleton, on its impaired waters list due to excessive levels of fecal coli form and excessive turbidity. Turbidity TMDL's often focus on erosion from fields, livestock over-grazing pastures or damaging stream-banks, and link streambank erosion to tile drainage.

Stevens County Farm Bureau is concerned about inadequate accounting for natural background levels, and streambank erosion. Newer research is finding that the vast majority of turbidity is from near channel sources (stream banks, gullies, ravines, etc.) and not from runoff from fields that are farther from the stream. The MPCA and the Pomme de Terre Watershed encourage local agricultural producers to contribute ideas and suggestions to develop and implement plan to meet the TMDL's pollution reduction goal and restore the waters to standards.

STEVENS SOIL & WATER CONSERVATION DISTRICT

Pomme de Terre Watershed Project

By Shaun McNally

Point and Non-Point pollution

The following is the second in a series of articles about the Pomme de Terre Watershed and the TMDL studies that are now underway studying the pollution problem in the watershed.

When dealing with water impairments, there are two types of water pollution we are dealing with. These are called point pollution and non-point pollution. What is the difference between the two, which is worse, and which pollutes our waters more?

Let's start with point pollution. When most people think of ways our waters get polluted, they usually think of a factory with belching smokestacks and pipes spewing brown liquids directly into an adjacent body of water. The image also usually includes foam and dead fish floating belly up near the effluent pipe. This is an image of classic point source pollution. The EPA defines point source pollution as "discrete conveyances, such as pipes or man-made ditches that discharges pollutants into the waters of the United States." This includes not only discharges from municipal sewage treatment plants and industrial facilities, but also storm drainage from larger urban areas, certain animal feedlots and runoff from many construction sites.

Since the passage of the Clean Water Act of 1972, wastewater treatment plants, industries, and concentrated animal feedlots must have a National Pollutant Discharge Elimination System (NPDES) permit in order to release wastewaters into receiving waters in accordance with the Clean Water Act. Since its introduction in 1972, the NPDES permit system is responsible for significant improvements in our nation's water quality. Because of the NPDES system, we know where the point sources are and how much "stuff" they are putting into the water. Consequently, point sources are relatively easy to monitor and regulate, and can often be controlled by treatment at the source.

Flood water running across a field is an example of non-point pollution.

Non-point pollution is pollution that, unlike pollution from industrial and sewage treatment plants, comes from many diverse sources. Non-point pollution is caused by rainfall or snowmelt moving over the ground. As the runoff moves, it picks up and carries with it natural and man-made pollutants, finally depositing them into our surface waters like the Pomme de Terre River. Loading of pollutants from non-point sources enter our water via sheet flow of runoff, rather than through a pipe.

Non-point sources include runoff from agricultural fields and pastures, urban runoff from areas with populations of less than 100,000, runoff and leakage from failed septic systems, and construction site runoff to name a few. Field runoff from agricultural fields may contain sediment, fertilizer, pesticides and animal waste. Due to the variety of sources, non-point pollution is difficult to measure and regulate.

With the clean up of point sources because of the Clean Water Act, non-point sources of pollution are now the dominant inputs of pollution to our nation's waters. According to the EPA, sediment from non-point sources is the number one pollutant of our nation's surface waters. In the early days of the Clean Water Act, efforts focused on regulating discharges from traditional point source facilities, with little attention paid to runoff from fields, streets and other "wet-weather" sources. Starting in the late 80s, efforts to address polluted runoff have increased significantly. For non-point runoff, voluntary programs including cost-sharing with landowners are the key tools to remediate the non-point problem.

The next article will focus on the Fecal Coliform problem in the watershed.

Shaun McNally is the Pomme de Terre Watershed Project Coordinator. He is located in the Stevens SWCD office in Morris. 320-589-4886 ext. 109

The Pomme de Terre River Association maintains a website: www.pdtriver.org

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STEVENS SOIL & WATER CONSERVATION DISTRICT

Pomme de Terre Watershed Project

By Shaun McNally

Turbidity and suspended solids

The following is the fourth in a series of articles about the Pomme de Terre Watershed and the TMDL studies that are now underway studying the pollution problem in the watershed.

Muddy water, murky water, cloudy water. If you've ever used these terms to describe how a body of water looks, you're talking about turbidity. If you are standing in a foot of water and can't see your feet, you are standing in turbid water.

Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky. These particles can include sediment – especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae and other microscopic organisms. In the Minnesota River Basin, which includes the Pomme de Terre, sediment is the primary contributor to turbidity.

Turbidity is measured using specialized optical equipment. Basically a light is directed through a water sample, and the amount the light is scattered is measured. The unit of measurement is called the Nephelometric Turbidity Unit (NTU). The greater the scattering of light, the higher the turbidity. Low turbidity values indicate high water clarity, and high turbidity values indicate low water clarity. You can try this for yourself at home. Get a small flashlight, a glass of water and some dirt. Shine the light through a glass of clean water and see what the beam looks like on the other side. Now stir in some dirt and shine the light through it again and compare what the light beam looks like. That is basically what a turbidimeter is doing.

Minnesota's water quality standard for turbidity for class 2B waters, which includes the Pomme de Terre, is 25 NTU. Any reading over 25 NTU is in violation of the standard. If at least 10 percent of the readings are over 25 NTU, the waterbody is placed on the MPCA's impaired waters list. Monitoring data over the last ten years indicates that 60 percent of the turbidity readings exceed the 25 NTU standard. Based on this information, the southern section of the Pomme de Terre, from Muddy Creek down to Marsh Lake, was placed on the list as impaired for turbidity in 2002.

Since turbidity is simply a measure of how light is scattered, we also need a measure of how much "stuff" is in the water. For this we measure Total Suspended Solid (TSS). This is a measure of how many milligrams of particles are in a one-liter sample of water. The more suspended solids in the water, the higher the turbidity reading will be. In the Pomme de Terre, the relationship of TSS to turbidity indicates a TSS concentration of 52 mg/L, approximately equal to the 25 NTU standard. TSS readings in the watershed routinely exceed 90 mg/L, and have gone as high as 230 mg/L of suspended solids.

High turbidity can significantly reduce the aesthetic quality of lakes and streams having a harmful impact on recreation, tourism and property values. Nobody likes to recreate in dirty water. Studies of lakeshore property show that property values can be influenced by water clarity readings. High turbidity can also increase the cost of water treatment for drinking and food processing. It can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function. Turbid waters mean fewer walleyes and more carp and bullheads.

Sediment often tops the list of substances or pollutants causing turbidity. Sources of sediment can include erosion from upland, riparian and stream channel areas. Human activities in agriculture and construction can accelerate this erosion. Stream and channel movement can also release sediment. Phosphorus from various sources can cause algal growth resulting in increased turbidities. Phosphorus sources may include wastewater treatment facilities, nutrient runoff from crop land, fertilizer runoff from nice green lawns, and other sources. Soil erosion on crop land has been a focus of soil and water conservation programs for many years. Urban stormwater runoff is also recognized as an important contributor of sediment.

If we look at the amount of Total Suspended Solids (TSS), and compare that number with the river flow, we can figure out how much sediment is actually being carried by the river. During an average year from April to September, over 11,000 tons of sediment flow down the Pomme de Terre River! That's our topsoil being carried down to the Gulf of Mexico.

In the next article, I will give a background on the TMDL process, how a waterbody is listed, and what has to happen once it is put on the list.

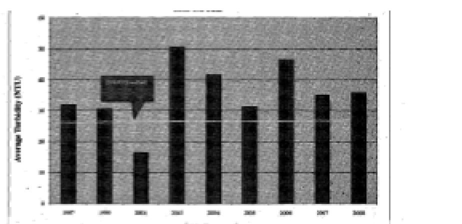
I would also like to invite everyone to the Pomme de Terre Watershed public meeting on Thursday, Sept. 18 from 7 to 9 p.m. at the Old #1 Bar and Grill at 412 Atlantic Ave. in Morris. Come and get more information about the turbidity TMDL, and get an update on the approved fecal Coliform TMDL and implementation plan, including focus areas and dollar amounts we are looking at.

Our website has been recently updated also, so be sure to check it out at www.pdtriver.org.

Shaun McNally is the Pomme de Terre Watershed Project Coordinator. He is located in the Stevens SWCD office in Morris. 320-589-4886 ext. 109.

...om Muddy Creek down to ...here the river empties ...to the Minnesota River ... Marsh Lake southwest ... Appleton, was placed on ...e EPA's impaired waters ...t in 2002 for high levels ... turbidity. Turbidity is a ...easurement of water ...arity. A decrease in water ...arity is caused by sus...nded and dissolved mat...r such as clay, silt, organ... matter, and algae. ...urbidity is recognized as ... indicator of water qual... Increased turbidity lev...s limit light penetration ...d inhibit healthy plant ...owth. High turbidity can ...ake it difficult for aquat... organisms to find food, ...fect gill functions and ...use spawning habitat to ...come covered in silt.

Turbidity is a measure ... the light scatter in a ...mple of water. A tur...dimeter basically shoots ...beam of light through a ...mple of water and meas...es the amount the light ... scattered. The clearer ...e water, the less the light ...am will be affected. The ...gher the turbidity read...g, the cloudier the water. ...n the Pomme de Terre ...iver, the turbidity stan...rd is 25 NTU. Any water ...mple that measures ...ove 25 NTU is in viola...on of the turbidity stan...rd. If ten percent of the ...mples collected in the ...evious ten years exceed ...e 25 NTU standard, the ...ater body will be placed ... the impaired waters ...t. Since 1997, over 60% of ...e water samples have ...ceeded the 25 NTU stan...rd. Since suspended ...lids make up a large portion of turbidity, a measurement of total suspended solids (TSS) is also used to evaluate and set loads. The 2008 monitoring season saw the highest ever recorded turbidity and TSS readings at the Appleton monitoring station since long term monitoring began there in 1971.



Sources of increased turbidity levels include erosion and runoff from agricultural fields or construction sites, urban runoff from precipitation, eroding stream banks, and excessive algal growth due to high nutrient levels from fertilizer runoff.

Once a body of water is placed on the impaired waters list, federal law requires the completion of a Total Maximum Daily Load (TMDL) study. According to the Environmental Protection Agency (EPA), a Total Maximum Daily Load is a calculation of the maximum amount of pollutant a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

A TMDL identifies sources of each pollutant that fails to meet water quality standards. Water quality sampling and computer modeling determine how much each pollutant source must reduce its contribution to assure the water quality standard is met. The TMDL takes the flow of the river into account when limits are set. The greater the amount of water flowing in the river, the more pollution it can handle before it reaches its maximum load.

The Pomme de Terre Turbidity TMDL study is scheduled to be completed early this summer, and will be sent to the EPA for approval. Once the EPA reviews and approves the TMDL study, an implementation plan will be developed. The plan will identify sources and causes of each pollutant and provide a strategy for implementation of practical management measures needed for the water body to meet water quality standards. The approval of both a TMDL study and implementation plan will enable the Pomme de Terre Watershed Project to apply for funding to provide competitive incentives to landowners to implement Best Management Practices on their lands to reduce the amount of sediment entering the river, creeks and ditches in the watershed.

Citizen involvement, education and outreach, and pollution prevention are key components of all TMDL implementation plans. A citizen stakeholder group is being created to help guide the implementation plan process. Anyone in the watershed who is interested in serving on this stakeholder group can contact Shaun McNally at the Stevens SWCD office: (320) 589-4886 ext. 109.

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...008 Annual Revi...

A supplement to the March 4, 2009 Morris Sun Tri...

...mission of Stevens Soil and Water Conservation District i...

Pomme de Terre River

Watershed Project

Public Meeting
Thursday Sept. 18, 2008

Old #1 Bar and Grill Southside
412 Atlantic Ave
Morris, MN

7-9 pm

Come and find out about the new Pomme de Terre Watershed turbidity TMDL project and get an update on the approved fecal Coliform TMDL and implementation plan. Find out how you can play a role in helping develop an implementation plan to clean up the Pomme de Terre River.

Free Refreshments!

Pomme de Terre River

Watershed Project
www.pdtriver.org

PUBLIC MEETING

Thursday, Sept. 18, 2008

Old #1 Bar and Grill Southside
412 Atlantic Avenue
Morris, MN • 7-9 PM

Come and find out about the new Pomme de Terre Watershed turbidity TMDL (Total Maximum Daily Load) Project and get an update on the approved fecal Coliform TMDL and implementation plan. Find out how you can play a role in helping to develop a turbidity implementation plan to clean up the Pomme de Terre River Watershed.

Free refreshments

Morris Sun Tribune
9/13/08

Pomme de Terre River Watershed
Public Meeting
Sept. 18, 2008

Comment Form

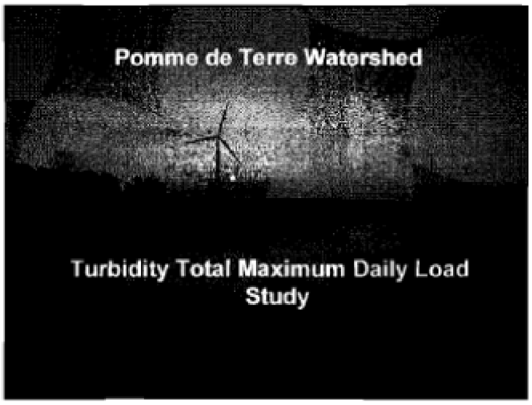
1. After hearing tonight's presentation, do you have any specific questions regarding the Pomme de Terre TMDL studies?

2. Do ***YOU*** have any suggestions for improving the water quality within the Pomme de Terre Watershed?

3. Are you willing to attend future meetings to receive updates and provide input regarding the Pomme de Terre TMDL study?

Name (optional): ____

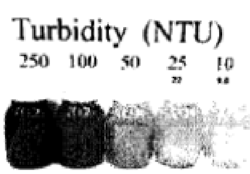
9/18/08 Kickoff Meeting Slideshow

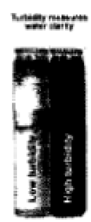


What is Turbidity?

- Turbidity is caused by particles suspended or dissolved in water that scatter light
- Particles can include: sediment especially clay and silt, fine organic and in organic matter, soluble colored organic compounds, algae, and other microscopic organisms
- In the MN River Basin, sediment is the primary cause of high turbidity.

Turbidity Examples



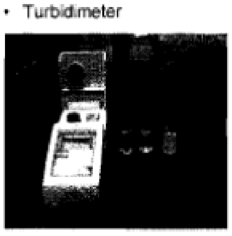


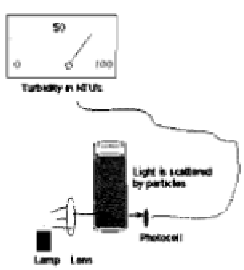
How is Turbidity Measured?

- Using a specialized optical turbidity meter.
- A beam of light is shot through the sample and the amount the light is scattered is measured.
- The unit of measure is the Nephelometric Turbidity Unit (NTU)
- The more turbid the water, the more the light will be scattered leading to a higher NTU reading

How is Turbidity Measured?

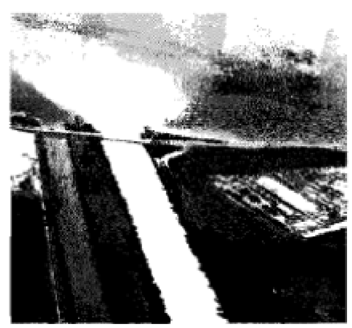
- Turbidimeter





Muddy Water

- Turbidity is linked to the "look" of the water and therefore the publics perception of water quality

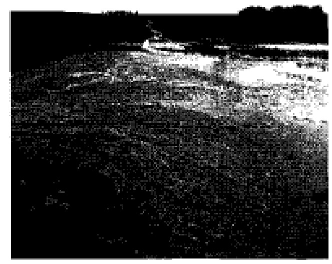


Turbidity Sources

- Runoff and erosion of agricultural areas is one of the biggest contributor of sediment to rivers, lakes and streams
- These are considered "non-point sources"

Erosion Rates

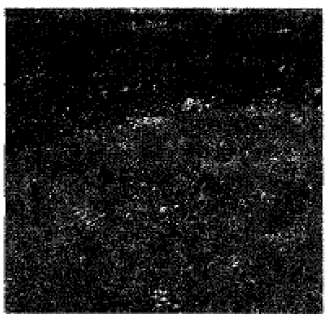
- Agricultural lands can contribute on average 7,054 tons per sq. mile per year of sediment to waterways due to erosion*



- *Carpenter et al. 1998. Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen. *Issues in Ecology* No. 3

Erosion Rates

- Compare that with erosion rates on lands with undisturbed grass cover:
- 176 tons per sq. mile per year of eroded sediment*



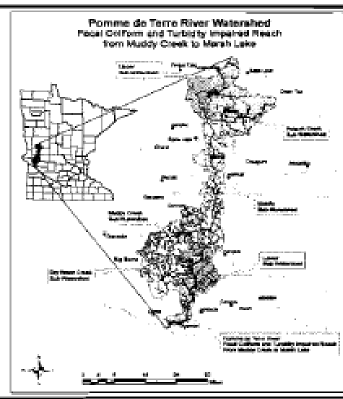
- *Carpenter et al. 1998. Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen. *Issues in Ecology* No. 3

What Does This Mean For The Pomme de Terre?

- The Pomme de Terre is classified as a class 2B stream
  - It's beneficial use is cool and warm water fisheries and all recreation
  - The EPA sets numeric criteria for each class of stream

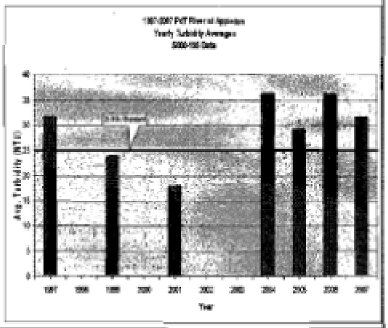
Turbidity Standard

- For a water body to be listed as impaired for turbidity **10%** of samples must be in violation of the turbidity standard.
- **61%** of the samples from the lower reach of the Pomme de Terre during the last 10 years violated the standard.



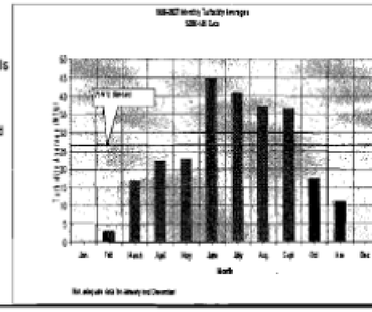
Yearly Turbidity Averages on the Pomme de Terre

- This graph shows the yearly turbidity averages since 1997.
- The trend is towards increasing turbidity levels
- The 25 NTU standard was exceeded in 07',06', 05', 04',97'
- Not adequate data for 98',00',02',03'.



Turbidity on the Pomme de Terre

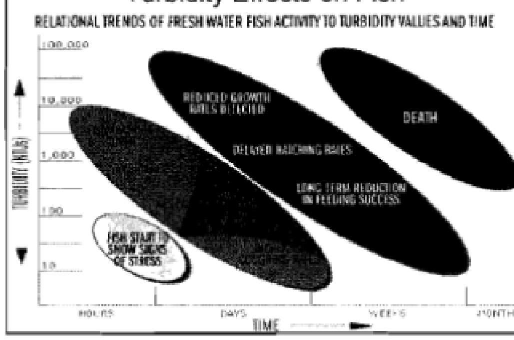
- This graph shows the average turbidity levels in the river month by month.
- The standard is 25 NTU
- Exceeded June-Sept



Impacts of High Turbidity

- Reduce the aesthetic quality of the water
  - Nobody likes to recreate in dirty water
- Increased cost for water treatment
- Lakeshore property values directly relate to water clarity.
- Harm aquatic life
  - Reduce food supplies
  - Degrade spawning beds
  - Affect gill function

Turbidity Effects on Fish

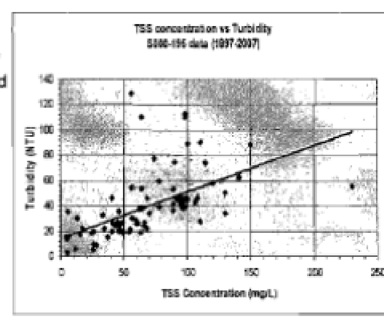


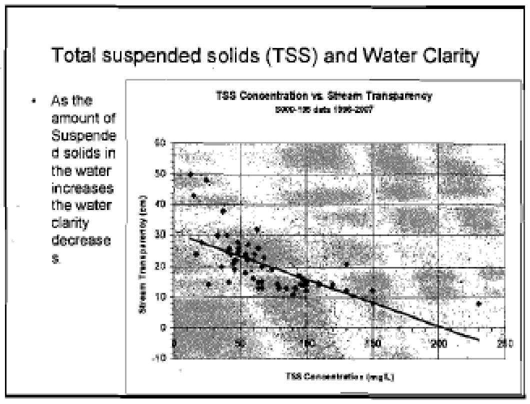
Total Suspended Solids (TSS)

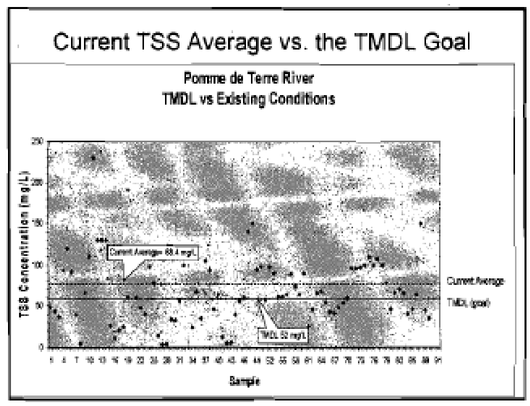
- TSS is often used as a surrogate measurement for turbidity.
- A water sample is poured through a filter, and the solids that are left on the filter are weighed.
- TSS levels are reported as mg of solid per one liter of water (mg/L)
- In the PdT, the relationship between TSS and turbidity is 52 mg/L TSS is approximately equal to 25 NTU.

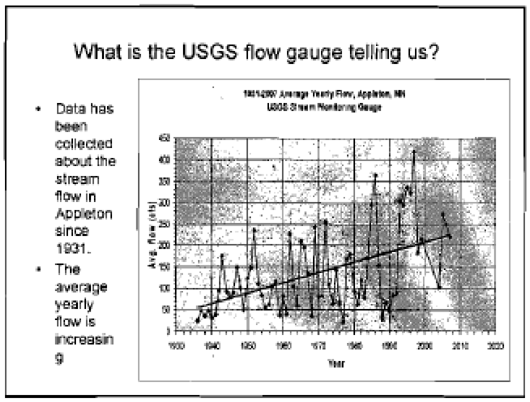
TSS and Turbidity

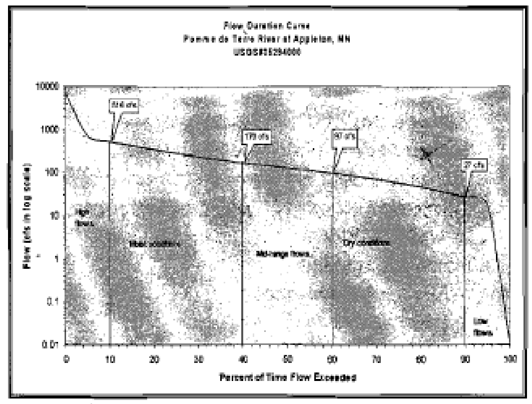
- As the amount of suspended solids in the water increases so do the turbidity levels.

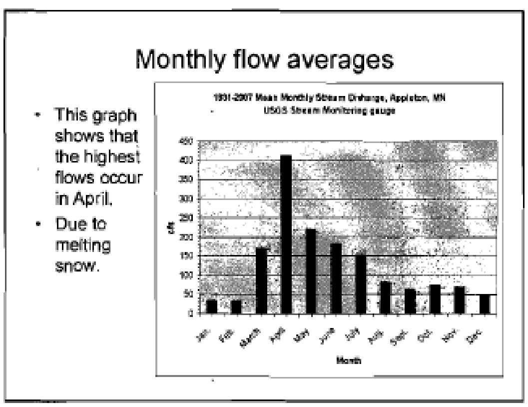


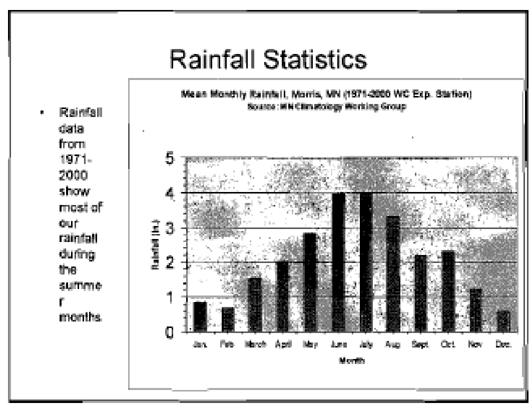

Total suspended solids (TSS) and Water Clarity
• As the amount of Suspende d solids in the water increases the water clarity decrease s.
TSS Concentration vs. Stream Transparency
Stream Transparency (cm)
TSS Concentration (mg/L)


Current TSS Average vs. the TMDL Goal
Pomme de Terre River
TMDL vs Existing Conditions
TSS Concentration (mg/L)
Current Average
TMDL (goal)
Sample


What is the USGS flow gauge telling us?
• Data has been collected about the stream flow in Appleton since 1931.
• The average yearly flow is increasin g
USGS Stream Monitoring Gauge
Avg. flow (cfs)
Year

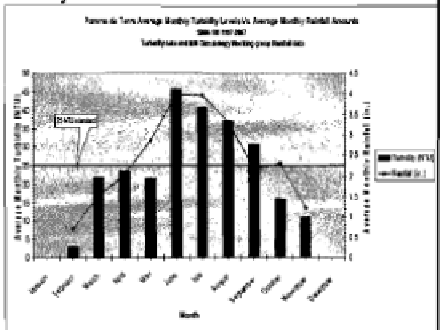

Flow Duration Curve
Pomme de Terre River at Appleton, MN
Flow (cfs in log scale)
Percent of Time Flow Exceeded


Monthly flow averages
• This graph shows that the highest flows occur in April.
• Due to melting snow.
USGS Stream Monitoring gauge
Month


Rainfall Statistics
• Rainfall data from 1971-2000 show most of our rainfall during the summe r months.
Mean Monthly Rainfall, Morris, MN (1971-2000 WC Exp. Station)
Month

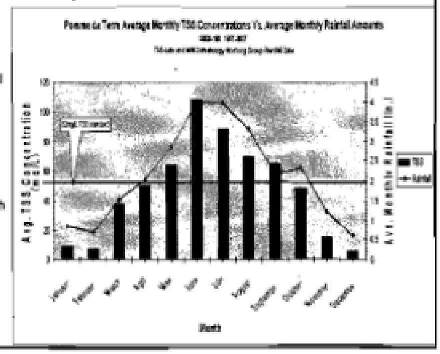
Turbidity Levels and Rainfall Amounts

- Our highest turbidity readings occur during our highest rainfall months

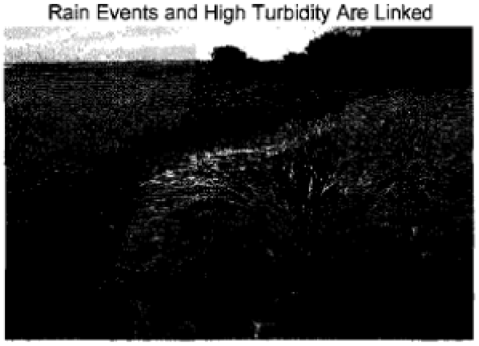


Suspended Solids and Rainfall

- The total suspended solids levels follows the same pattern as turbidity when plotted with rainfall amounts



Rain Events and High Turbidity Are Linked



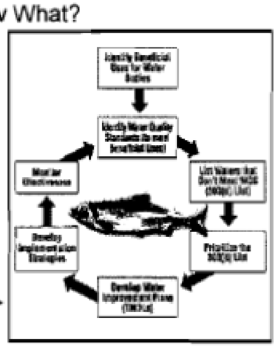
Rain Events and High Turbidity are linked

Muddy Creek: June 5, 2008
Pre rain

Muddy Creek: June 6, 2008
Post rain (1.11")

Now What?

- Now that the Pomme de Terre is on the impaired waters list we are required to do a TMDL study to determine how much pollutants the water can handle, where they are coming from and under what flow conditions they are coming from.
- We are here in the process

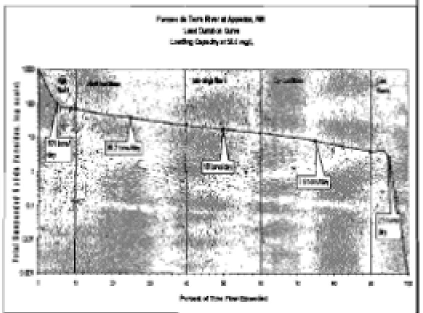


What is a TMDL?
Total Maximum Daily Load

- **It is a process:**
  - 1. Assess waters
  - 2. Determine if impaired
  - 3. Place water on 303(d) list
  - 4. Monitor, study water body
  - 5. Compute pollutant load allocation formula
  - 6. Develop implementation strategy
  - 7. Monitor changes in water body
  - 8. Delist?
- **It is a number:**
  - The TMDL is the maximum amount of a specific pollutant that can be discharged into a body of water and still meet water quality standards.
  - Or...."How much crap we can put in the water and it still not be considered polluted"

TMDL: The Number

- The maximum amount of pollutant that can be put into the water changes with the amount of water flowing in the stream



Why are TMDL Studies Important?

Provides the mechanism for studying a water body so that:

- You can determine how much pollution must be reduced from all sources
- You can plan an effective strategy for reducing existing pollutant loads to meet water quality standards

Why Develop a TMDL Study?

- Required by the Federal Clean Water Act
- Protects community assets and quality of life
- Restores beneficial uses of surface waters
- Provide a useful, long-range planning tool for managing water quality
- Clean water protects property values

Do TMDLs Mean More Regulation?

- No
  - Point Sources are already regulated and permit requirements are enforceable.
    - Municipal WWTFs
    - CAFOs
    - Municipal separate storm sewer systems (Morris)
    - Construction stormwater permits
  - **Existing** regulations that are currently unenforced may have to start to be enforced.
    - I.e.: county ditch buffer requirements

Do TMDLs Mean More Regulation?

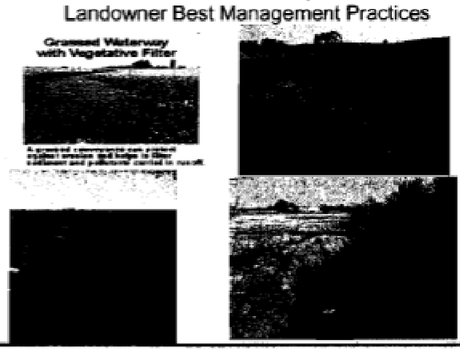
- For Non-Point Sources
  - The goal is to not regulate non-point sources.
  - We will rely on financial incentives and education to address certain non-point sources

An exclusion fence installed along the edge of this pasture protects the stream and riparian areas from grazing animals.

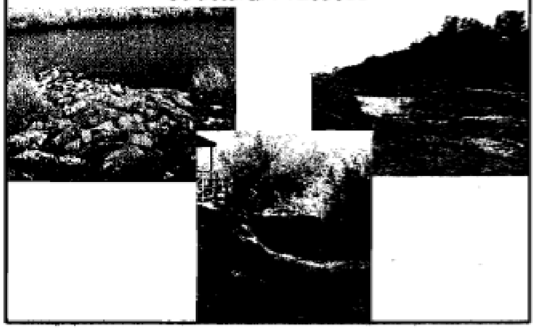
Fixing the Problem

- We will focus on the watershed as a whole, not just the Pomme de Terre River itself.
- That means looking at the River itself plus Muddy Creek, Drywood Creek, Pelican Creek and the county ditches.
- It doesn't make sense to fix the river, but ignore the waters flowing into the river.

What Will Help?
Landowner Best Management Practices



What Will Help?
Structural Practices



How will we implement these BMP's?

- Our goal is to provide incentives to landowners to implement BMP's on their lands.
- Since we are in a "high priority" watershed an approved TMDL and implementation plan means more money for the watershed to provide competitive incentives to landowners.
- It all comes down to $

Incentive Money

- Clean Water Legacy Act Funding
  - Administered by BWSR, DNR, MDA, MPCA
  - Provides funding to protect, restore, and preserve the quality of MN surface water.
  - Generated from a combination of state general fund, federal EPA 319 funds, general obligation boding, Environmental and Natural Resources Trust Fund.
  - Able to apply for CWL funds once TMDL and implementation plan are approved.
- Other Programs
  - CRP, CREP, RIM, EQUIP, WRP.
  - New WRP/RIM partnership pays 140% of township ELV.

For More Information, Contact
Shaun McNally
PdT Watershed Project Coordinator
Stevens SWCD

320-589-4886 Ext. 109
shaun.mcnally@mn.nacdnet.net

Pomme de Terre River
Watershed Project

Questions and Comments from the
Pomme de Terre River Watershed Turbidity TMDL Kickoff Meeting
Morris, MN September 18, 2008 7:00 – 9:00 pm

Turbidity Presentation

1. How do we determine where it is coming from?
2. How far back has this study gone to get an idea of trends?
3. Are the lakes being monitored also?
4. Does everyone across the country use a Load Duration Curve as a standard method to determine sources?
5. If an island is formed from riverbank erosion, can we take them out and straighten the river?

Fecal Coliform Presentation

1. How much rain was in a rain event?
2. Why are septics included when data show it is not a main part of the problem?
3. Is the funding for the Muddy Creek area of the entire watershed?
4. What does it mean in practice to have 2,400 cfu/100 mL of *E. coli*?
    a. Is it too high?
    b. Does it change the health of the stream and fish?
5. How much *E. coli* or fecal coliform does it take in the tributaries to cause a negative effect in the Pomme de Terre River?
    a. What is the dilution factor?
6. How much of Drywood Creek is pasture?
    a. Can we pinpoint the exact area or source of the fecal coliform?
7. Comment: Bald eagles have been sighted by Drywood Creek.
8. Comment: Drywood Creek has had a green tint, so we need to find an exact source.
9. Comment: With low fecal coliform during rain events, it would indicate that little fecal coliform is coming from cattle being directly in the stream. Relates to the cattle exclusion part of the implementation plan.
10. Which waterways are included in the implementation plan?
11. If this process fails and we do everything without tangible results, what happens?
12. Was the fecal TMDL and/or implementation plan approved?
13. If geese are shown to be 75% of the problem, than what?
14. How many feet of buffer are good enough?
15. Is the CRP standard more than needed?
16. Is the implantation plan using the nutrient trade system?

General Questions

1. What is the condition of Drywood Lake?
2. How deep are the lakes?
3. Is Artichoke Lake currently being monitored?
4. Is there a garbage clean up component?
    a. Comment: There is a lot of garbage on the river.
5. How long has Shaun been on board with this project?
6. Is fertilizer runoff high?
    a. Has this been tested for?

MEETING AGENDA

Pomme de Terre River Association
Joint Powers Board
Friday, March 6, 2009
9:00 a.m.
USDA-ARS Soils Lab, Morris

I. Introductions, agenda additions and approval

II. Approve minutes from December 5, 2008 meeting

III. Review 2008 financial summary

IV. MPCA Update – Kelli Daberkow

V. Watershed Project Coordinator Update – Shaun McNally

VI. Set next meeting date & time and adjourn

PLEASE NOTE: The Technical Advisory Committee will be meeting after our board. There will be two presentations given to the members of both groups, after our business meeting and before the TAC convenes.

- Kim Laing, MPCA will present the preliminary results from the 2008 Dry Wood Creek Phase 2 monitoring.
- Shaun McNally, Watershed Project Coordinator, will present the turbidity TMDL data.

Pomme de Terre Watershed Project
Technical Advisory Committee Meeting
3/6/09 Minutes

Attendees: Herb Kloos, Rod Wenstrom, Paul Groneberg, Jerry Johnson, Clinton Schuerman, Keith Swanson. Pete Waller and David Sill, BWSR; Kelli Daberkow and Kim Laing, MPCA; Shaun McNally, Matt Solemsaas, Chris Staebler, Stevens SWCD; Joe Montonye, Grant SWCD. Chris Domeier-DNR, Stacy Salveold-USFWS, Sharen Weyers-ARS, Jim Wulf, Brady Janzen, Larry Mahoney-Soybean Growers, Kurt Staples-Synes Twnsp, Troy Goodnough-CURE, Steve Commerford-MSGA, Bill Kleindl-Stevens County, Rick Gronseth-NRCS, Dean Schmidt-WesMin RC&D, Jim Erickson.

Kim Laing Drywood Phase II Presentation:

Kim Laing of the MPCA's St. Paul office gave a presentation on the 2008 Drywood Creek sub-watershed phase II preliminary data. She stated the Drywood Creek area was chosen for additional monitoring based on low biological scores during the 2007 intensive watershed monitoring.

The general goal of phase II monitoring is to try to determine the stressors on the stream system and characterize the watershed and stream system.

All fish sampling sites scored as impaired on the current IBI scoring system, although she said the scoring matrix is currently being re-worked, so those scores might not mean the same under the new scoring system.

Certain sites on the creek had levels of dissolved oxygen well below the 5 mg/L standard, the site with the beaver dam had the lowest levels, falling to near zero on a number of occasions for up to 12 hours at a time.

Blue green alga is present in Drywood Lake.

Turbidity levels were very high all year.

Nitrate levels were high during the spring snowmelt period, but were below the standard during the summer months.

E. coli levels were extremely high all summer.

Plans for this year include more nitrates testing during snowmelt period, more lake sampling of Drywood Lake, more stream geomorphology studies, possibly adding another biological monitoring site.

Shaun McNally Turbidity TMDL presentation

Shaun presented the turbidity data that will be used in the turbidity TMDL. 60% of the turbidity readings in the last 11 years have exceeded the 25 NTU standard.

The TSS surrogate for 25 NTU was determined to be 52 mg/L.

Shaun showed the flow duration curve for the PdT River

Shaun explained how a load duration curve was created and how the TSS readings are converted in to a load of tons per day and placed on the load duration curve.

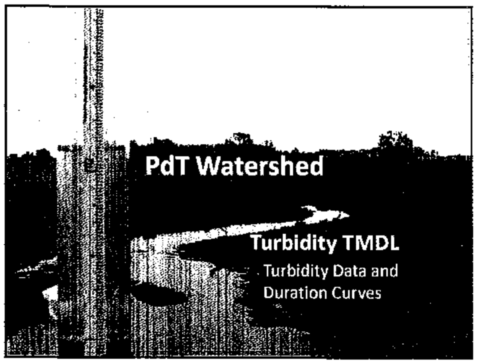
Turbidity and TSS levels are highest in the months with the highest rainfall.

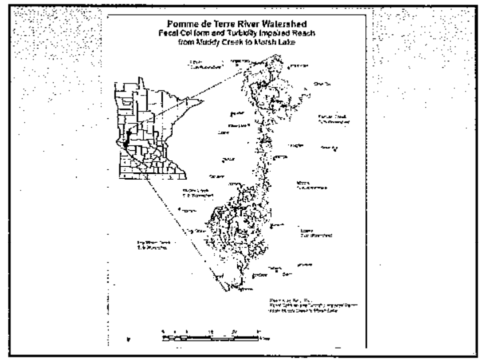
The load duration curve shows most of our exceedences occurring in the mid-range and moist condition flow zones.

This pattern indicates our TSS loading is coming from near channel sources during the mid-range flows and from saturated upland areas during the moist conditions.

This info will let us focus our implementation efforts.

3/6/09: TAC/Stakeholder meeting



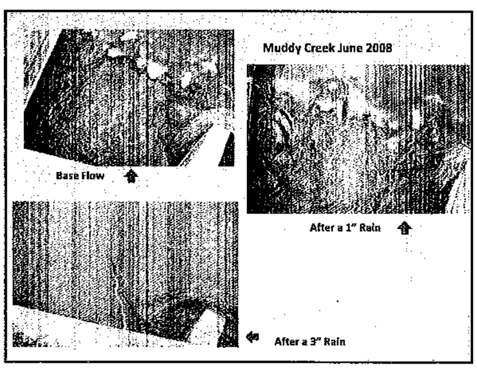


What is Turbidity?

- Turbidity is caused by particles suspended or dissolved in water that scatter light
- Particles can include: sediment especially clay and silt, fine organic and in organic matter, soluble colored organic compounds, algae, and other microscopic organisms
- In the MN River Basin, sediment is the primary cause of high turbidity.

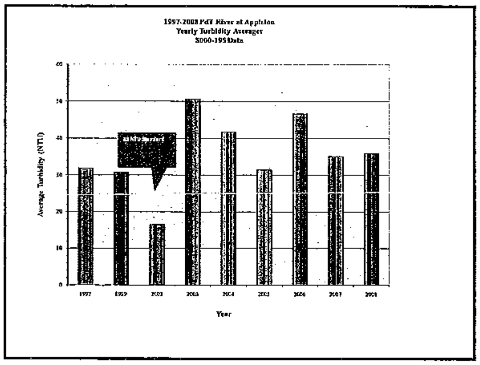
Impacts of High Turbidity

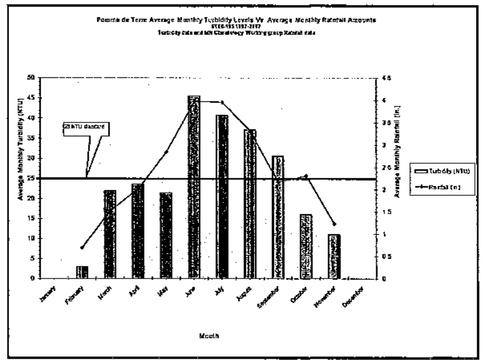
- Reduces the aesthetic quality of the water
  - Nobody likes to recreate in dirty water
- Increased cost for water treatment
- Lakeshore property values directly related to lake water clarity
- Harms aquatic life
  - Reduces food supply
  - Degrades spawning beds
  - Can affect gill function
  - Affects sport fishing

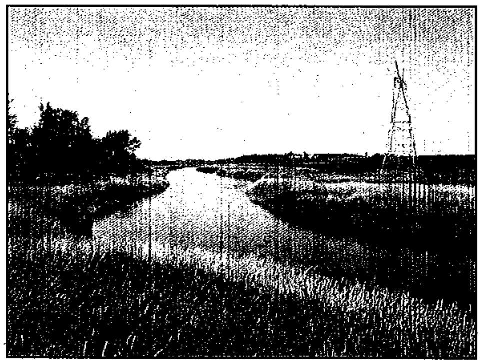


Turbidity in the Pomme de Terre

- The Pomme de Terre is classified as a class 2B stream
  - It's beneficial use is cool and warm water fisheries and all recreation
  - The EPA sets numeric criteria for each class of stream
  - [illegible]he turbidity [illegible] for [illegible] 2 [illegible] is [illegible]





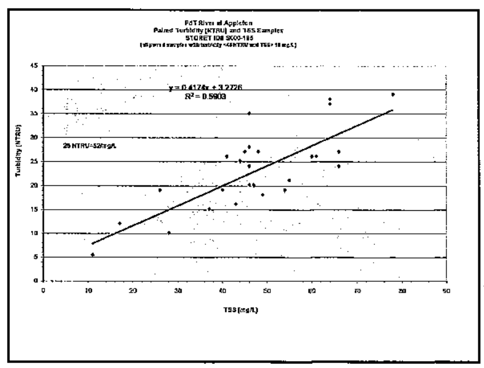


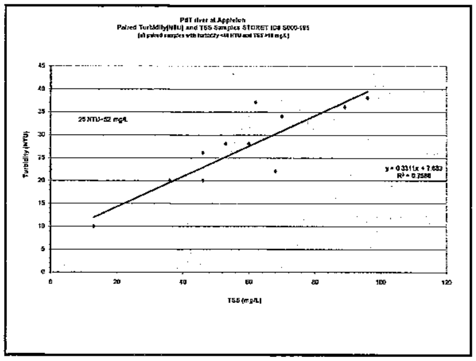
So How Much Stuff is in the River?

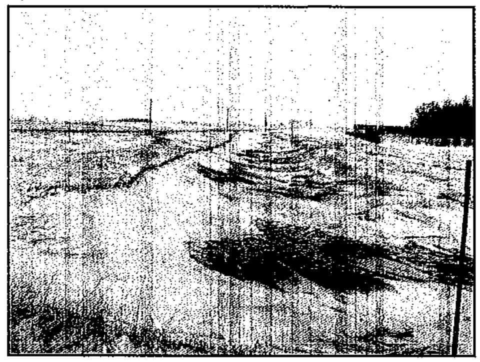
- Turbidity is a dimensionless unit
- Loading allocations, capacities and reductions are commonly based on a surrogate parameter, total suspended solids (TSS)
- TSS is the measurement of sediment and organic matter in a sample of water and is reported in mg/L
- Each stream has a different turbidity/TSS ratio

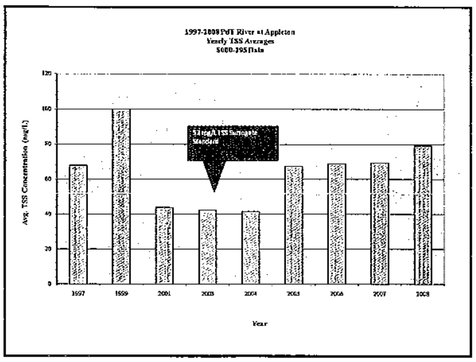
y=mx+b..Remember High School Math?

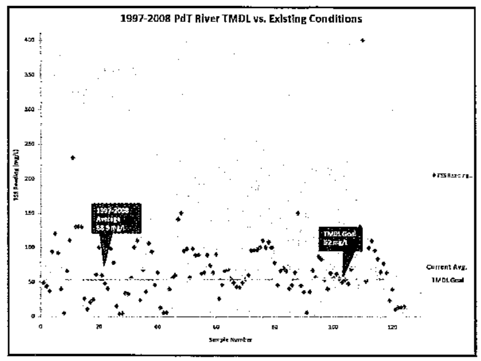
- To determine the TSS equivalent to 25 NTU you need paired turbidity and TSS measurements
- Plot the paired measurements on a graph and then do a regression analysis.
- 52 mg/L TSS is the equivalent to 25 NTU in the PdT River

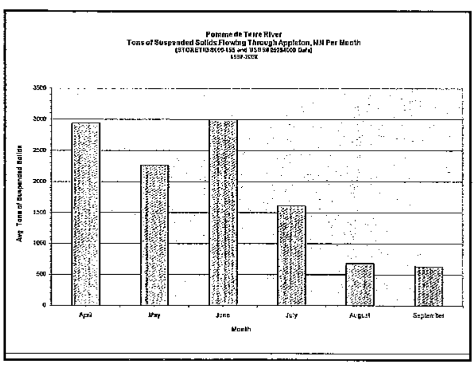


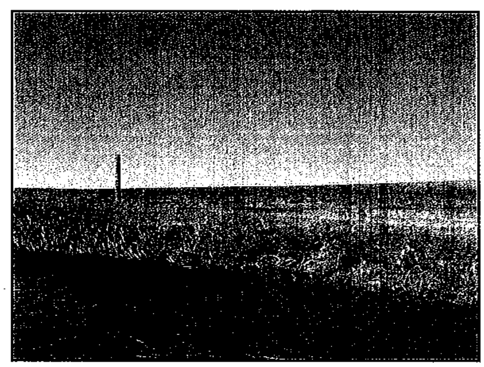

Paired Turbidity(NTU) and TSS Samples
25 NTU-52 mg/L
Turbidity (NTU)
TSS (mg/L)
R² = 0.7588




PdT River at Appleton
Yearly TSS Averages
Avg. TSS Concentration (mg/L)
Standard
Year
1997
2001
2007
2008


1997-2008 PdT River TMDL vs. Existing Conditions
TMDL Goal
Current Avg.
TMDL Goal
Sample Number


Pomme de Terre River
Tons of Suspended Solids Flowing Through Appleton, MN Per Month
Avg. Tons of Suspended Solids
April
May
June
July
August
September
Month



Duration Curve Approach

- Allows for characterizing water quality data at different flow regimes.
- Provides a visual display of the relationship between stream flow and loading capacity.
- Accounts for how stream flow patterns affect changes in water quality over the course of a year.
  - Seasonal variation is a TMDL requirement

Duration Curve Approach

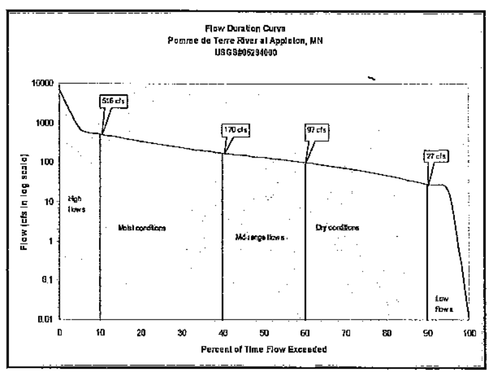
- Compile flow data for the river
- Produce a flow duration curve
- Calculate the TSS surrogate for the PdT (52 mg/L)
- Produce a load duration curve
- Integrate all the TSS measurements
- Determine loading capacity and allocation

Compile Flow Data and Develop the Flow Duration Curve

- USGS gauging site in Appleton has daily flow data from 1931.
- Last 30 years were used to better reflect current watershed conditions
- 7,012 daily flow values were compiled and then sorted by flow volume from highest to lowest and placed on a curve.

Flow Duration Curve

- Identifies intervals, which can be used as a general indicator of hydrologic condition (wet vs. dry and to what degree)
- Divide the curve into 5 flow regimes to provide additional insight about conditions and patterns associated with the impairment
- High flows, moist conditions, mid-range flows, dry conditions, low flows

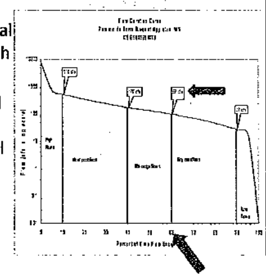


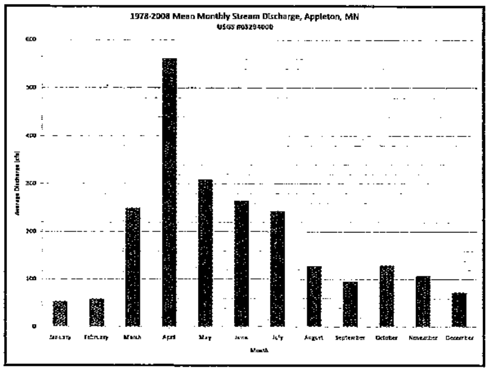
Flow Duration Intervals

- Low flows are exceeded a majority of the time
- Floods are exceeded infrequently
- Flow duration intervals are expressed as a percentage
  - 0% corresponds to the highest stream discharge on record (flood conditions, 8,890 cfs, 4/7/97)
  - 100% corresponds to the lowest stream discharge on record (drought, 0.01 cfs, 1988)

Flow Duration Intervals

- A flow duration interval of 60 is associated with a discharge of 97 cfs
- Implies that 60% of all observed stream discharge values equal or exceed 97 cfs.





Determine the TMDL (Maximum Amount of Pollutant)... More Math!

- Do this for each of the 5 flow regimes
- Each flow regime has a different TMDL (the more water flowing, the more pollution the River can take)
- Use the mid-range flow value for each flow regime
- Convert the flow and TSS concentration into a load of tons per day
- TMDL = $\frac{\text{median flow (cfs)} \times 52\text{mg/L} \times 28.31\text{(L/cf)} \times 86{,}400\text{(s/day)}}{907{,}184{,}740\text{(mg/ton)}}$

An Example: Moist Condition Flow Regime

- Flow range 170-516 cfs
- Median flow 273 cfs
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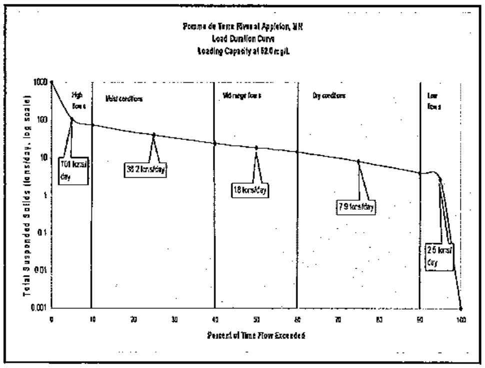

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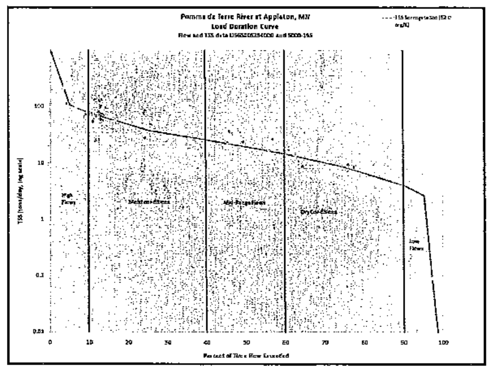

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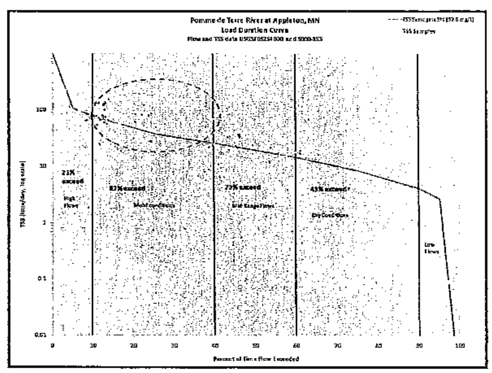

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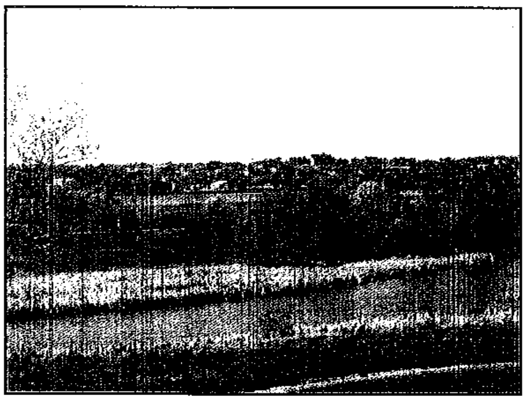
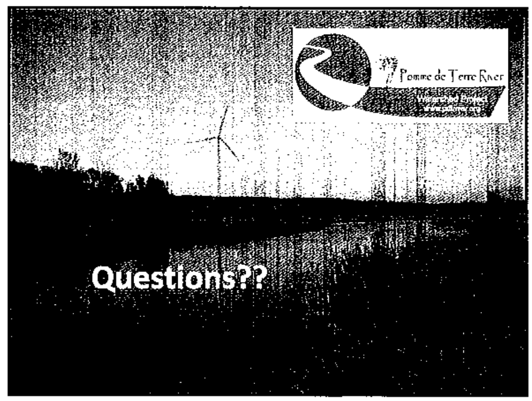
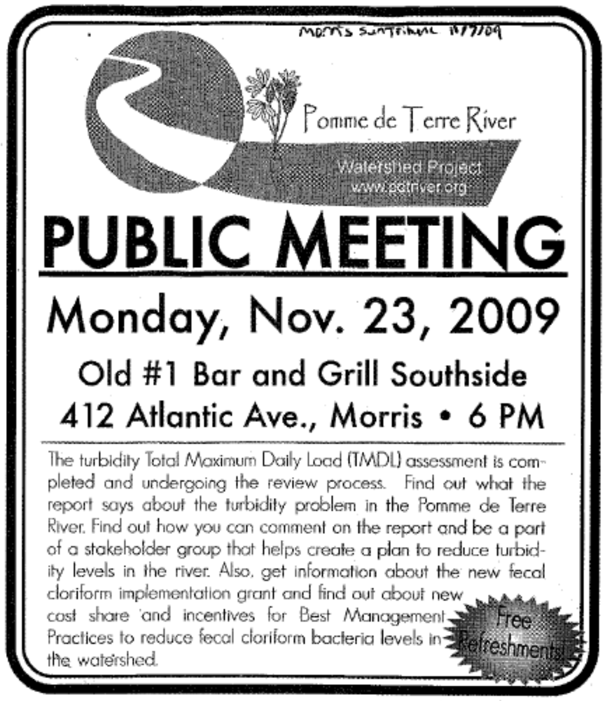






Pekarek-Scott, Katherine (MPCA)

From:	Shaun McNally [shaun.mcnally@stevensswcd.org]
Sent:	Monday, November 30, 2009 8:12 AM
To:	Pekarek-Scott, Katherine (MPCA)
Subject:	Meeting newspaper stuff
Attachments:	09 newspaper ad.pdf

Here is a scan of the newspaper advertisement.
It ran in the following papers the two weeks prior to the meeting except for the Morris paper where it ran for 3 weeks:

Morris Sun Tribune
Chokio Review
Hancock Record
Grant County Herald
Appleton Gazette
U of M, Morris Register

Shaun McNally
Pomme de Terre River
Watershed Project Coordinator
12 Hwy 28 E. Ste. 2
Morris, MN 56267
(320) 589-4886 ext. 109
(320) 287-1202 cell
shaun.mcnally@stevensswcd.org

Dear Interested Stakeholder of the Pomme de Terre Watershed,
You are cordially invited to the 2009 Pomme de Terre Watershed annual public meeting:

Monday November 23rd 2009
Old #1 Bar and Grill Southside
412 Atlantic Ave Morris, MN
6 pm

The turbidity Total Maximum Daily Load (TMDL) assessment is completed and undergoing the review and approval process. Find out what the report says about the turbidity problem in the Pomme de Terre River Watershed. Find out how you or your organization can comment on the report, and become part of a stakeholder group that helps create a plan to reduce turbidity levels in the river.

Also, get information about the new fecal coliform bacteria implementation grant and find out about new cost share and incentives for Best Management Practices to reduce fecal coliform bacteria levels in the watershed.

Please see the map on the back side of this invitation for the location of the meeting place. If you have any questions feel free to contact me.

Thank you,
Shaun McNally
PdT River Watershed Project Coordinator
320-589-4886 x109 shaun.mcnally@stevensswcd.org

November 3, 2009
Township Board Chairman,
As you may know, the Pomme de Terre River Watershed is currently the subject of a Total Maximum Daily Load (TMDL) assessment for excessive turbidity levels (sediment). The TMDL study is complete and is currently undergoing the review and approval process. Part of the TMDL process is developing an implementation plan to determine the focus and types of landowner Best Management Practices that will help in cleaning up the water in the Pomme de Terre Watershed. A vital part of this process is landowner stakeholder involvement. As township leaders, your input in this process is very important. We want you to have a say in how management practices are implemented.
I would like to invite you and/or members of your township board to be part of our watershed stakeholder group for the turbidity TMDL study and implementation plan. As part of this process, I plan on holding approximately four stakeholder meetings this winter. During these meetings, the stakeholder group will decide how we should focus our efforts to reduce the amount of sediment reaching the river.
On November 23rd, there will be a public meeting to go over the turbidity TMDL so you can find out what the report says about the turbidity problem in the watershed. We will also discuss the stakeholder process, and what the implementation plan entails. I would like to invite you and/or a member of your township board to this meeting. This would be a good chance to get involved early and find out about the project, the results we are finding, what the next steps are, and your role in the process.

PdT Watershed Public Meeting
Monday November 23rd 2009
Old #1 Bar and Grill Southside
412 Atlantic Ave. Morris
6 pm

Please pass this information on to the rest of your board, and anyone else you feel may be interested.
Thank you.
Shaun McNally
PdT River Watershed Project Coordinator

Agenda for Tonight

1. **How you or your organization can officially comment on the turbidity TMDL:** Katherine Pekarek-Scott, MPCA
2. **Turbidity TMDL: What's in the report**
3. **Fecal Coliform TMDL: Implementation plan and the new incentive and cost share money**
4. **Lake Assessment Project**

- I'd like the meeting to be concluded by 8 pm, but I'll stick around afterwards to discuss any additional questions anyone may have (but if you keep me too late, you'll have to buy me a round upstairs)

Rules for Tonight

- We are not here to argue about whether or not the river should be listed as impaired........It is.
- I don't want to hear the terms "hippie environmentalist", "corporate agriculture", or "that ?@$%#!* (fill in the blank) agency"
- Other people have differing views and perspectives of the river....please respect their opinions.
- No finger pointing or ratting out your neighbor
- Let's not talk about the damn geese ☺

Public Comment Period

- Public Comment Period will be this winter or upcoming spring
- Published in the State Register which can be found at http://www.comm.media.state.mn.us/bookstore/state_register.asp
- When on Public Comment Period the TMDL can be found on the internet at http://www.pca.state.mn.us/water/tmdl/tmdl-draft.html

Your Options:

1. Written Comments
2. Petition for Public Informational Meeting
3. Petition for a Contested Case Hearing
4. MPCA Decision

Contact Information:

Katherine Pekarek-Scott

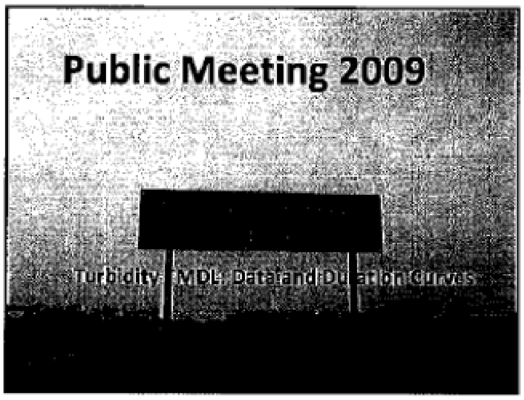
Minnesota Pollution Control Agency
1420 East College Drive, Suite 900
Marshall, MN 56258

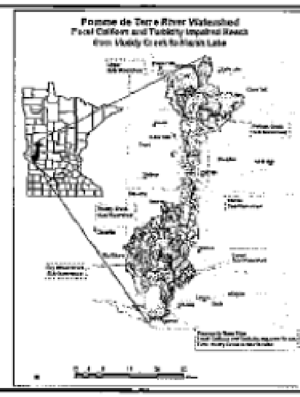
507-476-4267

katherine.pekarek-scott@state.mn.us

If You or your Organization Wish to be Notified When the Public Comment Period Officially Opens

- Sign up on the "Public Comment Notification" form





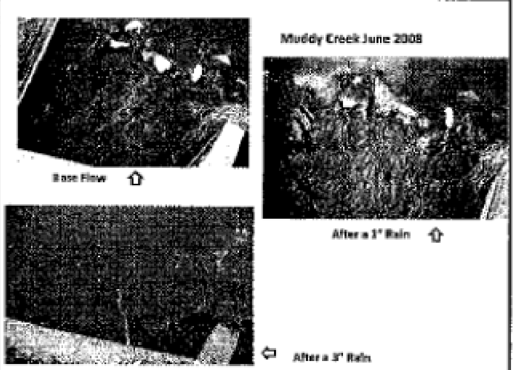
What is Turbidity?

- Turbidity is caused by particles suspended or dissolved in water that scatter light
- Particles can include: sediment especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae, and other microscopic organisms
- In the MN River Basin, sediment is the primary cause of high turbidity.

Impacts of High Turbidity

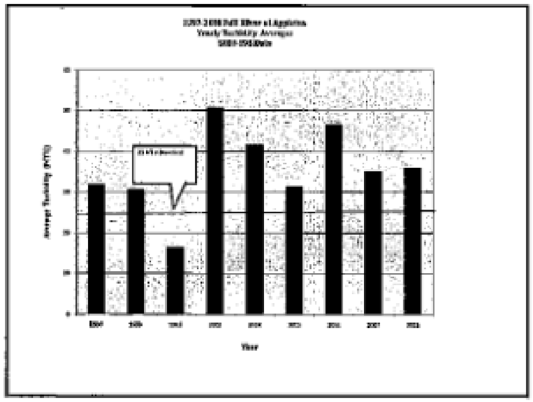
- Reduces the aesthetic quality of the water
  - Nobody likes to recreate in dirty water
- Increased cost for water treatment
- Lakeshore property values directly related to lake water clarity
- Harms aquatic life
  - Reduces food supply
  - Degrades spawning beds
  - Can affect gill function
  - Affects sport fishing

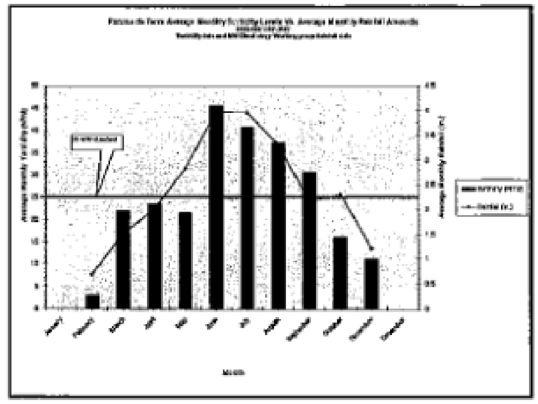
Muddy Creek June 2008

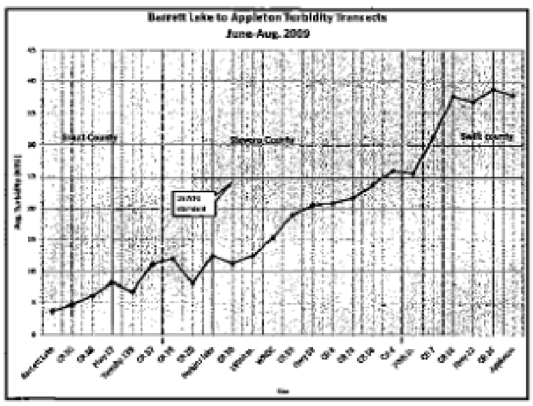


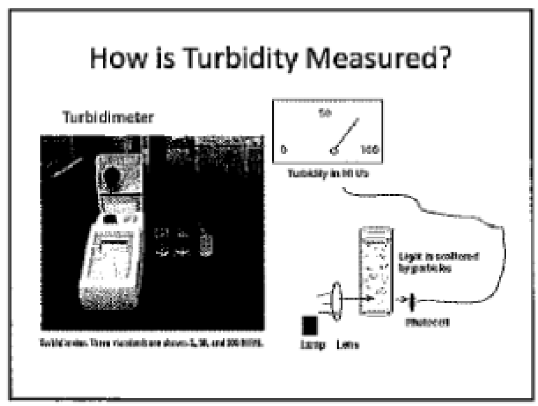
Turbidity in the Pomme de Terre

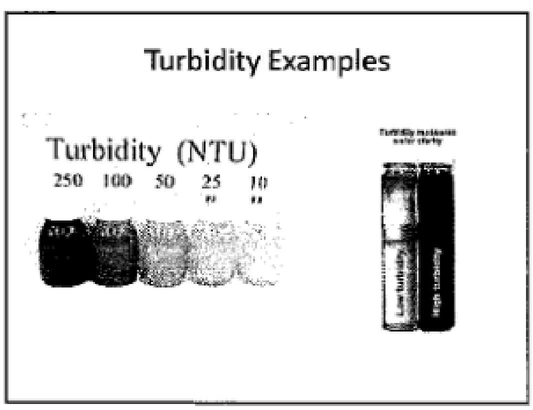
- The Pomme de Terre is classified as a class 2B stream
  - It's beneficial use is cool and warm water fisheries and all recreation
  - The EPA sets numeric criteria for each class of stream
  - **The turbidity limit for a class 2B stream is 25 NTU**

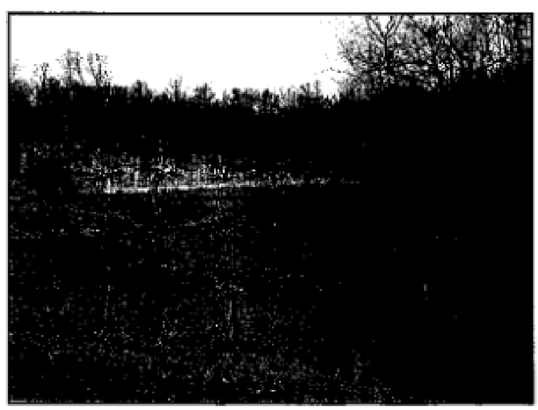





Barrett Lake to Appleton Turbidity Transects
June-Aug. 2009


How is Turbidity Measured?
Turbidimeter
50
0
100
Lamp
Lens
Photocell


Turbidity Examples
Turbidity (NTU)
250 100 50 25 10
Low turbidity
High turbidity

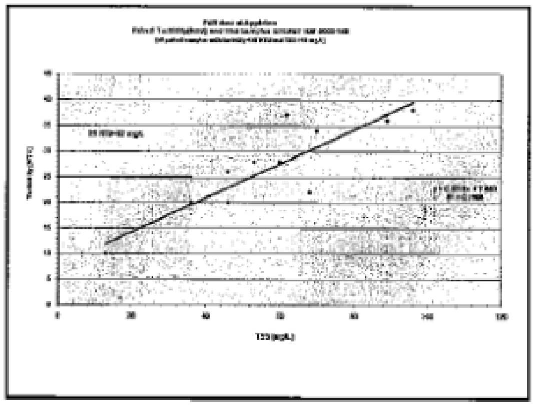


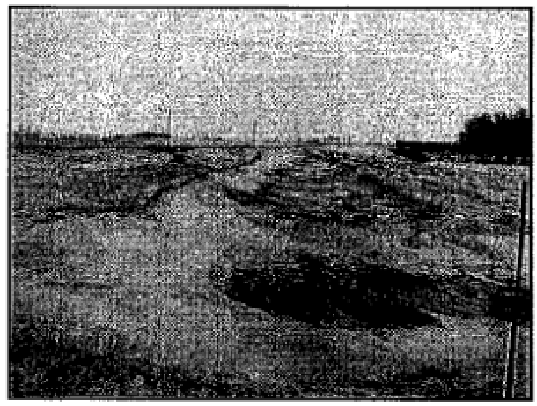
So How Much Stuff is in the River?

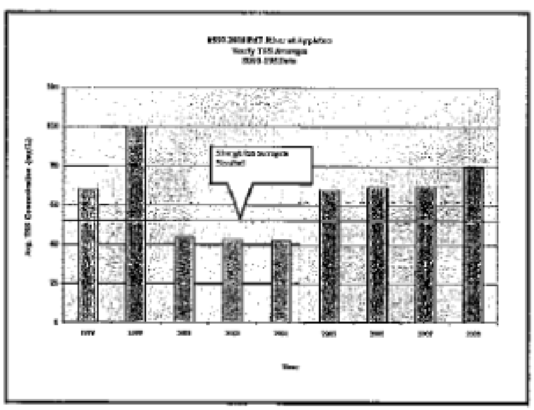
- Turbidity is a dimensionless unit
- Loading allocations, capacities and reductions are commonly based on a surrogate parameter, **total suspended solids (TSS)**
- TSS is the measurement of sediment and organic matter in a sample of water and is reported in mg/L
- Each stream has a different turbidity/TSS ratio

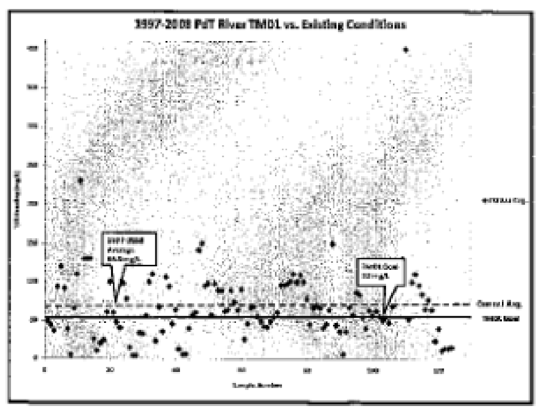
y=mx+b..Remember High School Math?

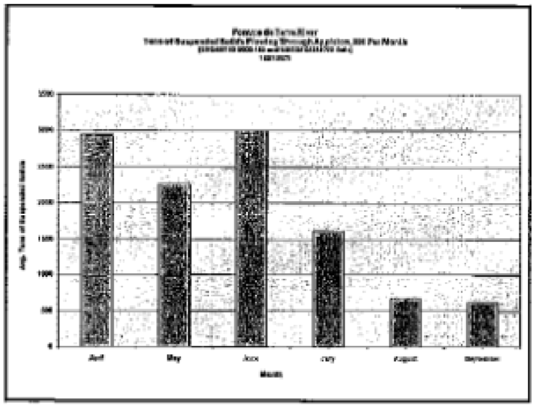
- To determine the TSS equivalent to 25 NTU you need paired turbidity and TSS measurements
- Plot the paired measurements on a graph and then do a regression analysis.
- 52 mg/L TSS is the equivalent to 25 NTU in the PdT River

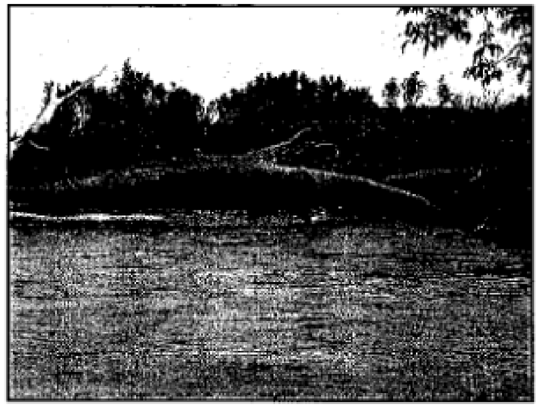












Duration Curve Approach

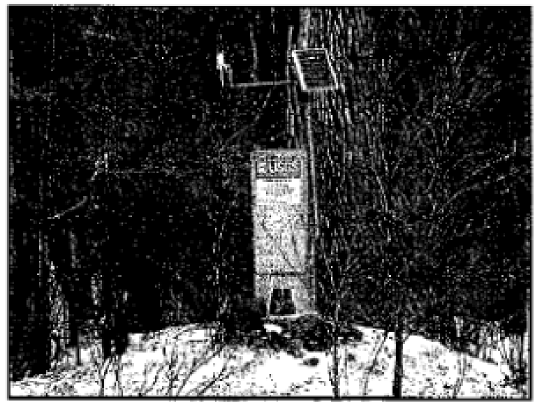
- Allows for characterizing water quality data at different flow regimes.
- Provides a visual display of the relationship between stream flow and loading capacity.
- Accounts for how stream flow patterns affect changes in water quality over the course of a year.
  – Seasonal variation is a TMDL requirement

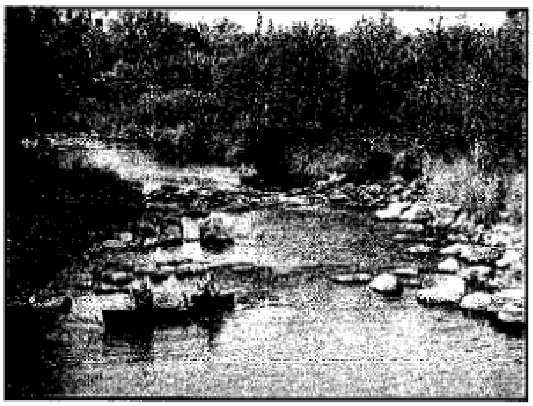
Duration Curve Approach

- Compile flow data for the river
- Produce a flow duration curve
- Calculate the TSS surrogate for the PdT (52 mg/L)
- Produce a load duration curve
- Integrate all the TSS measurements
- Determine loading capacity and allocation

Compile Flow Data and Develop the Flow Duration Curve

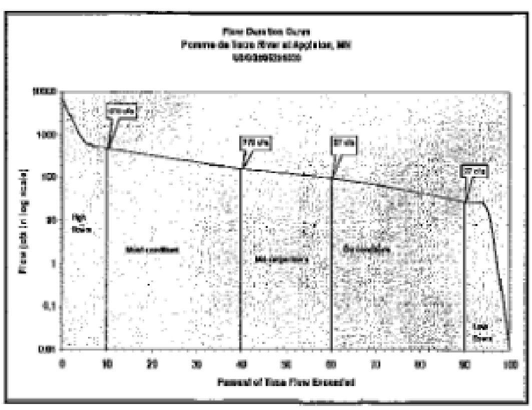
- USGS gauging site in Appleton has daily flow data from 1931.
- Last 30 years were used to better reflect current watershed conditions
- 7,012 daily flow values were compiled and then sorted by flow volume from highest to lowest and placed on a curve.





Flow Duration Curve

- Identifies intervals, which can be used as a general indicator of hydrologic condition (wet vs. dry and to what degree)
- Divide the curve into 5 flow regimes to provide additional insight about conditions and patterns associated with the impairment
- High flows, moist conditions, mid-range flows, dry conditions, low flows

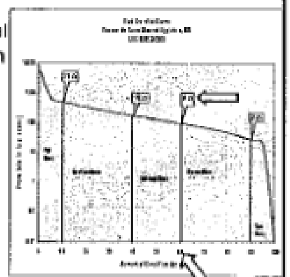


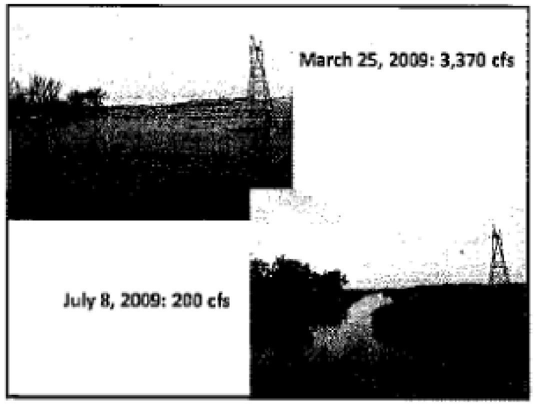
Flow Duration Intervals

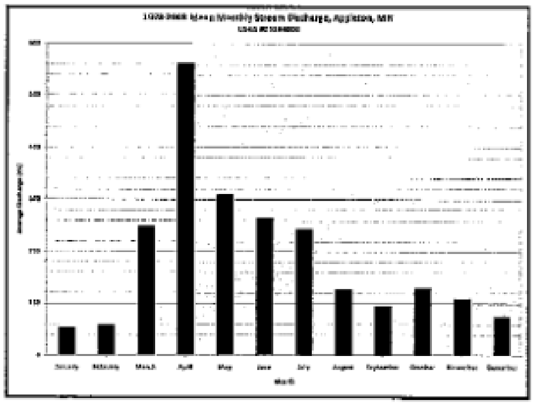
- Low flows are exceeded a majority of the time
- Floods are exceeded infrequently
- Flow duration intervals are expressed as a percentage
  - 0% corresponds to the highest stream discharge on record (flood conditions, 8,890 cfs, 4/7/97)
  - 100% corresponds to the lowest stream discharge on record (drought, 0.01 cfs, 1988)

Flow Duration Intervals

- A flow duration interval of 60 is associated with a discharge of 97 cfs
- Implies that 60% of all observed stream discharge values equal or exceed 97 cfs.







Determine the TMDL (Maximum Amount of Pollutant)… More Math!

- Do this for each of the 5 flow regimes
- Each flow regime has a different TMDL (the more water flowing, the more pollution the River can take)
- Use the mid-range flow value for each flow regime
- Convert the flow and TSS concentration into a load of tons per day
- TMDL = $\frac{\text{median flow (cfs)} \times 52\text{mg/L} \times 28.31\text{(L/cf)} \times 86{,}400\text{(s/day)}}{907{,}184{,}740\text{(mg/ton)}}$

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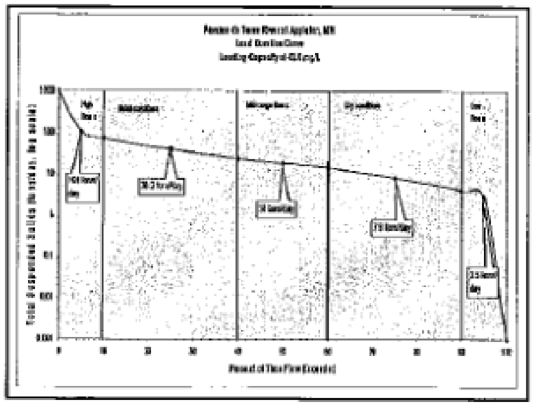

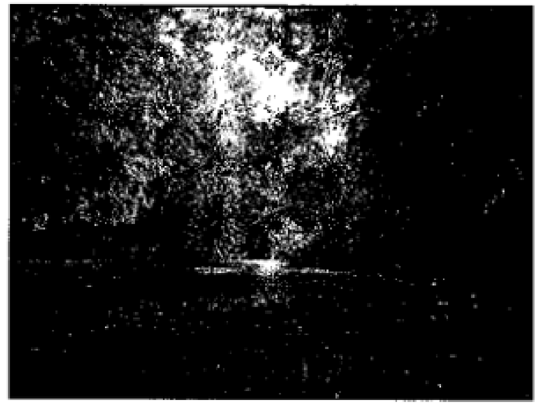

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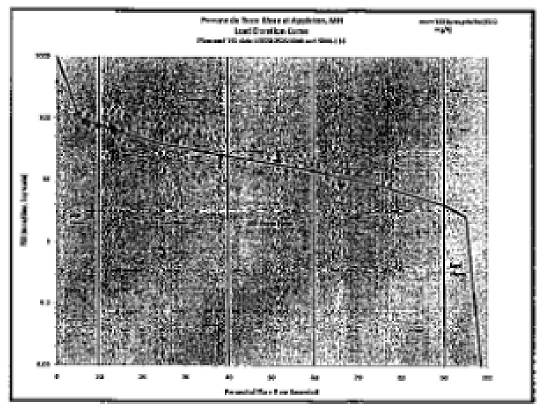

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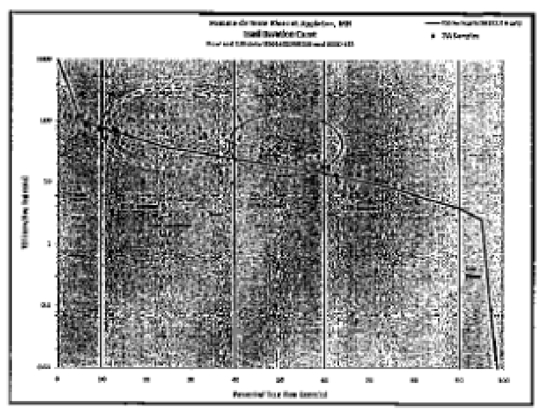

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- Moist Conditions
  - Target programs should also focus on saturated upland soils
  - Targeted activities:
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    - Grassed waterways

What's Next? Implementation Plan Creation

- We need representatives from a diverse group of watershed interests to help create the turbidity Implementation Plan.
- Time commitments? Approximately 4 meetings this winter and early spring
- Please sign up on the back of the suggestion sheet, or on the signup sheet

Pomme de Terre River Turbidity Total Maximum Daily Load (TMDL) Report
Formal Public Meeting
November 23, 2009 6:00pm
Old #1 Southside Bar and Grill, Morris MN

Meeting Minutes

Number of People in Attendance: 40

The meeting started at 6:10pm with an introduction of the meeting presented by Shaun McNally with the Pomme de Terre River Watershed Project. McNally presented the agenda for the meeting and went over the rules that will be followed during the meeting.

Katherine Pekarek-Scott with the Minnesota Pollution Control Agency (MPCA) described that the Public Comment Period will be coming either later this winter or early in the spring and went through the options that the public had to participate in the Comment Period. Pekarek-Scott asked for the people who wished to receive a notice of the Comment Period in the mail to put their contact information on a signup sheet.

McNally presented the findings of the TMDL Report. He started by identifying the location of the impairment, discussed what turbidity was and how it impacted the water. McNally then described the levels of turbidity in the Pomme de Terre (PdT) River Watershed, the process of developing a total suspended solids (TSS) surrogate, the TSS levels in the PdT, and the formation of the Load Duration Curve. He explained how a TSS loading capacity was formulated and that there were exceedences issues during mid flow and moist flow regimes.

McNally explained the next steps of developing an implementation plan and requested volunteers to be part of a stakeholder committee to help develop the plan.

The presentation concluded at 6:53pm and was opened up for questions which are listed below.

Q: When Shaun is taking turbidity readings, is he using a Transparency Tube or a Turbidity meter?
A: A meter is used to take turbidity readings.

Q: Are the regression lines (for developing a TSS surrogate) different for different water bodies?
A: Yes they are.

Q: How many times per month are turbidity readings taken?
A: Shaun took on average one reading a week, but other groups such as the MPCA also sample.

Q: On the graph showing turbidity rising (slide 14), what landmarks are associated with these?
A: Where Muddy Creek enters, there is not much of an increase. Where Dry Wood Creek enters, there is not much of an increase, but the turbidity levels were down this year and this might have looked different last year. Geology is also impacting the rise in turbidity.

Q: Can Shaun indicate on the map where 70th street is located?

Q: Does Dry Wood Creek have different geology?
A: There is more silt in the soil in the southern portion of the watershed.

Q: What is the elevation change in the watershed?
A: There is not much of an elevation change, about a 3.5 foot drop. There is not much for bluff or gully erosion in this watershed that is associated with more of an elevation change.

Q: Is the 3.5 foot drop for the entire watershed?
A: For the most part, except below Appleton where it is more, but turbidity readings are not taken after Appleton and thus not reflected in the data.

Q: Would you expect to see the turbidity reading go down after the lakes empty?
A: The lakes do help to settle out sediment in the system.

Q: Why do turbidity readings jump in the southern part of the watershed?
A: The geology changes, soil changes, and the river has more wide sweeping bends in it. This all impacts the turbidity levels.

Q: Would enforcing buffer statutes help and should we enforce these before we complete the study?
A: The MN DNR is currently revising the shoreline rules that regulate this and possible enforce can result from it.

Q: There is more turbidity coming from banks and where buffers already exist there is still a problem.
A: When the implementation plan is being developed, more in stream practices will have to be looked at for these situations.

Q: Have you seen any patterns in spikes over the years?
A: In the last 15 years, the flows of the river does spike higher, the high flows are going up, and peak flows are on the rise. The yearly precipitation, however, has stayed the same, but there are fewer storms in a year so each storm has more water associated with it.

Q: BMPs should include something to deal with what happens to banks under high flows.
A: That will be part of the implementation plan development.

Q: How does this TMDL and others such as the Chippewa and the Hawk relate to the Minnesota River Turbidity TMDL?
A: Pekarek-Scott answered this question. The Minnesota River Turbidity TMDL is for the main stem up to the Lac qui Parle Dam which is below the Pomme de Terre. The MN River TMDL includes the last reach of tributaries such as the Chippewa and the Hawk and forms allocations for them. The Chippewa River Turbidity TMDL for example is not doing a TMDL for that last reach so that it is not doubled up on TMDL allocations. There is a group of stakeholders working on this TMDL and they are working out the details of how to do the implementation plan at this point. There might be an implementation plan for the entire basin or the watersheds in the basin will develop an implementation plan, this has yet to be decided.

Q: Follow up question of what are the reductions in the MN River TMDL?
A: Not sure on the specific number. (The questioner stated that it is a 50% reduction) The PdT TMDL can only help in that reduction number.

Appendix C: Comment Letters and MPCA Response Letters

March 30, 2010

Katherine Pekarek-Scott
Minnesota Pollution Control Agency
1420 East College Drive, Suite 900
Marshall, MN 56258
Phone: (507) 476-4267
MN Toll Free: 1-800-646-6247
Fax: (507) 537-6001
Email: *katherine.pekarek-scott@state.mn.us*
Dear Ms Pekarek-Scott:

The Minnesota Department of Natural Resources (DNR) Clean Water Legacy Program Unit offers the following comments and recommendations on the draft TMDL report for turbidity on the Pomme de Terre River. The DNR shares your agencies interest in finding effective solutions to stream impairments, and protection for non-impaired waters, and we look forward to working with your agency to help protect and restore the water resources of the state.

This report does a good job of identifying the general nonpoint TSS load allocation but does not specifically identify and prioritize sources. As new collaborators in this process, it is sometimes hard to understand a process that requires completion of TMDL reports before the biological, chemical, and physical stressor identification work has identified the stressors and sources responsible for the various related impairments. As a general comment, it would seem to make more sense to compile existing data and complete the field investigations identifying stressors and sources, link physical and chemical conditions with biological impairments, use the empirical data to develop and calibrate the models (for example the HSPF model being used for this watershed), calculate loads, and prioritize an implementation and monitoring strategy targeting known problem areas. This process would actually make it easier to fulfill EPA requirements for a TMDL report and leave less for the implementation plan. As it is, the TMDL report requires some speculation in development and leaves specific identification of the causes and sources along with development of specific prioritized restoration strategies and monitoring planning to the implementation plan. We know that has been a common practice with other TMDL reports and maybe it has to be that way on occasion to meet statutory requirements of completing the TMDL within the required time frame. We think this whole sequence will make more sense as intensive watershed monitoring occurs followed by a whole watershed TMDL and implementation plan. For this plan, we suggest a stronger discussion of the work that will be completed this year and how that will assist with the work that is to be completed in the restoration plan. For example, the report could list the fish and invertebrate IBI work and HSPF model that will be completed this year - along with the other phase 2 work including the geomorphology work that will assess various stream stability components (competence, lateral, and vertical stability), estimate and validate bank erosion rates in tons per foot per year for various segments of the river, quantify stream and habitat types (riffle, run, pool, glide) that are present and what they mean, and help identify critical areas where buffers or riparian vegetation are inadequate.

Page 11 tables 2.3 and 2.4 do not mention pasture land. Is pasture included in grassland? Pasture land is not mentioned until page 26. Pasture management seems to be a key component of any restoration plan there.

This plan does a good job of laying out general implementation strategies and mentions specific critically needed strategies but stops short of identifying all the areas where they are needed. The locally targeted implementation strategies for Muddy Creek could be duplicated for Dry Wood Creek and likely many other locations. We would not rule out looking to the Middle Sub-Watershed for sources of sediment in the lower impaired reach.

For grade control in grassed waterways to control gully erosion and headcuts from forming we recommend smaller stepped grade control riffles rather than check dams. These riffles do a better job of passing water and sediment and stopping head cutting, without the sediment accumulation in the pool and downstream scour associated with check dams.

For channel restoration practices we really liked the concepts but the language could maybe be made clearer if it read: "Where appropriate, natural channel design practices could be used to restore the river to a more stable and natural dimension, pattern, and profile. For example, toe-wood brush-mat techniques could be used to greatly reduce accelerated bank erosion rates while providing roughness and pool habitat without increasing velocities downstream like rip rap does. Riffles, rock veins and weirs, and root wads, could be used for grade control, thalweg management, or erosion control. Artificially cut off meanders could be reconnected. These techniques should be a part of a larger effort to restore natural river functions including access to a working flood plain and diverse natural habitat including a variety of substrates including riffles, runs, pools, and glides."

Thank you for the opportunity to offer these suggestions and comments and we look forward to working together with you on the Pomme de Terre and other watersheds. Please contact me with any questions.

Dave Friedl
Clean Water Legacy Specialist
Minnesota DNR
1509 1st Ave N
Fergus Falls, MN 56537
218-739-7576 x264
David.friedl@state.mn.us

May 20, 2011

Mr. Dave Friedl
Clean Water Legacy Specialist
Minnesota Department of Natural Resources
1509 First Avenue North
Fergus Falls, MN 56537

RE: Pomme de Terre River Turbidity Total Maximum Daily Load Assessment Comment Letter Response

Dear Mr. Dave Friedl:

Thank you for your March 30, 2010, comment letter on the draft *Turbidity TMDL Assessment for the Pomme de Terre River*. Your letter was one of four letters received. The Minnesota Pollution Control Agency (MPCA) responses to your comments are below.

Comment: It would seem to make more sense to compile existing data and complete the field investigations identifying stressors and sources, link physical and chemical conditions with biological impairments, use the empirical data to develop and calibrate the models, calculate loads, and prioritize an implementation and monitoring strategy targeting known problem areas.

Response: The MPCA would agree that a more comprehensive watershed wide strategy would be beneficial and it is currently modifying its approach. This TMDL began before the modified approach was fully implemented and thus was not linked to any biological impairments. The MPCA staff feels that there was adequate data to complete the Load Duration Curve model that was used to calculate loads and used to help prioritize implementation strategies.

Comment: We suggest a stronger discussion of the work that will be completed this year and how that will assist with the work that is to be completed in the restoration plan.

Response: Additional language was added to section7 on page 35 that helps explain the usefulness of the monitoring for this TMDL.

Comment: Page 11 tables 2.3 and 2.4 do not mention pasture land. Is pasture included in grassland? Pasture land is not mentioned until page 26. Pasture management seems to be a key component of any restoration plan there.

Response: The cultivated category includes pasture land. The language has been updated on page 10 for clarification.

Comment: The locally targeted implementation strategies for Muddy Creek could be duplicated for Dry Wood Creek and likely many other locations. We would not rule out looking to the Middle Sub-Watershed for sources of sediment in the lower impaired reach.

Response: The Dry Wood Creek Sub-Watershed has been listed as a priority in the Stevens County Local Water Management Plan, but has not been listed yet in the Swift County Local Water Management Plan. Language has been added to include Dry Wood Creek under the Stevens County locally targeted implementation.

Comment: For grade control in grassed waterways to control gully erosion and headcuts from forming we recommend smaller stepped grade control riffles rather than check dams.

Response: The grade control structures section has been revised to incorporate your suggested language on page 37.

Comment: For channel restoration practices we really liked the concepts but the language could maybe be made clearer.

Response: The channel restoration practices section has been revised to incorporate your suggested language on page 38.

Sincerely,

Katherine Pekarek-Scott
Pollution Control Specialist
Marshall Office
Regional Division

KPS:bjw

cc: Randy Hukriede, MPCA
Bob Finley, MPCA
Lee Ganske, MPCA
File Copy

Comments and Questions should be addressed to:

Katherine Pekarek-Scott
Minnesota Pollution Control Agency
504 Fairgrounds Road, Suite 200
Marshall, MN 56258
507-476-4267
katherine.pekarek-scott@state.mn.us

EPA Comments on Public Notice Pomme de Terre Turbidity TMDL
Comments dated April 6, 2010

1. Which sub watershed is Artichoke Creek in?

2. Section 2.2 Land Use states that cultivated land includes confined animal feeding operations. Are these CAFO's permitted? If so please include permit numbers. Also are they contributing to the turbidity problem? Some discussion would be good to have on this.

3. Section 4 page 13 states that the transparency tube data was not used. Table 4.3 is the summary of transparency data for the PdT watershed. Is this included for informational use only?

May 20, 2011

Ms. Donna Keclik
U.S. Environmental Protection Agency Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

RE: Pomme de Terre River Turbidity Total Maximum Daily Load Assessment Comment Letter Response

Dear Ms. Donna Keckik:

Thank you for your April 6, 2010, comment letter on the draft *Turbidity TMDL Assessment for the Pomme de Terre River*. Your letter was one of four letters received. The Minnesota Pollution Control Agency (MPCA) responses to your comments are provided below.

Comment 1: Which sub watershed is Artichoke Creek in?

Response: Artichoke Creek is located in the Dry Wood Creek sub watershed. Table 2.2 was revised to include sub watersheds.

Comment 2: Section 2.2 Land Use states that cultivated land includes confined animal feed operations. Are these CAFO's permitted? If so please include permit numbers. Also are they contributing to the turbidity problems? Some discussion would be good to have on this.

Response: Concentrated Animal Feeding Operations (CAFOs) were not determined to be contributing to the turbidity problems and thus this statement was removed to avoid confusion.

Comment 3: Section 4 page 13 states that the transparency tube data was not used. Table 4.3 is the summary of transparency data for the PdT watershed. Is this included for informational use only?

Response: Table 4.3 was included as informational use only to show another line of evidence that the river is in exceedence of the turbidity standard. Additional language was added to pages 13 and 14 for clarification.

Sincerely,

Katherine Pekarek-Scott
Pollution Control Specialist
Marshall Office
Regional Division

KPS:bjw

cc: Randy Hukriede, MPCA
Bob Finley, MPCA
Lee Ganske, MPCA
File Copy

Comments and Questions should be addressed to:

Katherine Pekarek-Scott
Minnesota Pollution Control Agency
504 Fairgrounds Road, Suite 200
Marshall, MN 56258
507-476-4267
katherine.pekarek-scott@state.mn.us

3-25-2010

Katherine Pekarek-Scott
Minnesota Pollution Control Agency
1420 East College Drive
Marshall, MN 56258

RE: Pomme de Terre River Turbidity TMDL
Public Comment Period March 1- March 31, 2010

Ms. Pekarek-Scott

I am writing to address and comment on issues with the Pomme de Terre River Watershed TMDL.

#1) The Characterization of the Watershed
The entire PdT River Watershed is labeled to be represented in summary tables 4.1, 4.2, and 4.3. USEPA Storet data is available for several locations upstream from S000-195. Analysis of all available sites shows that the Total Suspended Solids (TSS) levels are associated with natural geologic conditions, specifically soil type. The north end of the PdT River begins flowing through an area of predominantly coarse textured soils, moving to finer textures along the way. TSS levels do gradually increase downstream. The report acknowledges this, "South of this point Morris), flowing through southern Stevens and eastern Swift Counties, the River is bordered by eroding, muddy banks becoming increasingly turbid before discharging into the Minnesota River at Marsh Lake." (page 9) What bothers me is that it seems to be an established approach by the MPCA to focus on land use, particularly agriculture. I suggest that the PdT Watershed Association use this report to help MPCA understand the geologic settings and conditions contributing to TSS loading.

#2) The trends in TSS levels
Pages 14 and 15 notes that sample frequency increased since 2004, but neglects to mention that the sampling schedule also was changed to exclude non-summer sampling entirely, while gathering additional summer samples. It causes the long term chart (Fig. 4.1) to be of little value as I would expect summer values to be higher than winter values regardless of impacts. Since winter samples are no longer taken, the correct procedure is to look back into the data and pull out only summer TSS values in all years. I would also note that in 2008 there were 9 samples submitted in May, June had 7, and then 3 per month from the period of July through October. This precludes the development of a proper long term average. I recognize that the MPCA requires the current standard to e applied at each river reach, but this TMDL is written with multiple broad reference to the entire watershed. There are numerous other monitoring data available located upstream from Appleton which are not referenced in the report. WHY NOT? The MPCA report "Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions" provides us with evidence that minimally impacted streams in this region would exhibit TSS ranging form near zero to nearly 500 mg/l, with a median summer value near 55. This should be considered in both the specific application of the 52 mg/l target for the PdT at Appleton, and as an overall assessment of the water quality of the PdT River throughout the watershed. The primary impacts of turbidity are from chronic, long term conditions across the watershed. This use of a singe site is really only helpful in identifying *a point* in the PdT watershed showing a somewhat higher *natural* TSS concentration. I believe the PdT Watershed Assn. Consider all available summer TSS data, weighted appropriately, from throughout the watershed, to establish site specific standards corresponding to the *natural changes* in underlying geology of the river.

#3) Activities of the Implementation

I see that most of the implementation activities proposed are geared toward agriculture. I understand that the inclusion of these activities in the report will increase the likelihood that they will be included in the implementation plan, which will allow producers access to cost share funds for these practices. However, I would like to point out that most of these practices have been largely adopted or implemented throughout the watershed. Are there other areas that need targeting like urban runoff diversion, rain gardens and other practices that may mitigate the impact of impervious surfaces. Are we throwing more money into a hole we have little ability to fix? One of the items suggested for implementation is to increase wetlands. Wetlands are the factory for methyl mercury which, by law, would be an increase in water impairment.

#4) Rural landscape contributions

I farm along the PdT River and I see a lot of naturally occuring soilbank erosion, so when I see on page 22 there is a statement which reads "the mechanisms for soil loss from agricultural sources and the factors that affect this have been extensively studied over the decades and are well understood.", I think w*hat are the references used to arrive at his statement?* Most available soil loss models are based upon the Universal Soil Loss Equation or a derivative, but research shows that these models don't provide an adequate framework for managing land and water resources (Emperical Models Based on the Universal Soil Loss Equation Fail to Predict Sediment Discharges from Chesapeake Bay Catchments- Bloomer, Weller and Jordan- Journal of Environmental Quality, Volume 37, January-February 2008). I am concerned that the lack of uncertainty in identification of specific contributing practices will result in wasted resources. I strongly encourage the PdT Watershed Association to seek the input of growers in understanding and addressing agricultural land uses.

#5) Public Participation

The PdT Watershed Association has done a great job of communicating with the public in development of the PdT Turbidity TMDL. However, the MPCA endorsed approach of limiting participation in technical review continues to hinder the process. I along with another another gentleman signed up to be on the technical review committee, but were not included in the process. Several of the items pointed out earlier in my comments above should have been discussed prior to completion of the draft report. It is worth noting that the technical committee met quarterly (page 39), yet minutes from only one technical committee meeting (March 6, 2009) are included in the report. The MPCA has failed to follow the intent of the Clean Water Legacy Act, "The agency shall seek broad and early public and stakeholder participation in scoping the activities necessary to develop a TMDL, including scientific models, methods, and approaches to be used in TMDL development"- MN Statute 114D.35, subdivision 1. Lack of stakeholder participation on the technical committee has really bothered me with this TMDL, I feel the results in the report are more of opinions than sound science.

Please consider these issues as we proceed with this TMDL process.
Thank you for your time,

Larry Mahoney
1910 50th St NW
Appleton, MN 56208
320.394.2121
detroitdiesel56208@yahoo.com

May 20, 2011

Mr. Larry Mahoney
1910 50th Street Northwest
Appleton, MN 56208

RE: Pomme de Terre River Turbidity Total Maximum Daily Load Assessment Comment Letter Response

Dear Mr. Mahoney:

The purpose of this letter is to acknowledge your e-mail of December 13, 2010, withdrawing the contested case hearing and public meeting requests on the draft "Turbidity TMDL Assessment for the Pomme de Terre River". The Minnesota Pollution Control Agency (MPCA) believes that agreed-upon changes to the draft report address your major concerns, and the MPCA plans to proceed with submittal of this draft report to the U.S. Environmental Protection Agency. The MPCA also felt it important to respond to your comment letter of March 25, 2010, although it is not proposing additional changes based on that letter. Your comments and our responses are shown below.

Comment 1: **The Characterization of the Watershed** The entire PdT River Watershed is labeled to be represented in summary tables 4.1, 4.2, and 4.3. USEPA Storet data is available for several locations upstream from S000-195. Analysis of all available sites shows that the Total Suspended Solids (TSS) levels are associated with natural geologic conditions, specifically soil type. The north end of the PdT River begins flowing through an area of predominantly coarse textured soils, moving to finer textures along the way. TSS levels do gradually increase downstream. The report acknowledges this, "South of this point Morris, flowing through southern Stevens and eastern Swift Counties, the River is bordered by eroding, muddy banks becoming increasingly turbid before discharging into the Minnesota River at Marsh Lake." (page 9). What bothers me is that it seems to be an established approach by the MPCA to focus on land use, particularly agriculture. I suggest that the PdT Watershed Association use this report to help MPCA understand the geologic settings and conditions contributing to TSS loading.

Response: The MPCA acknowledges that studies such as this one may not always fully describe the relative influence of natural geologic influences versus urban and agricultural land use influences. As the understanding of this increases, the Agency will improve these descriptions in the future.

Comment 2: **The trends in TSS levels** Pages 14 and 15 notes that sample frequency increased since 2004, but neglects to mention that the sampling schedule also was changed to exclude non-summer sampling entirely, while gathering additional summer samples. It causes the long term chart (Fig. 4.1) to be of little value as I would expect summer values to be higher than winter values regardless of impacts. Since winter samples are no longer taken, the correct procedure is to look back into the data and pull out only summer TSS values in all years. I would also note that in 2008 there were 9 samples submitted in May, June had 7, and then 3 per month from the period of July through October. This precludes the development of a proper long term average. I recognize that the MPCA requires the current standard to be applied at each river reach, but this TMDL is written with multiple broad reference to the entire watershed. There are numerous other monitoring data available located upstream from Appleton which are not referenced in the report. WHY NOT? The MPCA report "Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecorgions" provides us with evidence that minimally impacted streams in this region would exhibit TSS ranging from near zero to nearly 500 mg/l, with a median summer value near 55. This should be considered in both the specific application of the 52 mg/l target for the PdT at Appleton, and as an overall assessment of the water quality of the PdT River throughout the watershed. The primary impacts of turbidity are form chronic, long term conditions across the watershed. This use of a single site is really only helpful in identifying *a point* in the PdT watershed showing a somewhat higher *natural* TSS concentration. I believe the PdT Watershed Assn. Consider all available summer TSS data, weighted appropriately, from throughout the watershed, to establish site specific standards corresponding to the *natural changes* in underlying geology of the river.

Response: The decision to list the lower portion of the Pomme de Terre River as impaired due to violations of the turbidity standard was made in 2002. The purpose of the data analysis and reporting in this TMDL report is to provide a general check on the status of this specific impairment since 2002, and to give a general sense of the severity of the impairment. The MPCA staff believes that the data analysis and reporting was appropriate in this regard. You correctly point out that additional analyses or approaches to analysis could have been carried out. While this might have further enhanced our understanding of the overall watershed, it was deemed out of scope for a project focusing on a single impaired river reach – the lower Pomme de Terre.

Comment 3: **<u>Activities of the Implementation</u>** I see that most of the implementation activities proposed are geared toward agriculture. I understand that the inclusion of these activities in the report will increase the likelihood that they will be included in the implementation plan, which will allow producers access to cost share funds for these practices. However, I would like to point out that most of these practices have been largely adopted or implemented throughout the watershed. Are there other areas that need targeting like urban runoff diversion, rain gardens and other practices that may mitigate the impact of impervious surfaces. Are we throwing more money into a hole we have little ability to fix? One of the items suggested for implementation is to increase wetlands. Wetlands are the factory for methyl mercury which, by law, would be an increase in water impairment.

Response: The MPCA believes that the implementation plan discussion that will occur following approval of the TMDL, can and will cover a broad range of potential practices on both urban and agricultural lands. The targeting and effectiveness of practices should be part of the discussion. The MPCA has no interest in seeing public or private money spent ineffectually.

Comment 4: **<u>Rural landscape contributions</u>** I farm along the PdT River and I see a lot of naturally occurring soilbank erosion, so when I see on page 22 there is a statement which reads "the mechanisms for soil loss from agricultural sources and the factors that affect this have been extensively studied over the decades and are well understood.", I think *what are the references used to arrive at this statement?* Most available soil loss models are based upon the Universal Soil Loss Equation or a derivative, but research shows that these models don't provide an adequate framework for managing land and water resources (Empirical Models Based on the Universal Soil Loss Equation Fail to predict Sediment Discharges from Chesapeake Bay Catchments – Bloomer, Weller and Jordan – Journal of Environmental Quality, Volume 37, January-February 2008). I am concerned that the lack of uncertainty in identification of specific contributing practices will result in wasted resources. I strongly encourage the PdT Watershed Association to seek the input of growers in understanding and addressing agricultural land uses.

Response: This comment was specifically addressed during the contested case discussions. The statement you reference was removed.

Comment 5: **Public Participation** The PdT Watershed Association has done a great job of communicating with the public in development of the PdT Turbidity TMDL. However, the MPCA endorsed approach of limiting participation in technical review continues to hinder the process. I along with another gentleman signed up to be on the technical review committee, but were not included in the process. Several of the items pointed out earlier in my comments above should have been discussed prior to completion of the draft report. It is worth noting that the technical committee met quarterly (page 39), yet minutes from only one technical committee meeting (March 6, 2009) are included in the report. The MPCA has failed to follow the intent of the Clean Water Legacy Act, "The agency shall seek broad and early public and stakeholder participation in scoping the activities necessary to develop a TMDL, including scientific models, methods, and approaches to be used in TMDL development" – MN Statute 114D.35, subdivision 1. Lack of stakeholder participation on the technical committee has really bothered me with the TMDL, I feel the results in the report are more of opinions than sound science.

Response: While it came late in the process, the MPCA believes that the discussion to resolve the contested case hearing request was productive. The MPCA hopes to build upon this to improve public participation in the future.

Sincerely,

Katherine Pekarek-Scott
Pollution Control Specialist
Marshall Office
Regional Division

KPS:bjw

cc: Randy Hukriede, MPCA
Bob Finley, MPCA
Lee Ganske, MPCA
File Copy

Questions and Comments should be addressed to:

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MINNESOTA CORN GROWERS ASSOCIATION
738 1st Avenue East • Shakopee, MN 55379 • (952) 233-0333 • Fax (952) 233-0420 • www.mncorn.org

March 29, 2010

Katherine Pekarek-Scott
Minnesota Pollution Control Agency
1420 East College Drive
Marshall, MN 56258

Dear Ms. Pekarek-Scott:

The Minnesota Corn Growers Association's (MCGA) appreciates this opportunity to comment on behalf of nearly 6,000 farmer members on the draft Turbidity TMDL Assessment for the Pomme de Terre River (PdT). Minnesota farmers are active clean water advocates, eager to engage in a productive discussion at every level from the determination of designated uses and standards to the identification of pollution sources and restoration activities.

Issue #1- Characterization of Pomme de Terre Watershed

The summary tables 4.1, 4.2 and 4.3 are labeled as representing the entire PdT River Watershed. USEPA Storet data is available for several other locations upstream from site S000-195. Analysis of all available sites shows that Total Suspended Solids (TSS) levels are associated with natural geologic conditions, specifically soil type. The PdT River begins flowing through an area consisting of predominantly coarse textured soils, then moves into an area of finer textured soils. Along the way, TSS levels gradually increase. The report acknowledges this,

> "South of this point (Morris), flowing through southern Stevens and eastern Swift Counties, the River is bordered by eroding, muddy banks becoming increasingly turbid before discharging into the Minnesota River at Marsh Lake." (page 9)

yet continues the established MPCA approach of focusing on land use, particularly agriculture. We suggest that the PdT Watershed Association use this report to help MPCA understand the geologic setting and conditions contributing to TSS loading.

Issue #2- Trends in TSS levels

The discussion on pages 14 and 15 notes that more frequent samples have been taken since 2004, but neglects to mention that the sampling schedule also was changed to exclude non-summer sampling

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To promote opportunities for the profitability of corn farmers while enhancing quality of life.

entirely, while gathering additional summer samples. Thus the long term chart (Figure 4.1) is of little value, as one would typically expect summer values to be higher than winter values regardless of impacts. Given that winter samples are no longer taken, the only adjustment possible is to look back into the data and pull out only summer TSS values in all years. We would also note that in 2008 there were 9 samples submitted in May, 7 in June, then 3 per month from July through October. This precludes the development of a proper long term average. Also, while we recognize that MPCA requires the current standard to be applied at each river reach, this TMDL is written with multiple broad references to the entire watershed. Monitoring data is available for numerous other locations upstream from Appleton, but is not referenced in the report. The MPCA report "Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions" provides evidence that minimally impacted streams in this region would exhibit TSS ranging from near zero to nearly 500 mg/l, with a median summer value near 55. This should be considered in both the specific application of the 52 mg/l target for the PdT River at Appleton, and also as an overall assessment of the water quality of the PdT River throughout the watershed. The primary impacts of turbidity are from chronic, long term conditions across the watershed. The use of a single site has likely been helpful only in identifying a point in the PdT River exhibiting somewhat higher natural TSS concentrations. We suggest that the PdT Watershed Association consider all available summer TSS data, weighted appropriately, from throughout the watershed, to establish site specific standards corresponding to the natural changes in underlying geology of the river.

Issue #3- Implementation Activities

The PdT Turbidity TMDL proposes numerous implementation activities, most of which are applicable to agriculture. We appreciate that the inclusion of these practices in the report increases the likelihood that they will be included in the subsequent implementation plan, and that their inclusion in the implementation plan may allow producers access to cost share funding for these practices. However, we would point out that most of the practices have already been largely adopted or implemented throughout the watershed. Further, the lack of implementation practices targeted toward other areas may send the message that these other areas are not worthy of improving and limits the ability of the watershed to provide funding for efforts like urban runoff diversion, rain gardens and other practices which may mitigate the impacts of impervious surfaces. We encourage the PdT Watershed Association to actively solicit input during development of the implementation plan to identify such practices.

Issue #4- Rural landscape contributions

What references were used to arrive at the following statement?

"the mechanisms for soil loss from agricultural sources and the factors that affect this have been extensively studied over the decades and are well understood." (page 22)

Most available soil loss models are built upon the Universal Soil Loss Equation or a derivative, but research shows that these models do not provide an adequate framework for managing land and water resources (Empirical Models Based on the Universal Soil Loss Equation Fail to Predict Sediment Discharges from Chesapeake Bay Catchments- Bloomer, Weller and Jordan- Journal of Environmental Quality, Volume 37, January–February 2008). We are concerned that the lack of uncertainty in identification of specific contributing areas in the landscape, coupled with a limited understanding of cause and effect relationships between various practices will result in wasted resources. We encourage the PdT Watershed Association to actively seek the input of resource managers (primarily farmers) in understanding and addressing agricultural land uses.

Issue #5- Public Participation

The PdT Watershed Association is to be commended for their overall efforts in communicating with the public in development of the PdT Turbidity TMDL. However, the MPCA –endorsed approach of limiting participation in technical review continues to hinder the process. Several of the issues pointed out in previous comments should have been discussed prior to completion of the draft report. In addition, we would note that the technical committee met quarterly (page 39), yet minutes from only one technical committee meeting (March 6, 2009) are included in the report. The MPCA has failed to follow the intent of the Clean Water Legacy Act, "The agency shall seek broad and early public and stakeholder participation in scoping the activities necessary to develop a TMDL, including the scientific models, methods, and approaches to be used in TMDL development"(Minn. Stat. 114D.35, subdivision 1).

Thank you for the opportunity to provide comments. Please feel free to contact the MCGA office for further discussion.

Best regards,

DeVonna Zeug

DeVonna Zeug, President
Minnesota Corn Growers Association

May 20, 2011

Ms. DeVonna Zeug
Minnesota Corn Growers Association
738 First Avenue East
Shakopee, MN 55379

RE: Pomme de Terre River Turbidity Total Maximum Daily Load Assessment Comment Letter Response

Dear Ms. DeVonna Zeug:

The purpose of this letter is to respond to your March 29, 2010, comment letter on the draft "Turbidity TMDL Assessment for the Pomme de Terre River". Following your comment letter, and a nearly identical one from Mr. Larry Mahoney, the Minnesota Pollution Control Agency (MPCA) received a request for a contested case hearing and public meeting from Mr. Mahoney. This led to a series of discussions and meetings with Mr. Mahoney, Warren Formo of the Minnesota Agricultural Water Resources Coalition, and others. These discussions, and agreed-upon changes to the draft report, led to a withdrawal of the contested case hearing and public information request. The MPCA believes that agreed-upon changes to the draft report address the major concerns expressed by the Corn Growers and Mr. Mahoney, and is not proposing additional changes based on your comment letter. At this time, the MPCA plans to proceed with submittal of this draft report to the U.S. Environmental Protection Agency (EPA). Your comments and our responses are shown below.

Comment 1: Characterization of Pomme de Terre Watershed. The summary tables 4.1, 4.2 and 4.3 are labeled as representing the entire PdT River Watershed. The USEPA Storet data is available for several other locations upstream from site S000-193. Analysis of all available sites shows that Total Suspended Solids (TSS) levels are associated with natural geologic conditions, specifically soil type. The PdT River begins flowing through an area consisting of predominantly coarse textured soils, then moves into an area of finer textured soils. Along the way, TSS levels gradually increase. The report acknowledges this:

> "South of this point (Morris), flowing through southern Stevens and eastern Swift Counties, the River is bordered by eroding, muddy banks becoming increasingly turbid before discharging into the Minnesota River at Marsh Lake." (page 9)

Yet continue the established MPCA approach of focusing on land use, particularly agriculture. We suggest that the PdT Watershed Association use this report to help MPCA understand the geologic setting and conditions contributing to TSS loading.

Response: The MPCA acknowledges that studies such as this one may not always fully describe the relative influence of natural geologic influences versus urban and agricultural land use influences. As our understanding of this increases, the MPCA will improve these descriptions in the future.

Comments 2: Trends in TSS levels. The discussion on pages 14 and 15 notes that more frequent samples have been taken since 2004, but neglects to mention that the sampling schedule also was changed to exclude non-summer sampling entirely, while gathering additional summer samples. Thus the long term chart (Figure 4.1) is of little value, as one would typically expect summer values to be higher than winter values regardless of impacts. Given that winter samples are no longer taken the only adjustment possible is to look back into the data and pull out only summer TSS values in all years. We would also note that in 2008 there were 9 samples submitted in May, 7 in June, and 3 per month from July through October. This precludes the development of a proper long term average. Also, while we recognize that MPCA requires the current standard to be applied at each river reach, this TMDL is written with multiple broad references to the entire watershed. Monitoring data is available for numerous other locations upstream from Appleton, but is not referenced in the report. The MPCA report "Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoregions" provides evidence that minimally impacted streams in this region would exhibit TSS ranging from near zero to nearly 500 mg/l, with a median summer value near 55. This should be considered in both the specific application of the 52 mg/l target for the PdT River at Appleton, and also as an overall assessment of the water quality of the PdT River throughout the watershed. The primary impacts of turbidity are from chronic, long term conditions across the watershed. The use of a single site has likely been helpful only in identifying a point in the PdT River exhibiting somewhat higher natural TSS concentrations. We suggest that the PdT Watershed Association consider all available summer TSS data, weighted appropriately, from throughout the watershed, to establish site specific standards corresponding to the natural changes in underlying geology of the river.

Response: The decision to list the lower portion of the Pomme de Terre River as impaired due to violations of the turbidity standard was made in 2002. The purpose of the data analysis and reporting in this TMDL report is to provide a general check on the status of this specific impairment since 2002, and to give a general sense of the severity of the impairment. The MPCA believes that the data analysis and reporting was appropriate in this regard. You correctly point out that additional analyses or approaches to analysis could have been carried out. While this might have further enhanced the MPCA's understanding of the overall watershed, it was deemed out of scope for a project focusing on a single impaired river reach – the lower Pomme de Terre.

Comment 3: Implementation Activities. The PdT Turbidity TMDL proposes numerous implementation activities, most of which are applicable to agriculture. We appreciate that the inclusion of these practices in the report increases the likelihood that they will be included in the subsequent implementation plan, and that their inclusion in the implementation plan may allow producers access to cost share funding for these practices. However, we would point out that most of the practices have already been largely adopted or implemented throughout the watershed. Further, the lack of implementation practices targeted toward other areas may send the message that these other areas are not worthy of improving and limits the ability of the watershed to provide funding for efforts like urban runoff diversion, rain gardens and other practices which may mitigate the impacts of impervious surfaces. We encourage the PdT Watershed Association to actively solicit input during development of the implementation plan to identify such practices.

Response: The MPCA believes that the implementation plan discussion that will occur following approval of the TMDL, can and will cover a broad range of potential practices on both urban and agricultural lands. The targeting and effectiveness of practices should be part of the discussion. The MPCA has no interest in seeing public or private money spent ineffectually.

Comment 4: Rural landscape contributions. What references were used to arrive at the following statement?

> "the mechanisms for soil loss from agricultural sources and the factors that affect this have been extensively studied over the decades and are well understood." (page 22)

Most available soil loss models are built upon the Universal Soil Loss Equation or a derivative, but research show that these models do not provide an adequate framework for managing land and water resources (Empirical Models Based on the Universal Soil Loss Equation Fail to Predict Sediment Discharges from Chesapeake Bay Catchments-Bloomer, Weller and Jordan-Journal of Environmental Quality, Volume 37, January-February 2008). We are concerned that the lack of uncertainty in identification of specific contributing areas in the landscape, coupled with a limited understanding of cause and effect relationships between various practices will result in wasted resources. We encourage the PdT Watershed Association to actively seek the input of resource managers (primarily farmers) in understanding and addressing agricultural land uses.

Response: This comment was specifically addressed during the contested case discussions. The statement you reference was removed.

Comment 5: Public Participation. The PdT Watershed Association is to be commended for their overall efforts in communicating with the public in development of the PdT Turbidity TMDL. However, the MPCA endorsed approach of limiting participation in technical review continues to hinder the process. Several of the issued pointed out in previous comments should have been discussed prior to completion of the draft report. In addition, we would note that the technical committee me quarterly (page 39), yet minutes from only one technical committee meeting (March 6, 2009) are included in the report. The MPCA has failed to follow the intent of the Clean Water Legacy Act, "The agency shall seek broad and early public and stakeholder participation in scoping the activities necessary to develop a TMDL, including the scientific models, methods, and approaches to be used in TMDL development" (Minn. Stat. 114D.35, subdivision 1).

Response: While it came late in the process, the MPCA staff believes that the discussion to resolve the contested case hearing request was productive. The MPCA staff hopes to build upon this to improve public participation in the future.

Sincerely,

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KPS:bjw

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