Watershed

March 2019

Lower Red River of the North Watershed Total Maximum Daily Load Report

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

Authors and contributors:

Rachel Olm, Tim Erickson, and Mark Deutschman
Houston Engineering, Inc.
6901 East Fish Lake Road, Suite 140
Maple Grove, Minnesota 55369

Mr. Cary Hernandez and Ms. Danielle Kvasager
Minnesota Pollution Control Agency
714 Lake Avenue, Suite 220
Detroit Lakes, Minnesota 56501

Acknowledgements:

Mr. Dan Money
Two Rivers Watershed District
410 South 5th Street, Suite 112
Hallock, Minnesota 56728

Mr. Danny Omdahl
Middle-Snake-Tamarac Rivers Watershed District
453 North McKinley Street, PO Box 154
Warren, Minnesota 56762

Cover Photo Credit:

Minnesota Pollution Control Agency. Tamarac River at U.S. Highway 75 (August 14, 2014)

Document number: wq-iw5-15e

Contents

List of Tables

List of Figures

Acronyms

AUID	Assessment Unit Identifier
BMP	Best Management Practice
BWSR	Minnesota Board of Water and Soil Resources
CAFO	Concentrated Animal Feeding Operation
DEM	Digital Elevation Model
DNR	Minnesota Department of Natural Resources
EDA	Environmental Data Access
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information System
ft	feet
GIS	Geographic information system
gpd	gallons per day
HSPF	Hydrological Simulation Program-FORTRAN
HUC	Hydrologic Unit Code
JRWD	Joe River Watershed District
kg/day	kilograms per day
LA	Load Allocation
LAP	Lake Agassiz Plain
LDC	Load Duration Curve
LiDAR	Light Detection and Ranging
LRRW	Lower Red River (of the North) Watershed
m	meter
mgd	million gallons per day
mg/L	milligrams per liter
mL	milliliter
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer Systems
MSTRWD	Middle-Snake-Tamarac Rivers Watershed District
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
SSTS	Subsurface Sewage Treatment Systems
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TRWD	Two Rivers Watershed District
TSS	Total Suspended Solids
USGS	United States Geological Survey
WLA	Wasteload Allocation
WMP	Watershed management plan
WRAPS	Watershed Restoration and Protection Strategy
WWTF	Wastewater Treatment Facility

Executive Summary

The Clean Water Act (1972) requires that each state identify impaired waters and develop a Total Maximum Daily Load (TMDL) study for each of them. In Minnesota, the Minnesota Pollution Control Agency (MPCA) is tasked with assessing and listing waterbodies that do not meet water quality standards (Minn. R. 7050.0220), and developing TMDLs for them. A TMDL estimates how much pollutant can enter a waterbody and still meet the water quality standards, identifies the pollutant sources causing the impairment, and allocates pollutant load reductions to those sources.

The Lower Red River of the North Watershed (LRRW)[1] (Hydrologic Unit Code [HUC] 09020311) is located in the far northwestern portion of Minnesota in portions of Kittson, Marshall, and Roseau Counties. Land use within the LRRW is predominantly agricultural, comprising 80% of the landscape. The focus of this report will be on the tributaries within the LRRW, which flow to the main channel of the Red River of the North (Red River).

The MPCA lists six LRRW waterbodies (all of which are streams) on the draft 2018, 303(d) list as having impaired water quality (i.e., not meeting the standards that have been set for them) and needing a TMDL study. These waterbodies contained a total of 13 impairment listings. Eleven of these impairments are not addressed in this TMDL report, because either they are located on the mainstem of the Red River (n=7; these will be addressed in a separate TMDL report for the Red River), or because more information is needed (n=4). The remaining two listed impairments (1 caused by a poor aquatic macroinvertebrate community and the other caused by a poor fish community) on the same reach are addressed in this TMDL report using one total suspended solids (TSS) TMDL study. Although not yet listed as of the draft 2018, 303(d) list, one additional impairment will also be addressed in this TMDL report, based on data that indicates an impairment caused by TSS.

Information from multiple sources was used to evaluate the potential sources of pollutants and ultimate health of each waterbody, including (but not limited to): stressor identification (SID) studies, Hydrological Simulation Program – FORTRAN (HSPF) modeling, analysis of the available water quality data for the last 10 years, and Geographic Information System (GIS) analysis. The following pollutant sources were evaluated for each waterbody: watershed runoff; loading from upstream sources, point sources, feedlots, septic systems, wildlife and other natural sources; and hydrologic alterations. Load duration curves (LDCs) for each impaired stream reach were also used to determine the pollutant reduction needed to meet current water quality standards.

The findings in this TMDL report were used to guide the development of implementation strategies as part of the Lower Red River Watershed Restoration and Protection Strategy (WRAPS) process. The purpose of the WRAPS report is to support local working groups and jointly develop scientifically-supported restoration and protection strategies, to be used in local water planning efforts. These implementation strategies are intended to meet the TMDL goals outlined in this document. The WRAPS report, as well as other technical reports referenced in this document, are publically available on the MPCA's LRRW website: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/red-river-of-the-north-tamarac-river.html

[1] Also known as the Red River of the North – Tamarac River Watershed

1. Project Overview

1.1 Purpose

The LRRW[2] (HUC 09020311) is situated in the far northwestern portion of Minnesota. The entirety of HUC 09020311 spans 2,453 square miles within Minnesota, North Dakota, and Manitoba (Canada) (HEI 2013). However, only the area within Minnesota is addressed in this report, herein referred to as the LRRW (**Figure 1-1**). The LRRW has a drainage area of approximately 886 square miles within portions of Kittson, Marshall, and Roseau Counties (MPCA 2015a). As the LRRW is part of the greater Red River of the North (Red River) Basin, it encompasses a portion of the Red River.

The LRRW is located entirely within the Lake Agassiz Plain (LAP) ecoregion (HEI 2013). Land use is predominantly agricultural. Municipalities within the LRRW include Donaldson, Halma, Humboldt, Karlstad, Kennedy, Saint Vincent, Stephen, and Strandquist (MPCA 2015a). There are no permitted Municipal Separate Storm Sewer Systems (MS4s) in the LRRW. The LRRW spans three existing watershed districts, including the entire Joe River Watershed District (JRWD) to the north, the southwest portion of the Two Rivers Watershed District (TRWD) in the center, and the northern (Tamarac River) portion of the Middle-Snake-Tamarac Rivers Watershed District (MSTRWD) to the south (**Figure 1-2**).

The MPCA lists 13 impairments among 6 waterbodies (all of which are streams) on the draft 2018, 303(d) list as having impaired water quality (i.e., not meeting the standards that have been set for them) in the LRRW and needing a TMDL. Eleven of these impairments are not addressed in this TMDL report, because either they are located on the mainstem of the Red River (n=7; these will be addressed in a separate TMDL report for the Red River), or because more information is needed (n=4). See **Section 1.2** for further specifics on deferments. The remaining two listed impairments (1 caused by a poor aquatic macroinvertebrate community and the other caused by a poor fish community) on the same stream reach are addressed in this TMDL report. High suspended solids was identified as a stressor causing the poor aquatic macroinvertebrate and fish communities in the waterbody; data indicates that this biologically-impaired reach is prone to high suspended sediment (MPCA 2015a). Thus, a TSS TMDL has been calculated as a surrogate to address these biological impairments. Although not yet listed as of the draft 2018 303(d) list, one additional impairment is addressed in this TMDL report, based on data that supports a TSS-caused impairment.

A TMDL is defined as the maximum quantity of a pollutant that a waterbody can receive while meeting the (numeric) water quality standard for beneficial uses. The TMDL study apportions the maximum load between point sources (i.e., a wasteload allocation [WLA] to sources, which are authorized by a permit under the Clean Water Act), nonpoint sources (i.e., load allocation [LA]) and a margin a safety (MOS). The MOS is a portion of the loading capacity reserved to account for uncertainty.

In 2006, Minnesota passed the Clean Water Legacy Act (CWLA), in part, to protect, restore, and preserve the quality of Minnesota's surface waters. As a result, the MPCA established a watershed approach to developing TMDLs and WRAPS to help restore and protect Minnesota's waters. This report is intended to fulfill the TMDL requirement.

[2] Also known as the Red River of the North – Tamarac River Watershed.

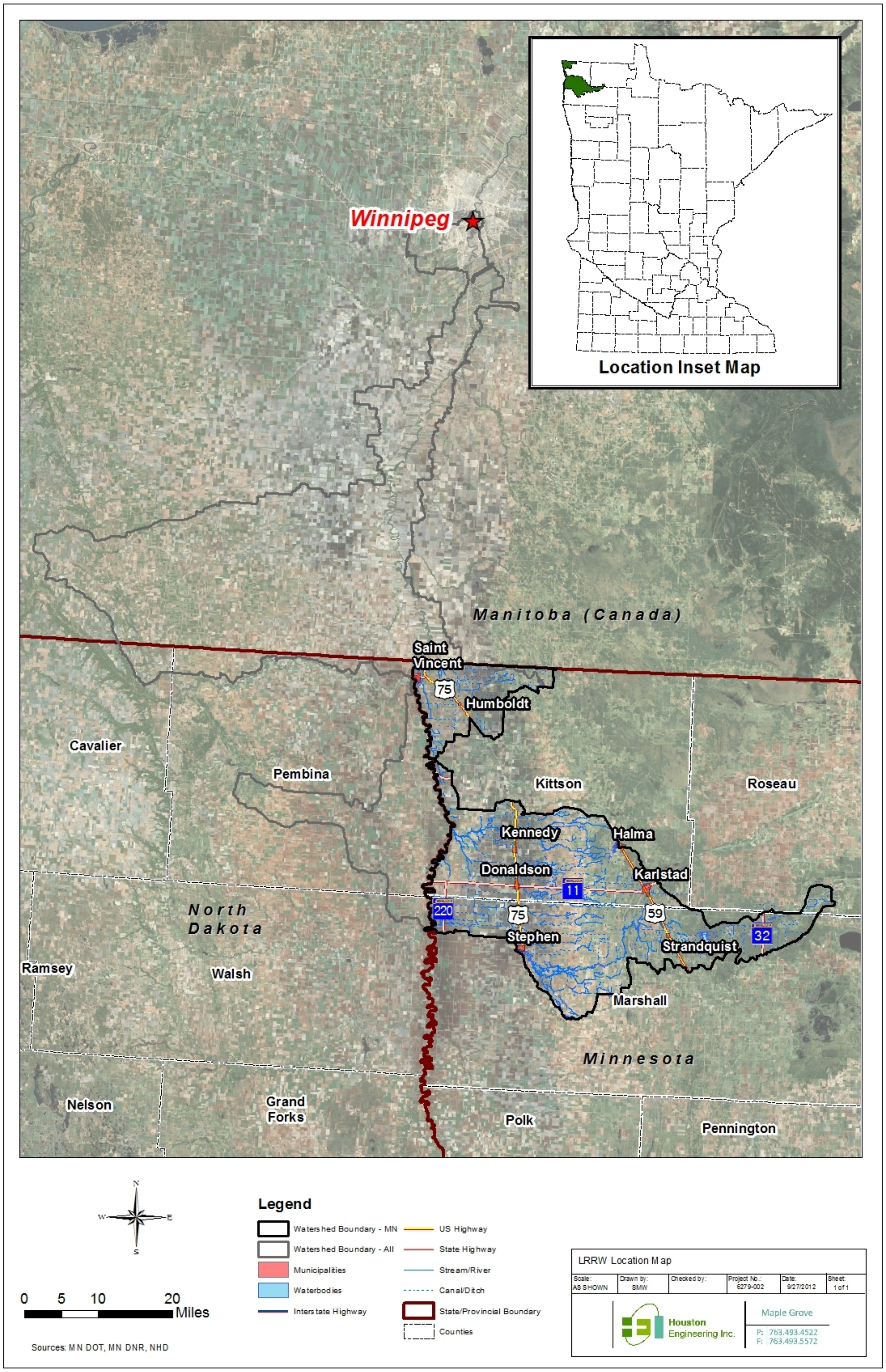

Figure 1-1: Location of LRRW within northwestern Minnesota.

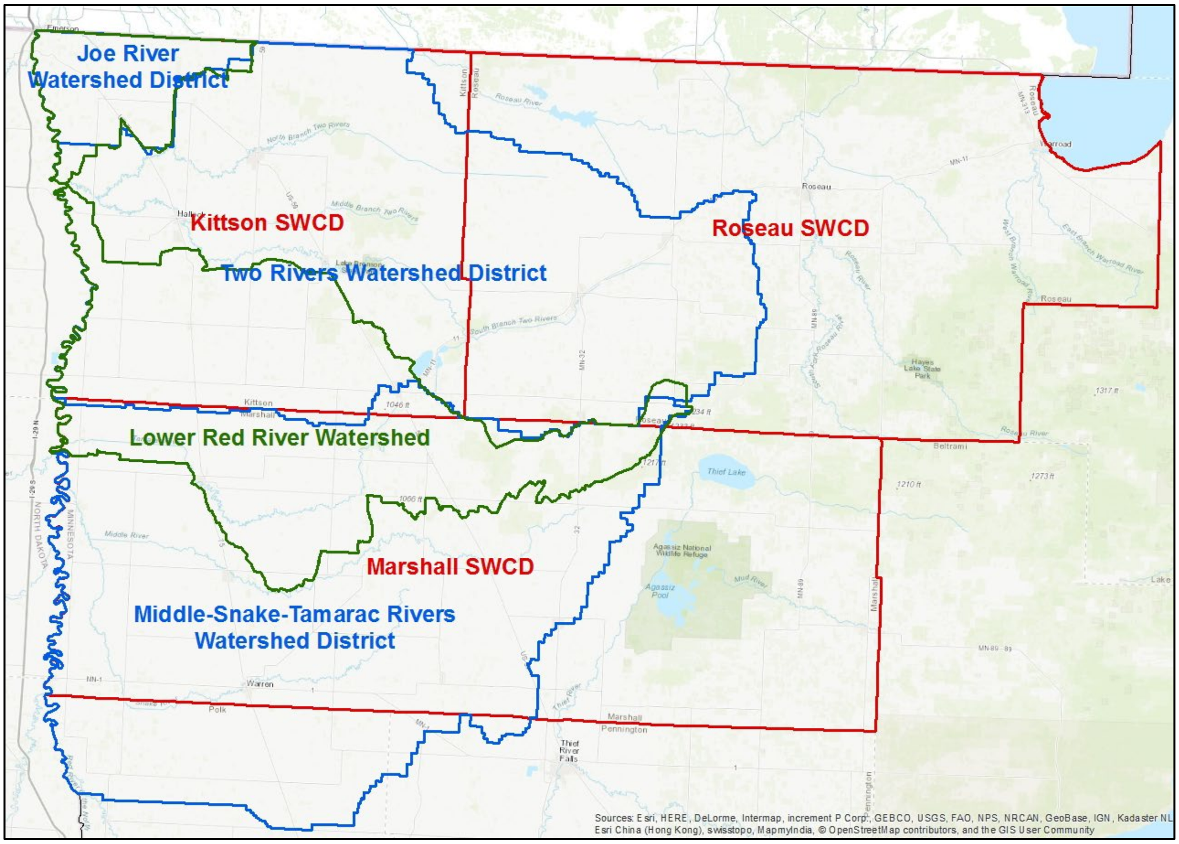

Figure 1-2: Administrative boundaries of SWCDs and watershed districts in relation to the boundary of the LRRW.

1.2 Identification of Waterbodies

Thirteen impairments on six waterbodies (all of which are streams) in the LRRW are listed on the draft 2018, 303(d) list. This report contains two TSS TMDLs to address three impairments in two stream reaches in the LRRW (**Table 1.1**; **Figure 1-3**). Two of the three impairments are on the draft 2018, 303(d) list (the ones caused by poor aquatic macroinvertebrate and fish communities in the same stream reach), while the third is not yet on the 303(d) list, but is addressed with a TSS TMDL in this report, based on data that indicates a TSS impairment. A TSS TMDL is used as a surrogate to address the two biological impairments on Assessment Unit Identifier (AUID) 09020311-503; high suspended sediment was identified as a stressor to the biological communities and the LRRW HSPF model estimates that TSS exceeds the water quality standard between 1% and 22% of the time on this AUID from 1996 to 2009. Additionally, the discrete TSS data (2002 through 2010; *n*=69) for the reach had a range of 3 to 69 mg/L. This data indicates that the reach is prone to high suspended sediment (MPCA 2015a).

Eleven impairments on five waterbodies in the LRRW are not addressed in this report. Though not listed in **Table 1.1**, seven impairments are located on two AUIDs that are part of the Red River mainstem, and those will be addressed in a TMDL report for the Red River. The remaining four impairments are on three AUIDs that are tributaries to the Red River: The *Escherichia coli* (*E. coli*) impairment is being deferred due to lack of observed and simulated flow data during the years when *E. coli* exceeded standards; the impairments for pH and chloride are being deferred pending more data to determine the most appropriate United States Environmental Protection Agency (EPA) category (pH was found to meet standards in 2011 and more data may support delisting and/or more data may show that the high pH and chloride are due to natural conditions) and; the chlorpyrifos (a pesticide) impairment will be addressed by the Minnesota Department of Agriculture and the MPCA by 2025, as estimated in the draft 2018, 303(d) list.

Table 1.1: Lower Red River Watershed impairments on the draft 2018 303(d) list and/or addressed in this TMDL report.

Assessment Unit ID[a]	Waterbody	Pollutant	Beneficial Use	Year Listed	TMDL target completion year	Addressed in this TMDL?
09020311-503	Tamarac River: Florian Park Reservoir to Stephen Dam	Macroinvertebrate Bioassessments[b]	Aquatic Life	2012	2018	Yes (TSS)
		Fish Bioassessments[b]	Aquatic Life	2002	2018	
09020311-505	Tamarac River: Stephen Dam to Red R	Chlorpyrifos	Aquatic Life	2014	2025	No
		Turbidity[c]	Aquatic Life	N/A	N/A	Yes (TSS)
09020311-513	Joe River: Salt Coulee to MN/Canada border	Chloride	Aquatic Life	2006	2022	No
		pH	Aquatic Life	2006	2022	No
09020311-516	Judicial Ditch 19: Headwaters to Tamarac R	*E. coli*	Aquatic Recreation	2012	2018	No

[a] Seven 303(d) impairments on the mainstem of the Red River are not listed in this table.
[b] Biological impairments are addressed using a TSS TMDL as a surrogate.
[c] Although not listed as of the draft 2018 303(d) list, data indicates an impairment is present, so a TSS TMDL is included in this report.

1.3 Priority Ranking

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

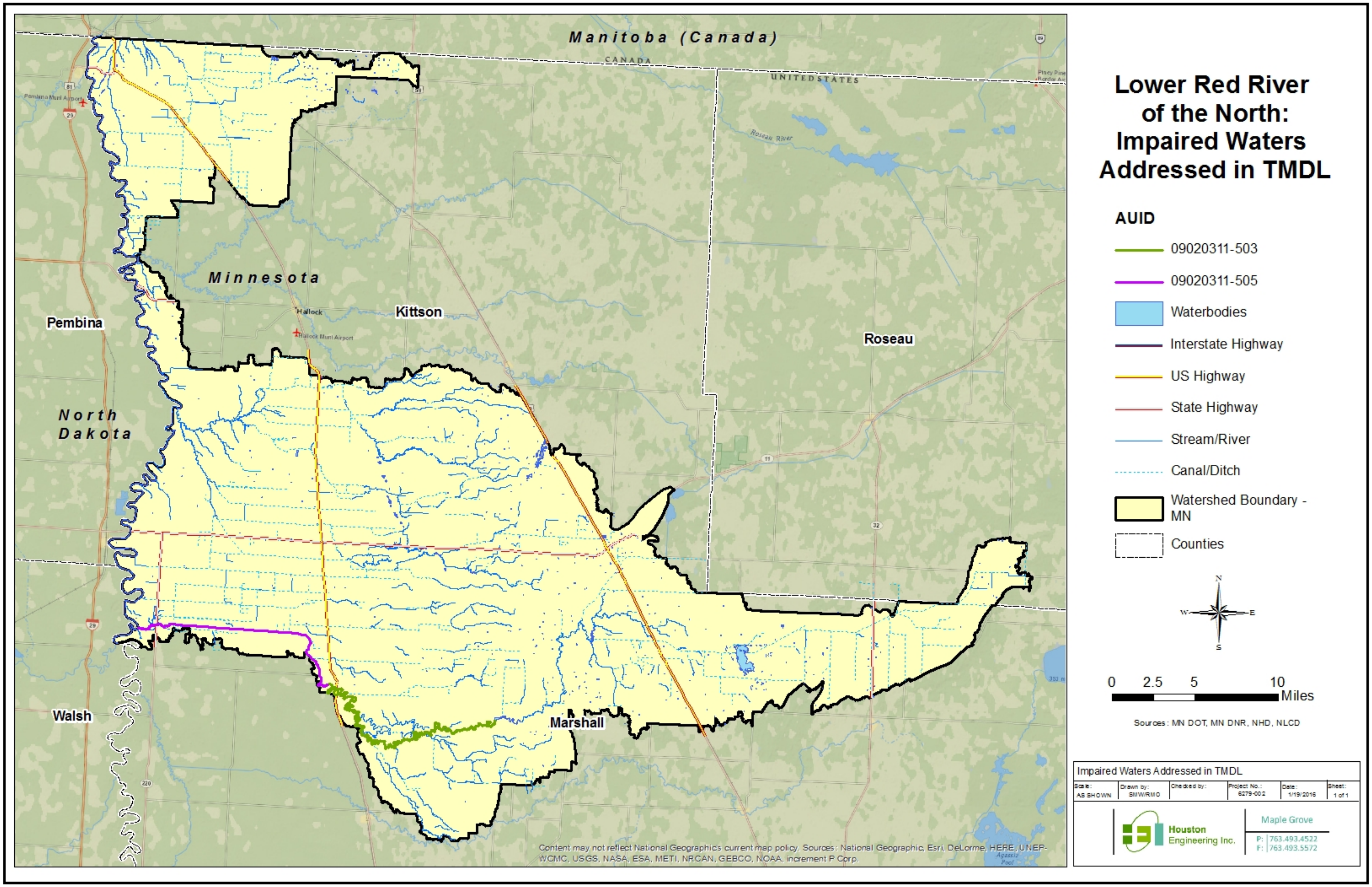

Figure 1-3: Impaired waters in the Lower Red River Watershed addressed in this TMDL report.

2. Applicable Water Quality Standards and Numeric Water Quality Targets

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. Use attainment status describes whether or not a waterbody is supporting its designated beneficial use as evaluated by the comparison of monitoring data to criteria specified in the *Minnesota Water Quality Standards* (Minn. R. ch. 7050 [2008][3]). These standards can be numeric or narrative in nature and define the concentrations in or conditions of surface waters that allow them to meet their designated beneficial uses, such as use by aquatic, biological communities (aquatic life use), use by humans for activities such as bathing, watercraft use, and swimming (aquatic recreation use), or human consumption of fish (aquatic consumption use). Impaired waters addressed in this TMDL report are classified as Class 2Bd or 2B waters (MPCA 2013).

> ***Class 2Bd waters -*** The quality of Class 2Bd 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 waters is also protected as a source of drinking water (Minn. R. 7050.0222, subp. 3).
>
> ***Class 2B waters*** - The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water (Minn. R. 7050.0222, subp. 4).

2.1 Lakes

The LRRW contains 38 lakes that are defined by the state of Minnesota (i.e., have a Minnesota Department of Natural Resources [DNR] lake number) (MPCA 2013). The sole TMDL that's applicable within the LRRW and has been approved by EPA is for an aquatic consumption impairment due to mercury in fish tissue in the Florian Park Reservoir (DNR lake number 45-0119-00). The impairment has been on the 305(b) list since 1998 (remains on the draft 2018 list), and the TMDL was approved by EPA on March 27, 2007 as part of the Minnesota Statewide Mercury TMDL (MPCA 2007). No lakes are currently listed on the 303(d) list.

The MPCA collected very little lake water chemistry data during the intensive watershed monitoring effort and no lakes were capable of being assessed during the MPCA's intensive watershed monitoring effort due to the LRRW's limited natural ability for water retention. For example, Secchi depth and TP data from 2008 and 2010 were available for Florian Park Reservoir (45-0119-00); however, residence time for this waterbody was estimated to be between 3 to 7 days, which does not meet the 14-day residence time requirement to be assessed as a lake (MPCA 2013). This limited natural ability for water retention may be attributed to the topography of the watershed, low abundance of wetlands, and the

[3] https://www.revisor.mn.gov/rules/?id=7050

presence of hydrologic class D, C/D, or C soil types consisting mainly of clay and silt that are characterized by low permeability and high runoff rates (MPCA 2013). There is no further discussion regarding lakes in this report.

2.2 Streams

The Minnesota narrative water quality standard for all Class 2 waters (Minn. R. 7050.0150, subp. 3) states that:

> *The aquatic habitat, which includes the waters of the state and stream bed, shall not be degraded in any material manner, there shall be no material increase in undesirable slime growths or aquatic plants, including algae, nor shall there be any significant increase in harmful pesticide or other residues in the waters, sediments, and aquatic flora and fauna; the normal fishery and lower aquatic biota upon which it is dependent and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of the fish and other biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste, or other wastes to the waters*.

Applicable TSS water quality standards for the LRRW stream impairments in this report are shown in **Table 2.1**, while **Table 1.1** shows the specific water bodies affected.

Table 2.1: Surface water quality standards for LRRW stream reaches addressed in this report.

Parameter	Water Quality Standard	Units	Criteria	Period of Time Standard Applies
Total suspended solids (TSS)-Southern Nutrient Region	Not to exceed 65	mg/L	Upper 10th percentile	April 1 – September 30

In January of 2015, the EPA issued an approval of the adopted amendments to the State Water Quality Standards, replacing the historically-used turbidity standard with TSS standards. The TSS TMDL replaces the turbidity TMDL. Therefore, this TMDL report will address the biological impairments in AUID 09020311-503 and high suspended solids in AUID 09020311-505 in the LRRW with TSS TMDLs. See the MPCA's *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List* for details regarding how waters were/are assessed for conformance to the turbidity (MPCA 2014a) and TSS (MPCA 2016) standards.

TSS is a measurement of the weight of suspended mineral (i.e., soil particles) or organic (i.e., algae) sediment per volume of water (MPCA 2015a). The recently approved Minnesota State TSS standards are based upon nutrient regions, which are loosely based on ecoregions. The LRRW is located in the Southern Nutrient Region. The state TSS standard for this region is 65 mg/L (MPCA 2015a).

3. Watershed and Waterbody Characterization

The LRRW is situated in the far northwestern portion of Minnesota. The LRRW has a drainage area of approximately 886 square miles within portions of Kittson, Marshall, and Roseau Counties (MPCA 2015a). The Tamarac River is the prominent surface water feature in the LRRW and extends from its headwaters, situated northwest of Strandquist, to its confluence with the Red River, located west of Stephen (MPCA 2015a). The LRRW contains 140 miles of perennial stream and river, 355 miles of intermittent stream, 24 miles of perennial drainage ditch, and 471 miles of intermittent drainage ditch (MPCA 2015a). No part of the LRRW is located within tribal land areas.

Historically, land cover in the LRRW during European settlement times (mid-late 1800s) consisted almost entirely of prairies (**Figure 3-5**). Currently, approximately 80% of the land is in agricultural production, while approximately 5% of the land use is comprised of residential and commercial development (see **Figure 3-6**; **Table 3.2**). Municipalities within the LRRW include Donaldson, Halma, Humboldt, Karlstad, Kennedy, Saint Vincent, Stephen, and Strandquist (MPCA 2015a). There are no MS4s in the LRRW.

The LRRW is located entirely within the LAP Level III Ecoregion, as defined by the EPA (HEI 2013). The EPA defines an ecoregion as a relatively homogeneous ecological area characterized by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables. Since natural processes often vary by ecoregion, some water quality standards have taken these regions into account. A description of the LAP Level III Ecoregion is given as follows:

> "The Lake Agassiz Plain (LAP) was formed by Glacial Lake Agassiz, the last in a series of proglacial lakes to fill the Red River Valley in the three million years since the beginning of the Pleistocene. Thick beds of lake sediments on top of glacial till create the extremely flat floor of the Lake Agassiz Plain. The historic tall grass prairie has been replaced by intensive row crop agriculture. The preferred crops in the northern half of the region are potatoes, beans, sugar beets, and wheat; soybeans, sugar beets, and corn predominate in the south."

Much of the LAP has been surface drained for agricultural use. The drainage network in place today in the Red River Basin "has thousands of miles of principal drains and probably tens of thousands of miles of small laterals and on-farm channels." (Carlyle 1984). The Red River Valley is among the world's largest artificially drained landscapes.

More information about the physical characteristics of the LRRW can be found in the LRRW Biotic SID Report (MPCA 2015a), the LRRW Monitoring and Assessment Report (MPCA 2013), and/or the Lower Red River Watershed Conditions Report (HEI 2013).

3.1 Streams

The direct drainage areas, total contributing drainage areas, any noncontributing areas, and upstream waterbodies for impaired AUID numbered stream reaches with TMDL studies in this report are listed in **Table 3.1**. The direct drainage areas include only the areas draining to the impaired AUID, or the total drainage areas minus the noncontributing area. Direct drainages and total contributing drainage areas were delineated using hydrologically-conditioned 3-meter digital elevation models (DEM) derived from the states airborne Light Detection and Ranging (LiDAR) technology. The noncontributing areas are based on a 10-year, 24-hour event.

Table 3.1: Direct and total drainage areas of impaired stream reaches.

AUID Suffix (09020311-XXX)	Name	HUC-10 Subwatershed	Direct Drainage Area (acres)	Total Drainage Area (acres)	Noncontributing Area (acres)	Upstream Waterbody
-503	Tamarac River: Florian Park Reservoir to Stephen Dam	Lower Tamarac River	65,990	127,021	0	Florian Park Reservoir
-505	Tamarac River: Stephen Dam to Red R	Lower Tamarac River	61,031	127,021	0	Tamarac River: Florian Park Reservoir to Stephen Dam (AUID 09020311-503)

3.2 Subwatersheds

For purposes of this TMDL report, the watershed is divided into seven 10-digit HUC subwatersheds (see **Figure 3-1**), which are used to organize components of this TMDL report throughout the document. Those subwatersheds are the Upper Tamarac River (0902031101), Lower Tamarac River (0902031102), Judicial Ditch No 10 (0902031103), Unnamed Coulee (0902031104), city of Drayton-Red River (0902031105), Red River (0902031107), and the Joe River (0902031108) HUC-10 Subwatersheds. The Lower Tamarac River Subwatershed contains drainage areas for impaired reaches, addressed by this TMDL report, within the LRRW.

3.2.1 The Lower Tamarac River Subwatershed (HUC 0902031102)

The Lower Tamarac River Subwatershed is located in the southwestern-most portion of the LRRW. It is located entirely in the LAP ecoregion. The majority of this region is in agricultural production. The city of Stephen is located within this subwatershed. The Lower Tamarac River HUC-10 Subwatershed contains two impaired stream reaches of the Tamarac River (AUID 09020311-503 and AUID 09020311-505). Both of the impaired stream reaches flow north and west.

The Lower Tamarac River Subwatershed 10-digit HUC is shown in **Figure 3-2**. The drainage areas for the two individual impaired reaches are shown in **Figure 3-3** and **Figure 3-4**. Each figure includes the total drainage area, direct drainage areas, registered animal feedlots within the total drainage areas, water quality sites, National Land Cover Database 2011 (NLCD 2011: Homer et al. 2015) land uses, and any point sources (i.e., Wastewater Treatment Facility (WWTF)) located in the total drainage areas.

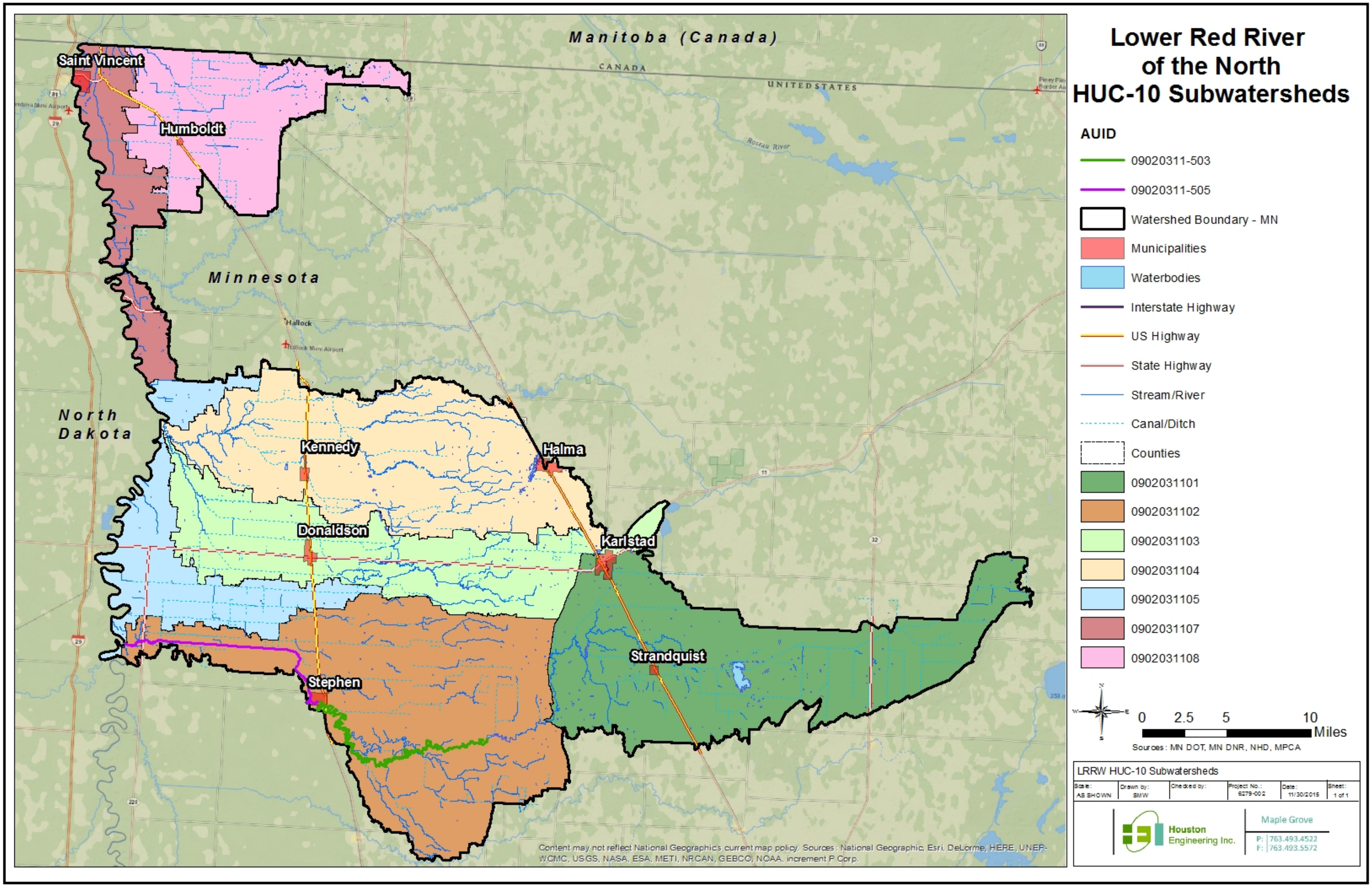

Figure 3-1: Lower Red River Watershed HUC-10 Subwatersheds.

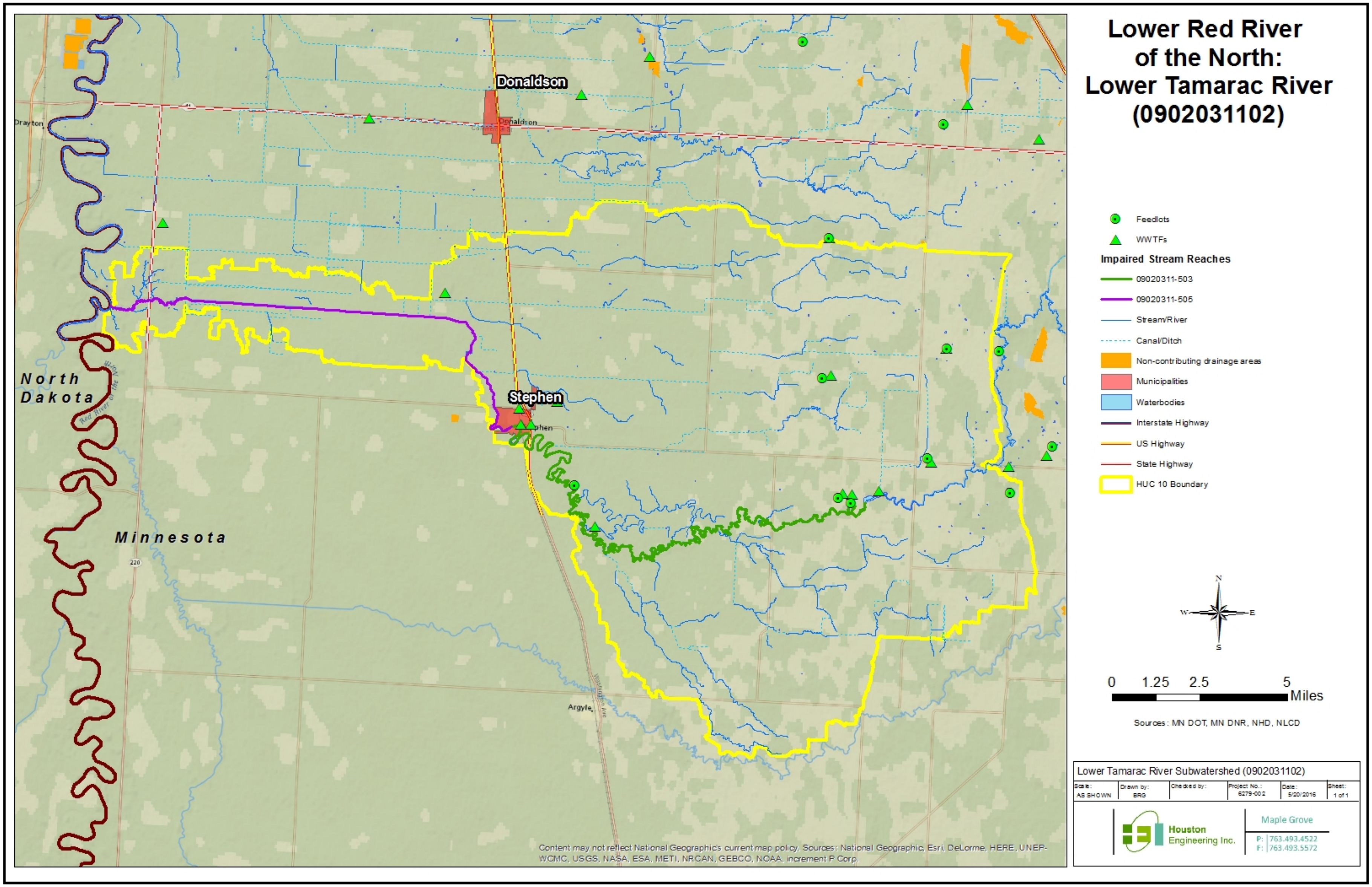

Figure 3-2: Lower Tamarac River Subwatershed in the LRRW.

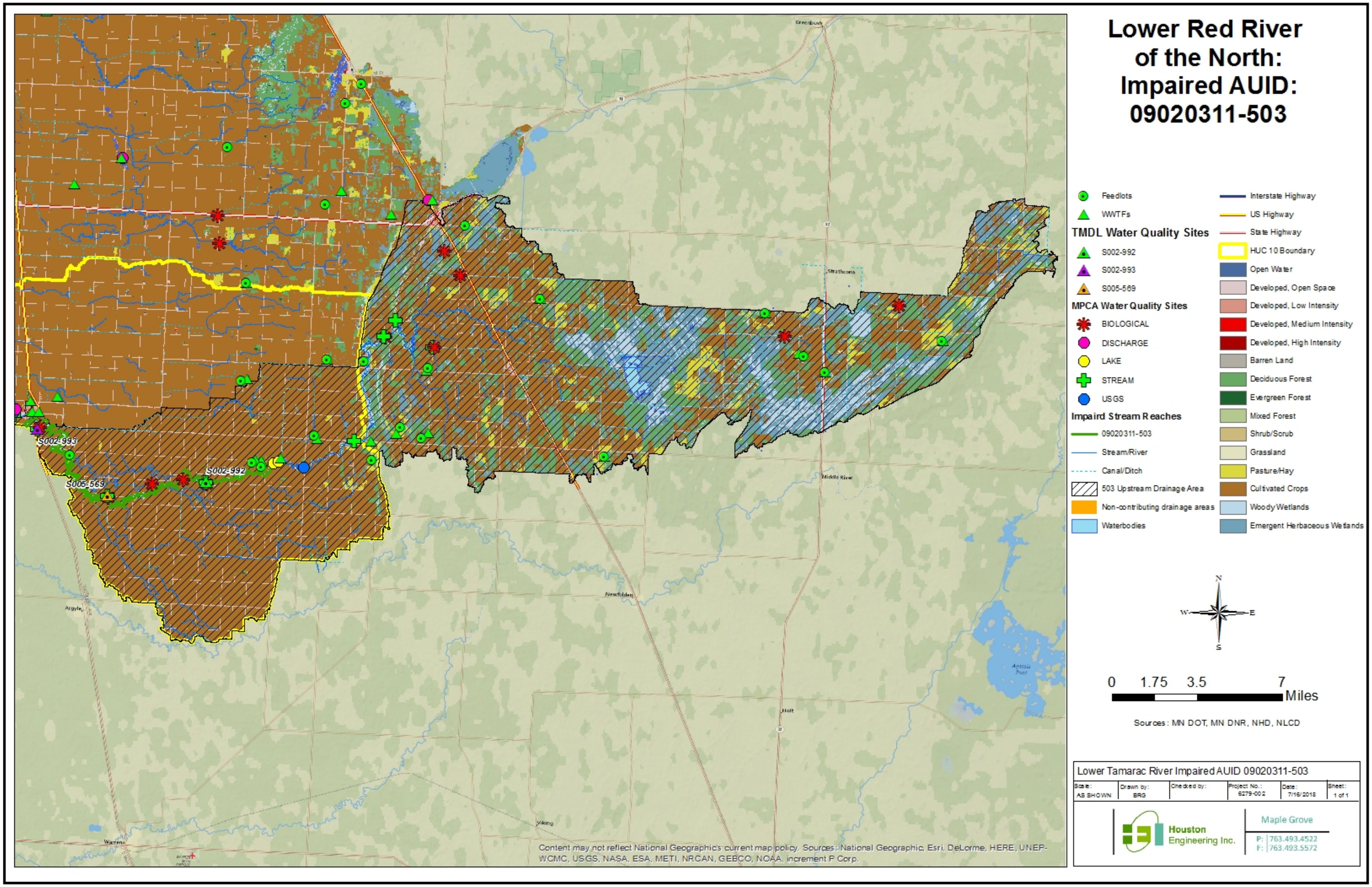

Figure 3-3: Drainage area for AUID 09020311-503 (Tamarac: Florian Park Reservoir to Stephen Dam) in the Lower Red River Watershed.

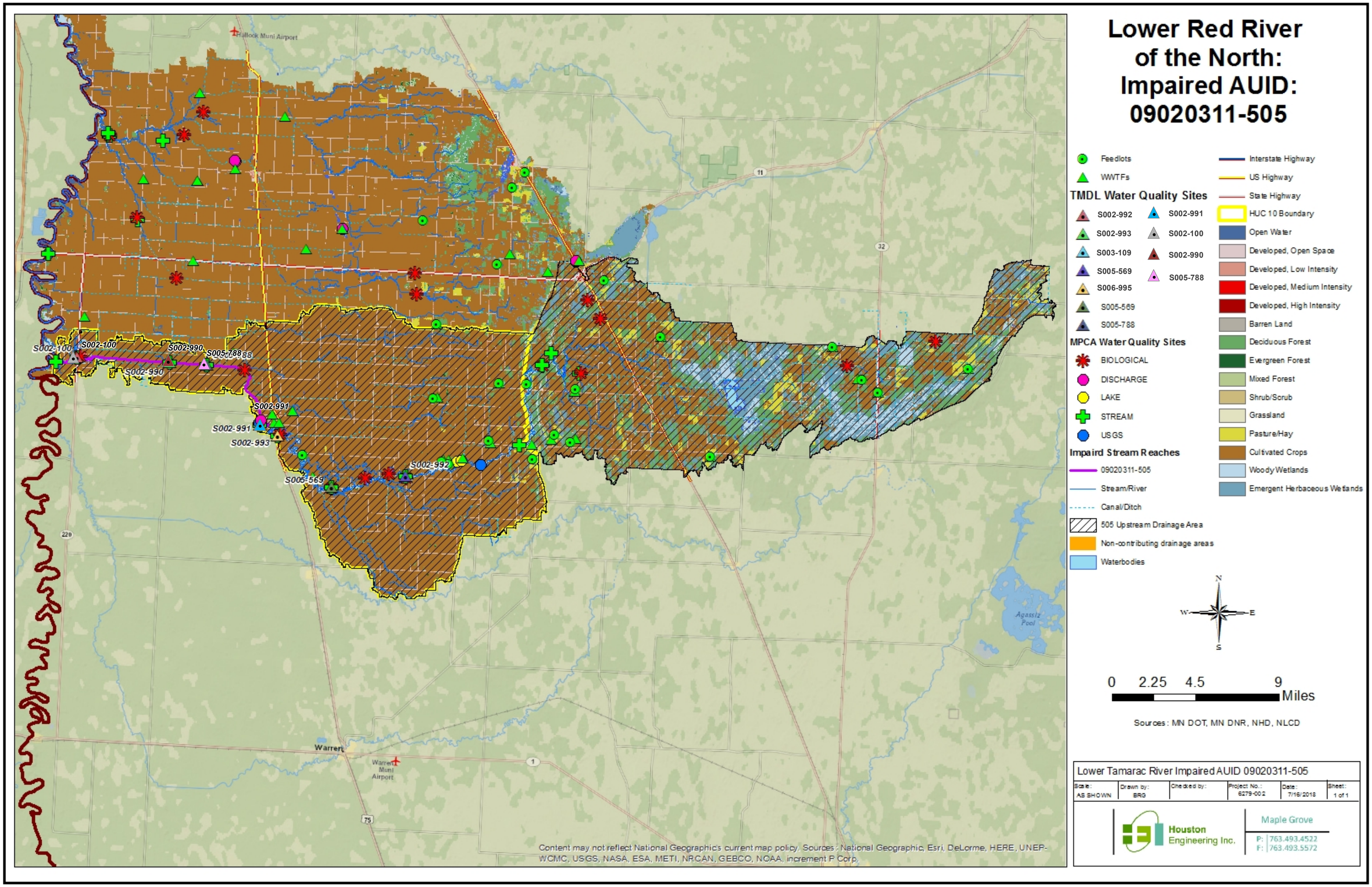

Figure 3-4: Drainage area for AUID 09020311-505 (Stephen Dam to Red River) in the Lower Red River Watershed.

3.3 Land Use

Historically, land cover in the LRRW during European settlement times (mid-late 1800s) consisted almost entirely of prairies (**Figure 3-5**). More current land use within the LRRW can be described using the Multi-Resolution Land Characteristic Consortium 2011 National Land Cover Dataset[4] (NLCD 2011) (**Figure 3-6**). Land cover in the LRRW is now primarily cropland, comprising 80% of the entire watershed area. The entire watershed is defined as the 886 square mile portion of the LRRW contained within Minnesota. **Table 3.2** contains a summary of land cover in the LRRW, including the HUC-10 subwatershed that contains the impaired reaches.

Table 3.2: Land use percentages in the LRRW by drainage area. Land use statistics are based on the NLCD 2011.

Watershed/ Immediate Drainage Area	Open Water	Urban	Barren	Forest/ Shrub	Pasture/ Hay/ Grassland	Cropland	Wetland
Entire Watershed	1.59%	5.14%	0.01%	5.52%	1.86%	80.04%	5.83%
AUID 09020311-503 and AUID 09020311-505							
Lower Tamarac River Subwatershed (HUC 0902031102)	0.25%	4.94%	0.00%	1.45%	0.54%	91.26%	1.55%

[4] http://www.mrlc.gov/nlcd2011.php

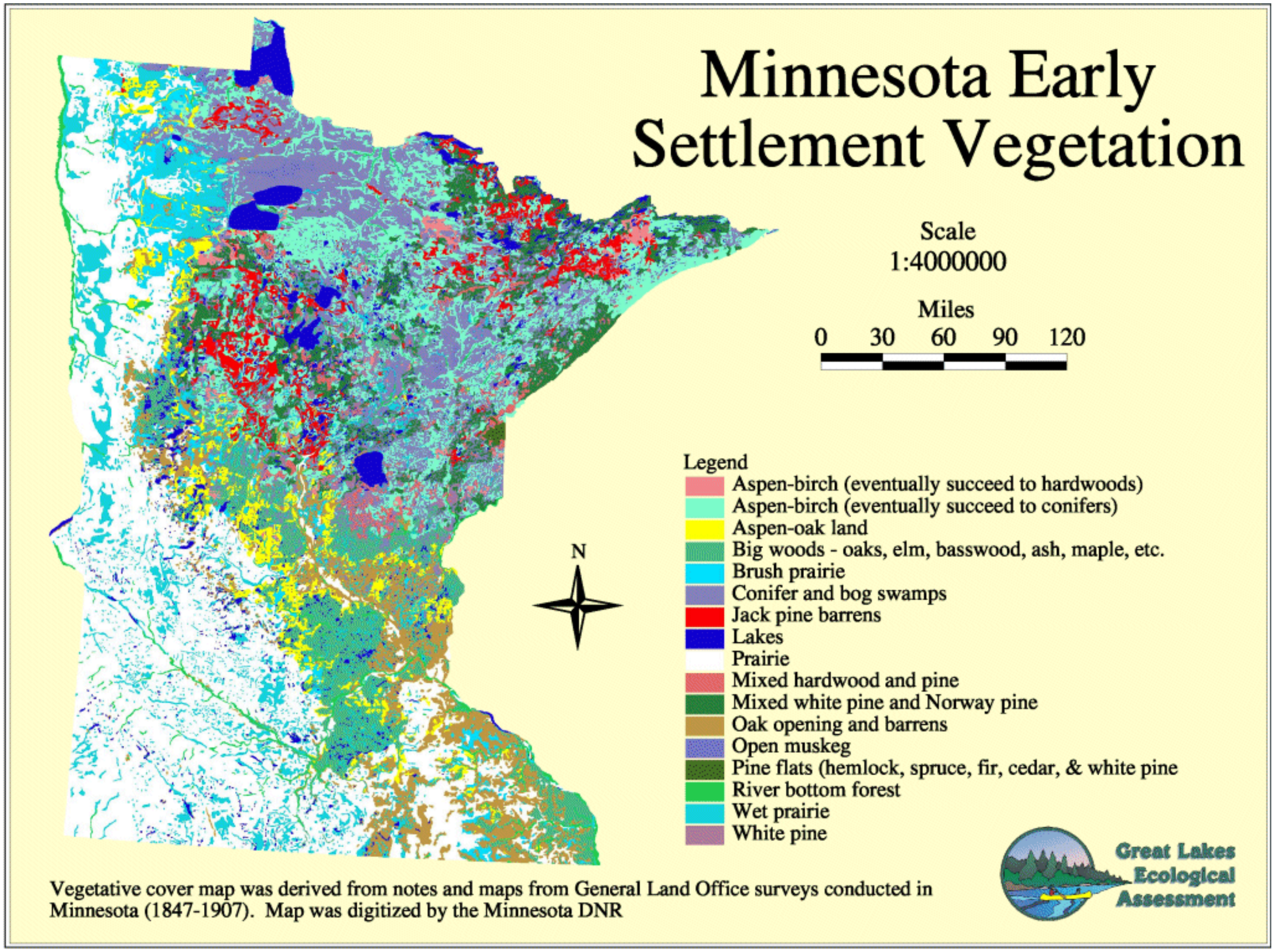

Figure 3-5: Historical map of land cover in Minnesota based on European settlement data. The original version is the "Marschner's Map", created by Francis J. Marschner in 1930.[5]

[5] http://www.mngeo.state.mn.us/chouse/land_use_historic.html

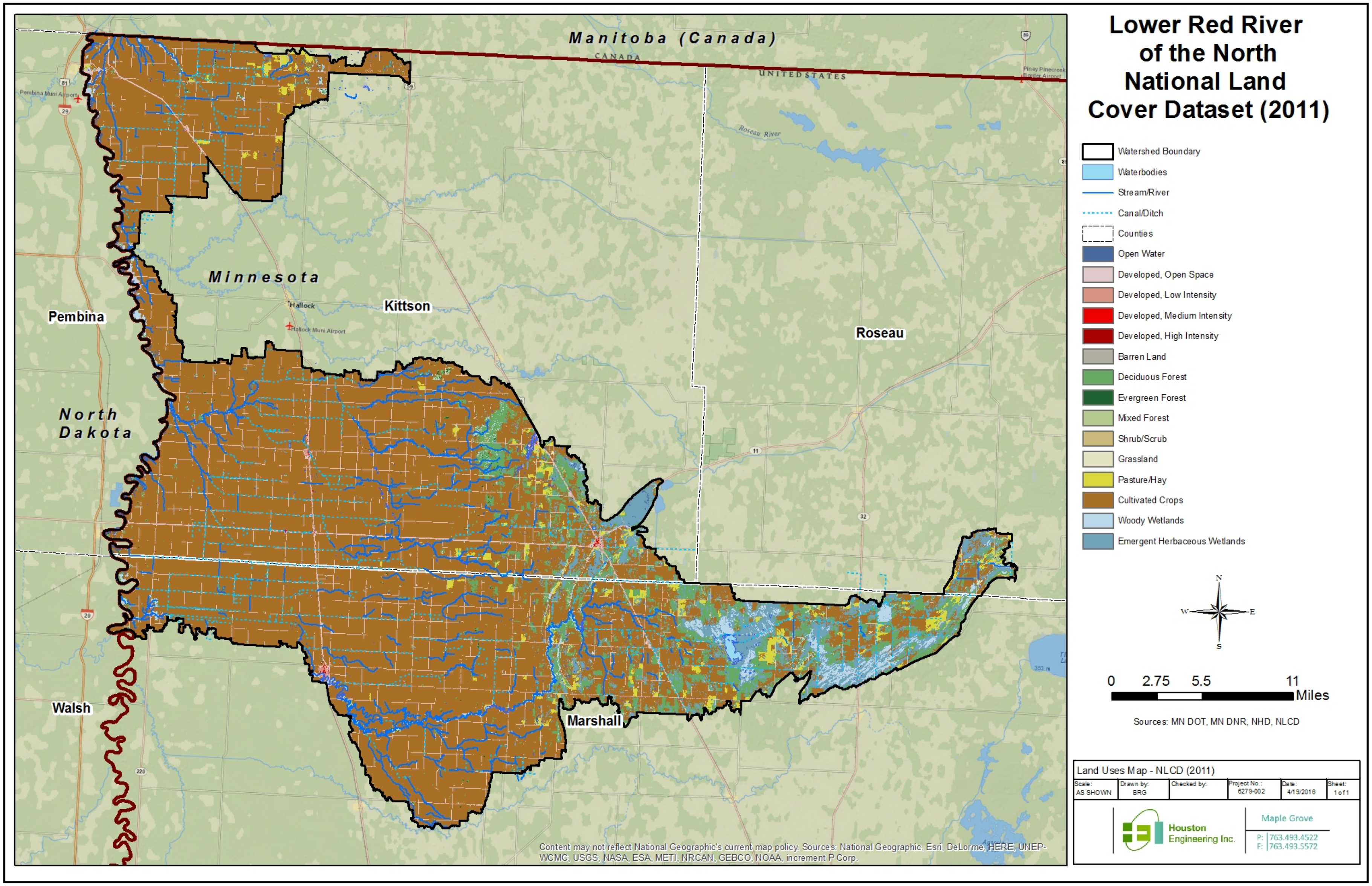

Figure 3-6: Land use within the Lower Red River Watershed based on the NLCD 2011.

3.4 Current/Historical Water Quality

The existing water quality conditions were evaluated using data downloaded from the MPCA's Environmental Quality Information System (EQuIS) database. EQuIS stores water quality data from more than 17,000 sampling locations across the state, containing information from Minnesota streams and lakes dating back to 1926. EQuIS stores data collected by the MPCA, partner agencies, grantees, and citizen volunteers. All water quality sampling data utilized for assessments, modeling, and data analysis for this report and reference reports, are stored in this database and are accessible through the MPCA's Environmental Data Access (EDA) website.

According to EQuIS and the MPCA spatial datasets, there are 21 biological monitoring sites, 2 lake water quality monitoring sites, 24 stream water quality monitoring sites, 4 United States Geological Survey (USGS) discharge sites, and 8 streamflow discharge sites located in the LRRW (**Figure 3-7**). Not all sites were used in the development of the LRRW's TMDLs. Sites were excluded for various reasons including: 1) their period of record being outside of the assessment period (2005 through 2015); 2) the sites were not located in impaired stream reaches or lakes; or 3) a site did not have relevant observed data. Ultimately, three stream water quality monitoring sites were used to develop the TMDL for Tamarac River (Florian Park Reservoir to Stephen Dam, AUID 09020311-503) and four stream water quality monitoring sites were used to develop the TMDL for the other reach of the Tamarac River (Stephen Dam to Red River, AUID 09020311-505).

The MPCA conducts intensive watershed monitoring for 2 years in each of Minnesota's 80 watersheds on a 10-year cycle (i.e., every major watershed is sampled for 2 years, once every 10 years). The LRRW intensive watershed monitoring began in the summer of 2008. To supplement between intensive monitoring years, the MPCA coordinates two programs aimed at encouraging citizen surface water monitoring (i.e., the Citizen Lake Monitoring Program [CLMP] and the Citizen Stream Monitoring Program [CSMP]). Sustained citizen monitoring can provide the long-term picture needed to help evaluate current water quality status and trends. The advanced identification of lake and stream sites that will be sampled by agency staff provides an opportunity to actively recruit volunteers to monitor those sites, so that water quality data collected by volunteers are available for the years before and after the intensive monitoring effort by MPCA staff (MPCA 2012; page 14).

Data from the current 10-year assessment period (2005 through 2015) that was consistent with the months where the water quality standard applies were used for development of this TMDL report. For TSS, data collected only during the months of April through September were used.

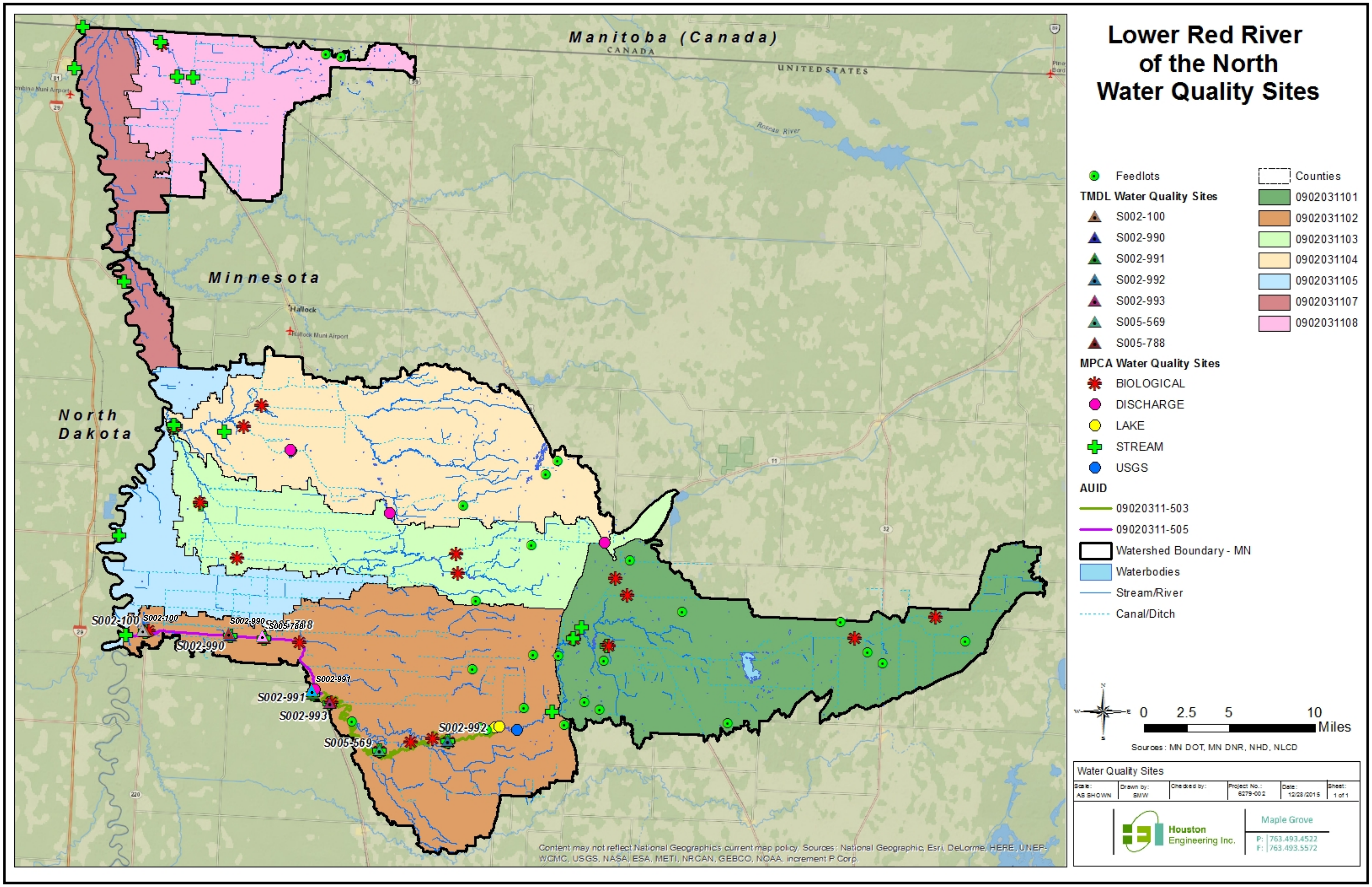

Figure 3-7: Water quality monitoring sites located within the Lower Red River Watershed.

3.4.1 Total Suspended Solids (TSS)

TSS is a direct measurement of the mass per volume of TSS in a water quality sample. In January of 2015, the EPA issued an approval of the adopted amendments to the State Water Quality Standards, replacing the historically-used turbidity standard with TSS standards. Therefore, MPCA is employing the TSS water quality standards to calculate TSS TMDLs in lieu of the since-replaced turbidity standard.

The Minnesota state TSS standards are based upon nutrient regions, which are loosely based on ecoregions. The LRRW is located in the Southern Nutrient Region due to its heavy agricultural land use; therefore, the applicable TSS standard is 65 milligrams per liter (mg/L) (MPCA 2015a). **Table 3.3** lists all water quality sites within impaired reaches in the LRRW with TSS measurements during the assessment period.

Table 3.3: Summary of sites with total suspended solids measurements (n=sample size).

AUID Suffix (09020311-XXX)	Site ID	Total Suspended Solids				
		Sampling Years	Sample Size (n)	Average [mg/L]	90th Percentile	# of Exceed.
-503 (Tamarac: Florian Park Res. to Stephen Dam)	S002-992	2009-2010	25	11.8	32.8	1
	S002-993	NA	0	NA	NA	NA
	S005-569	2009-2010	25	19.0	38.2	0
-505 (Tamarac: Stephen Dam to Red River)	S002-100	2005-2014	155	166.9	340.0	109
	S002-990	NA	0	NA	NA	NA
	S002-991	NA	0	NA	NA	NA
	S005-788	2009-2013	34	85.9	200.2	14

3.5 Pollutant Source Summary

A key component for developing TMDLs is understanding the sources contributing to the impairment(s). The majority of streams in the LRRW have been physically altered to promote farmland drainage, including channelization and widening. The altered landscape and stream channel characteristics have resulted in impaired conditions as measured with a broad suite of aquatic community, water chemistry, and stream habitat indicators. Several stressors in the LRRW play a role in influencing water quality in the system and limiting the health of these aquatic communities.

In instances where this TMDL report references "Natural Background Conditions", natural background conditions are considered the landscape condition that occurs outside of human influence. Minn. R. 7050.0150, subp. 4, defines the term "Natural causes" as the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. Natural background sources can include inputs from natural processes such as soil loss from upland erosion and stream development, atmospheric deposition, and loading from forested land, wildlife, etc. Natural background concentrations may, or may not, be better than the current conditions.

For each impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment; therefore, natural background is included in the MPCA's waterbody assessment process. There were no data to explicitly determine whether natural background sources are a major driver of any of the impairments and/or that they affect the waterbodies' ability to meet state water quality standards. For all impairments addressed in this TMDL report, natural background sources are implicitly included in the LA portion of the TMDL allocation tables and TMDL reductions should focus on the major anthropogenic sources such as livestock, cropland, streambank, WWTFs, failing SSTSs, and others.

This section provides a brief description by pollutant of the sources in the LRRW potentially contributing to the listed impairments. A more in-depth discussion of the biological stressors, pollutant sources, and causal pathways, excluding *E. coli*, can be found in the LRRW Biotic SID Report (MPCA 2015a). More discussion on the current conditions in the watershed can be found in the LRRW Monitoring and Assessment Report (MPCA 2013).

3.5.1 Total Suspended Solids (TSS)

The LRRW Biotic SID Report (MPCA 2015a) describes the sources and causal pathways for TSS. Land use modifications such as removal of riparian buffers, tiling, and agricultural development result in increased sediment loading to surface waters (MPCA 2013). In addition, hydrologic alteration, including channelization, ditching, and impoundments may be contributing factors to a flashy flow regime, leading to unstable stream channels and high delivery of sediment (MPCA 2015a).

3.5.1.1 Permitted (Point) Sources

Permitted WWTFs in the State of Minnesota are required to monitor their effluent to ensure that concentrations of specific pollutants remain within levels specified in their National Pollutant Discharge Elimination System (NPDES) discharge permit. The TMDL studies assume that a portion of the release from WWTFs will contain sediment from treatment ponds; therefore, a portion of the WLA needs to be assigned to WWTFs, which contribute to TSS impaired reaches. In the LRRW, there are three "minor" (as defined by the MPCA) Municipal Wastewater NPDES Permits: Karlstad WWTF (MNG580146), Kennedy WWTF (MN0029751), and Stephen WWTF (MNG580162). There are also two "minor" Industrial Wastewater NPDES Permits for CHS Hallock (MN0068969) and Enbridge Energy Ltd (MN0056324), but while CHS Hallock does have a wastewater (and stormwater) station, Enbridge Energy only has a stormwater station and thus would not be considered for a wastewater WLA had it contributed effluent to an impaired stream. Only the Stephen WWTF contributes effluent directly to a TSS-impaired reach addressed in this report: AUID 09020311-505 (**Table 3.4**).

Table 3.4: WWTF permit in the LRRW that discharges to an impaired stream addressed in this TMDL report.

				A					
Facility	**NPDES Permit Number**	**Discharges to**	**System Type**	**Secondary pond size [acres]**	**Operating Depth [ft]**	**Average Wet Weather Design Flow [gpd]**	**Calendar month avg. TSS effluent limits**		**Permitted Daily Flow [mgd][a] (A*0.163*10^6)**
							mg/L	**kg/day**	
Stephen WWTF	MNG580162	Tamarac River (09020311-505)	3-cell pond	7.1	3.5	100,000	45	194	1.157

[a] Computed based on the surface area of the secondary pond size and a maximum daily discharge of six inches per day.

The TMDL studies assumes that 0.1% of the total TSS LA is reserved for a TSS WLA from construction and/or industrial stormwater runoff for both TSS TMDLs (see **Section 4.1.3** for an explanation of the 0.1% estimation). The LA represents the nonpoint source portion of the loading capacity, and is the primary term in the TMDL equation in rural landscapes.

3.5.1.2 Non-permitted (Nonpoint) Sources

The LRRW is located within the Red River Basin, a region with one of the highest median suspended sediment concentrations of any region in Minnesota, along with the Western Corn Belt Plains ecoregion (MPCA 2015a). The majority of the annual suspended sediment load is delivered to streams within the basin between the months of March and May, when agricultural fields are particularly vulnerable to erosion (MPCA 2015a).

Agriculture is the most extensive land use within the LRRW. As such, very little of the natural vegetation remains, and a large portion of the LRRW's natural waterways have been highly altered to promote farmland drainage. According to the MPCA, 72% of all the watercourses in the LRRW have been hydrologically altered (i.e., channelized, ditched, or impounded) (MPCA 2015a). This degree of hydrologic alteration results in increased and quicker peak flows, creating a "flashy" flow regime and unstable stream channels (MPCA 2015a). Sediment loading is made worse from increased tiling within the watershed (MPCA 2013).

The Tamarac and Joe Rivers are very low gradient streams with a fine textured stream bed of silt and clay (MPCA 2013). Consequently, the stability of these streams can be influenced by the backwater flooding of the mainstem Red River. The increased periods of saturation combined with increased stream flows due to channelization, result in an increased rate of bank erosion within these streams (MPCA 2013). While channel instability had been made worse by the removal of riparian buffers within the LRRW (MPCA 2013), the Buffer Law was signed into law in June 2015 (amended in April 2016 and May 2017), making riparian buffers required. Buffers of up to 50 feet along lakes, rivers, and streams and buffer of 16.5 feet along ditches were required on public waters by November 1, 2017, and are required on public ditches by November 1, 2018. See **Section 6.1.7** for county buffer compliance rates as of September 2017.

Figure 3-8 shows an example of field scale catchments that have been ranked based on their delivery of sediment to the subwatershed outlet of Tamarac River, determined using results extracted from the LRRW HSPF model. The Highest Priority (Highest 90%) subwatersheds have the highest yields and most likely would benefit the most from BMP implementation and protective strategy management.

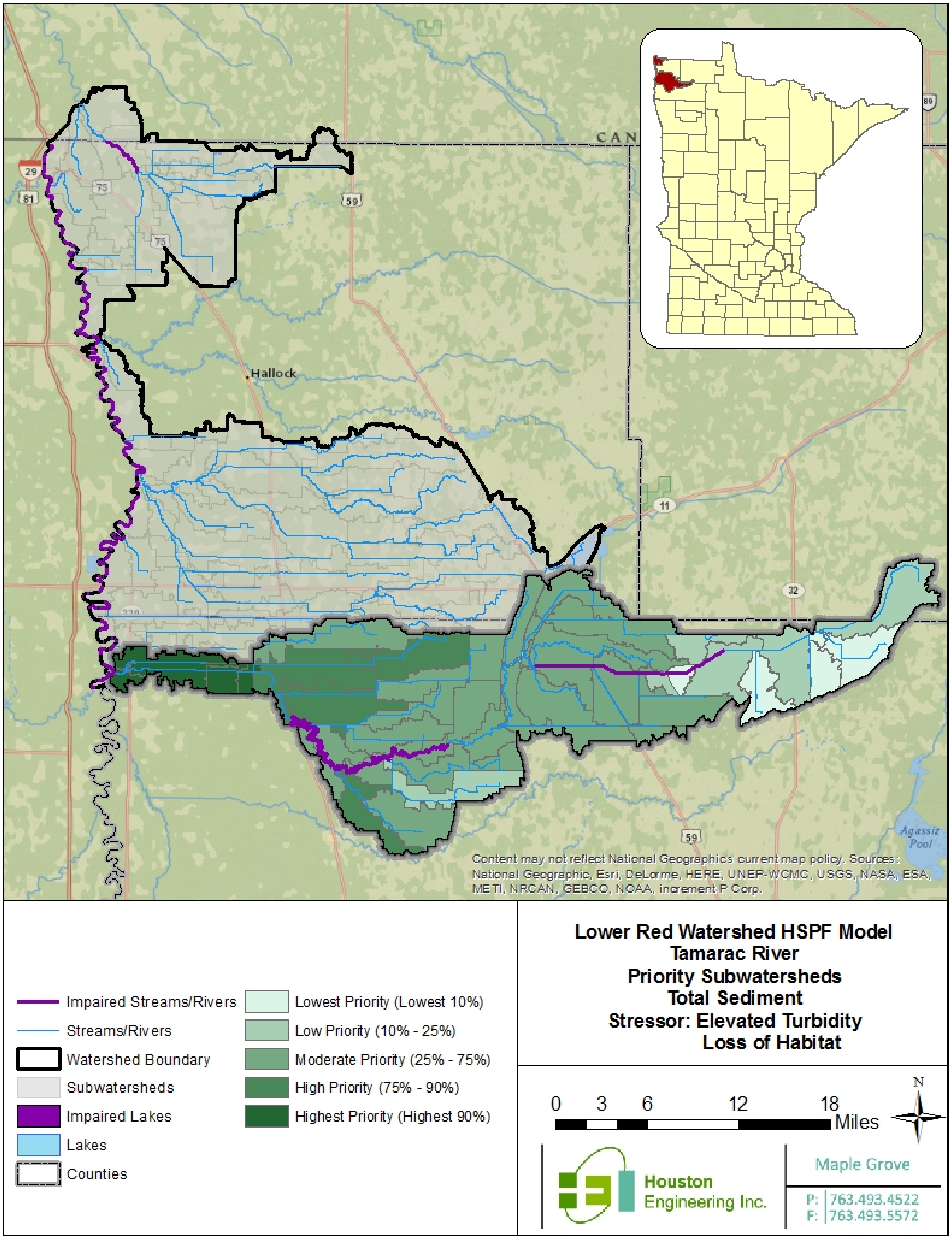

Figure 3-8: Tributary scale subwatershed priority for implementation for the stressors elevated turbidity and loss of habitat for Tamarac River, using average (1996-2009) annual total sediment yields estimated using the HSPF.

4. TMDL Development

TMDLs are developed based on the following equation:

$$TMDL = LC = \sum WLA + \sum LA + MOS + RC$$

Where:

LC = loading capacity, or the greatest amount of a pollutant a waterbody can receive and still meet water quality standards (see **Section 4.1.1**);

WLA = wasteload allocation, or the portion of the loading capacity allocated to existing or future permitted point sources (see **Sections 3.5.1.1**);

LA = load allocation, or the portion of the loading capacity allocated for existing or future nonpoint sources (see **Section 3.5.1.2**);

MOS = margin of safety, or accounting for any uncertainty associated with attaining the water quality standard. The MOS may be explicitly stated as an added, separate quantity in the TMDL calculation or may be implicit, as in a conservative assumption (EPA 2007);

RC = reserve capacity, or the portion of the TMDL that accommodates for future loads;

The following sections discuss each component of the LRRW TMDLs in greater detail.

4.1 Total Suspended Solids

4.1.1 Loading Capacity Methodology

The loading capacity (LC) is the greatest amount of a pollutant a waterbody can receive and still meet the water quality standard. The loading capacities for the Tamarac River reaches in the LRRW with a TSS impairment and receiving a TMDL (AUIDs 09020311-503 and 09020311-505) was determined using the LDC approach. An LDC is developed by combining the (simulated or observed) river/stream flow at the downstream end of the AUID with the measured TSS/turbidity data available within the segment. Methods detailed in the EPA document *An Approach for Using Load Duration Curves in the Development of TMDLs* were used in creating the curves (EPA 2007).

A system’s water quality often varies based on flow regime, with elevated pollutant loadings sometimes occurring more frequently under one regime or another. Loading dynamics during certain flow conditions can be indicative of the type of pollutant source causing an exceedance (i.e., point sources contributing more loading under low flow conditions). The LDC approach identifies these flow regimes and presents the observed and “allowable” loading within each regime, to compute necessary load reductions. To represent different types of flow events, and pollutant loading during these events, five flow regimes were identified in the LRRW LDCs based on percent exceedance: Very High Flow (0% to 10%), High Flow (10% to 40%), Mid Flow (40% to 60%), Low Flow (60% to 90%), and Very Low Flow (90% to 100%).

Benefits of LDC analysis include: (1) the loading capacities are calculated for multiple flow regimes, not just a single point; (2) use of the method helps identify specific flow regimes and hydrologic processes/patterns where loading may be a concern; and (3) ensuring that the applicable water quality standards are protective across all flow regimes. Some limitations with the LDC approach exist: (1) the approach is limited in the ability to track individual loadings or relative source contributions and (2) is appropriate when a correlation between flow and water quality exists and flow is the driving force behind pollutant delivery mechanics.

LDCs were developed for two AUIDs on the Tamarac River (09020311-503 and 09020311-505). Observed daily flow data is limited within the LRRW and no USGS gauging stations were in reaches needing LDCs. Therefore, simulated daily mean flows from the LRRW HSPF model (RESPEC 2014) were used to create the LDCs for both AUIDs. The HSPF model simulates flows from 1995 through 2009. In order to best capture the flow regimes of both AUIDs, the period 1996 through 2009 was used in development of the LDCs and 1995 was used as a warm-up period for the model; however, simulated flow should not be considered an exact representation of actual flow (RESPEC 2014).

Table 4.1: Assessment Unit Identification Numbers (AUIDs) associated with Load Duration Curves, pollutant/stressor, and data used.

AUID Suffix (09020311-XXX)	Reach Name	Pollutant/ Stressor	Water Quality Stations	Years of TSS/turbidity data used for LDCs	HSPF Flow RCHRES ID[a]
-503	Tamarac R.: Florian Park Reservoir to Stephen Dam	Turbidity	S002-992, S002-993, S005-569	2002-2009	RCHRES 360
-505	Tamarac R.: Stephen Dam to Red R	Turbidity	S002-100, S002-990, S002-991, S005-788	2000-2009	RCHRES 490

[a] No USGS gauging stations are listed as a data source, because none were present along either of the AUIDs.

The TSS LDCs were created using the Southern Region TSS standard of 65 mg/L. The TSS LDCs were calculated using the TSS data collected during the assessment period, April through September. In addition to TSS data, the useable dataset was expanded using converted turbidity data. The proposed standard only applies during the months of April through September. Therefore, the proposed TSS standard LDCs were created using turbidity/TSS data and flow data from this period.

When available, TSS was used as the preferred value for calculating solids loading. However, since turbidity data may be prevalent in the historical record, turbidity was used to expand the TSS dataset. This is consistent with MPCA guidance (MPCA 2012). An explicit 10% MOS was applied.

The water quality data used in this work was obtained from the MPCA through their EQuIS database. For the purposes of creating the curves (which will inform TMDL development), water quality data during the simulation period (1996 through 2009) was used. While TSS/turbidity data exists beyond 2009, the HSPF model only estimates flows for 1995 through 2009. **Table 4.1** lists the water quality stations where TSS/turbidity data were collected and used to develop the TSS LDCs.

The LDC approach was also used to compute needed sediment load reductions in the LRRW.

4.1.2 Load Allocation Methodology

LA represents the portion of the loading capacity designated for nonpoint sources of sediment. Once WLAs, reserve capacities, and MOSs were determined and subtracted from the loading capacity, the remaining loading capacity was considered to be LA. LAs are associated with loads that are not regulated by NPDES Permits, including nonpoint sources of pollutants and "natural background" contributions. "Natural background" can be described as physical, chemical, or biological conditions that would exist in a waterbody that are not a result of human activity. Nonpoint sources of pollution in the LRRW were discussed previously (see **Section 3.5.1.2**) and include land use modification and hydrologic alteration.

4.1.3 Wasteload Allocation Methodology

The WLA represents the regulated portion of the loading capacity, requiring an NPDES Permit. Regulated sources may include construction stormwater, industrial stormwater, MS4 permitted areas, NPDES permitted feedlots, and WWTFs. The only regulated TSS sources with a WLA in the LRRW's impaired stream reaches are the Stephen WWTF and construction and industrial stormwater discharges. As shown in **Table 3.4** and discussed in **Section 3.5.1.1,** the Stephen WWTF discharges directly to TSS-impaired AUID 09020311-505. There are no MS4s or NPDES permitted feedlots in the drainage basins of any impaired stream reach.

WLAs for construction and industrial stormwater discharges were combined and addressed through a categorical allocation. The TMDL studies assume that 0.1% of the LRRW's land area is under construction and therefore contributes construction and/or industrial stormwater runoff at any given time. Historical permits and land use analysis in the LRRW support this assumption. Available historical permits within the watershed dated back to 2011. Land use analysis was based on the NLCD 2011.

Stormwater runoff from construction sites that disturb a) one acre of soil or more, b) less than one acre of soil and is part of a "larger common plan of development or sale" that is greater than one acre, or c) less than one acre, but determined to pose a risk to water quality are regulated under the state's NPDES/State Disposal System (SDS) General Stormwater Permits for Construction Activity (MNR1000001). This permit requires and identifies best management practices (BMPs) to be implemented to protect water resources from mobilized sediment and other pollutants of concern. If the owner/operators of impacted construction sites within the LRRW obtain and abide by the NPDES/SDS General Construction Stormwater Permit, the stormwater discharges associated with those sites are expected to meet the WLAs set in this TMDL report.

Similar to construction activities, industrial sites are regulated under general permits, in this case either the NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or the NPDES/SDS General Permit for Construction Sand & Gravel, Rock Quarrying, and Hot Mix Asphalt Production facilities (MNG490000). Like the NPDES/SDS General Construction Stormwater Permit, these permits identify BMPs to be implemented to protect water resources from pollutant discharges at the site. If the owner/operators of industrial sites within the LRRW obtain and abide by the necessary NPDES/SDS General Stormwater Permits, the discharges associated with those sites are expected to meet the WLAs set in this TMDL.

To calculate the WLA for construction and industrial stormwater, 0.1% of the LA for the stream reach was assumed and assigned to construction/industrial stormwater WLA. As the LA captures nonpoint sources allocation, the construction/industrial stormwater WLA is dependent on the LA.

The one relevant WWTF in the LRRW is limited to discharging from a single surface secondary treatment cell. It is permitted to discharge only during specified discharge windows in the spring and fall. The discharge windows are March 1 through June 30 and September 1 through December 31 with no discharge to ice covered waters.

Per MPCA guidance, the permitted WLA was calculated for the WWTF based on the Calendar Month Average TSS and the maximum discharge of six inches per day. The WLA was computed for TSS based on the maximum permitted daily flow rate from the facility. **Table 4.2** provides the daily TSS WLA for the one WWTF in the LRRW that discharges to a TSS-impaired stream. The effluent limit for the WWTF is 45 mg/L, below the numeric standard of 65 mg/L in the stream. Therefore, a sediment reduction is not needed for the Stephen WWTF beyond current permit conditions/limits.

Table 4.2: Daily TSS WLA for the one relevant LRRW WWTF.

				A				B	
Facility	**NPDES Permit Number**	**Discharges to**	**System Type**	**Secondary pond size [acres]**	**Operating Depth [ft]**	**Permitted Daily Flow [mgd][a] (A*0.163*10^6)**	**Calendar month avg. TSS effluent limits**		**Daily TSS WLA (tons/day) [B/907.2]**
							mg/L	**kg/day**	
Stephen WWTF	MNG580162	Tamarac River (09020311-505)	3-cell pond	7.1	3.5	1.157	45	197	0.22

4.1.4 Margin of Safety

The purpose of the MOS is to account for any uncertainty with attaining water quality standards. Uncertainty can be associated with data collection, lab analysis, data analysis, modeling error, and implementation activities. An explicit 10% of the loading capacity MOS was applied to each flow regime for all LDCs developed for TMDLs. The explicit 10% MOS accounts for:

- Uncertainty in the observed daily flow record;
- Uncertainty in the simulated flow data from the HSPF model;
- Uncertainty in the observed water quality data, including uncertainty associated with the transformation of turbidity data to a TSS surrogate; and
- Allocations and loading capacities are based on flow, which varies from high to low. This variability is accounted for using the five flow regimes and the LDCs.

The majority of the MOS is apportioned to uncertainty related to the HSPF model than with the other causes of uncertainty. There is no reason to believe that this number is inappropriate.

4.1.5 Seasonal Variation

A summary of the TSS load reduction results can be found in **Table 4.3**. Results are summarized by indicating the maximum required percent load reduction for each curve, and the flow regime and water quality criterion under which this maximum reduction occurred. The critical flow regime for TSS loading is very high flows for both AUIDs.

Table 4.3: Maximum required sediment load reductions for the Lower Red River Watershed.

AUID Suffix (09020311-XXX)	Total Suspended Solids Standard	
	Max. % Load Reduction	Critical Flow Regime
-503 (Tamarac: Florian Park Res. to Stephen Dam)	13%	Very High
-505 (Tamarac: Stephen Dam to Red River)	95%	Very High

4.1.6 Reserve Capacity

No additional reserve capacity was included for the point sources in the LRRW, given the nature of assumptions used to create the WLAs. Similarly, no reserve capacity was included for nonpoint sources in the watershed (LAs), given that the land use in the LRRW is dominated by agriculture and is unlikely to substantially change in the future. For more information on future growth and reserve capacity, see **Section 5.**

4.1.7 TMDL Summary

Table 4.4 and **Table 4.5** show the computed loading capacities and allocations for the LRRW streams that are currently impaired by turbidity, using the TSS standard. The various components of these allocations were developed as described in **Sections 4.1.1** to **4.1.4**. In addition to the TMDL components, the existing load, the unallocated load (if applicable), and the estimated load reduction as a percentage are given for each flow regime. The existing load is based on existing water quality data, and the unallocated load is the potential load available if the existing load is lower than the loading capacity for a given flow regime (i.e. the loading capacity minus the existing load minus the MOS [the MOS is subtracted as well since its purpose is to provide a buffer to account for uncertainty]). An unallocated load is only provided if the existing load is lower than the loading capacity. The estimated load reduction is required load reduction, as a percentage of existing load, to meet the loading capacity. A load reduction is only provided if the loading capacity is less than the existing load. It should be noted that the sum of some of the TMDL calculations may not equal the loading capacity of the AUID, due to rounding errors.

The LDC method is based on an analysis that encompasses HSPF model simulated flow from 1996 through 2009. In the TMDL equation tables of this report, (**Table 4.4**, **Table 4.5**) only five points on the entire loading capacity curve are depicted (the midpoints of the designated flow zones). However, it should be understood that the entire curve represents the TMDL and is ultimately approved by EPA. The LDCs used to develop the loading capacities and allocations are provided in **Appendix A.**

Table 4.4: TSS loading capacities and allocations for AUID 09020311-503.

Total Suspended Solids		Flow Condition				
		Very High	High	Mid	Low	Very Low
		Tons per day				
Loading Capacity		**114.94**	**20.80**	**5.91**	**1.53**	**0.08**
Wasteload Allocation	**Total WLA**	**0.10**	**0.02**	**0.01**	**0.001**	**0.0001**
	Construction/ Industrial Stormwater	0.10	0.02	0.01	0.001	0.0001
Load Allocation	**Total LA**	**103.35**	**18.70**	**5.31**	**1.38**	**0.07**
Margin of Safety (MOS)		**11.49**	**2.08**	**0.59**	**0.15**	**0.01**
Existing Load		**131.66**	**9.06**	**1.73**	**0.48**	**0.004**
Unallocated Load		**0.00**	**9.66**	**3.59**	**0.90**	**0.07**
Estimated Load Reduction		**13%**	**0%**	**0%**	**0%**	**0%**

Very high flow regime is the critical flow condition with maximum reduction needed.
Existing load estimated based on the 90th percentile exceedance concentration and the mid-point flow for the flow regime.

Table 4.5: TSS loading capacities and allocations for AUID 09020311-505.

Total Suspended Solids		Flow Condition				
		Very High	High	Mid	Low	Very Low
		Tons per day				
Loading Capacity		**156.98**	**31.19**	**8.29**	**2.06**	**0.19**
Wasteload Allocation	**Total WLA**	**0.36**	**0.25**	**0.23**	**0.222**	*
	Construction/ Industrial Stormwater	0.14	0.03	0.01	0.002	0.0002
	Stephen WWTF	0.22	0.22	0.22	0.22	*
Load Allocation	**Total LA**	**140.92**	**27.82**	**7.23**	**1.63**	**0.17**
Margin of Safety (MOS)		**15.70**	**3.12**	**0.83**	**0.21**	**0.02**
Existing Load		**3,067.22**	**130.07**	**38.14**	**4.18**	**0.21**
Unallocated Load		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Estimated Load Reduction		**95%**	**76%**	**78%**	**51%**	**13%**

Very high flow regime is the critical flow condition with maximum reduction needed.
Existing load estimated based on the 90th percentile exceedance concentration and the mid-point flow for the flow regime.
* The outflow from the WWTF will be greater than the median flow under this condition. Since outflow is a portion of streamflow, loading under this condition is unlikely to occur. If outflow from this WWTF occurs during this flow condition, the WLA will be the permitted outflow concentration multiplied by the flow rate.

5. Future Growth Considerations

The primary economic force in the LRRW is agriculture. As the LRRW is almost entirely agricultural, little change in land use is expected in the future. Like much of the Red River Valley, land use in the LRRW has changed very little in many years. Analysis of the NLCD 2006 (Fry et al. 2011) and 2011 datasets show about 1% change in land uses in the LRRW between the years. Most of these small changes occurred in increases in cropland and urban areas and decreases in forest, wetland, and grassland areas.

Small changes are occurring in the demographics of the LRRW. In the TRWD and JRWD, statistics from the U.S. Census bureau have shown a general decline in population predominately in rural and western areas since the 1950s and 1960s, primarily due to relocation from flood prone areas and the declining farming economy for small family farms (TRWD 2004 and JRWD 2004). From 1990 to 2000, population statistics have shown both increases and decreases in townships and cities within the MSTRWD (HEI and MSTRWD 2011).

5.1 New or Expanding Permitted MS4 WLA Transfer Process

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

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

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

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

The MPCA, in coordination with the EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to waterbodies with an EPA-approved TMDL (MPCA 2014b). This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target, and will ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA to comment on the permit changes based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that the new or expanded wastewater discharge is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

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

6. Reasonable Assurance

Reasonable assurance of the load reductions and strategies developed under this TMDL report comes from multiple sources. WLAs are assured through the issuance and regulation of NPDES Permits. LAs and their associated nonpoint source implementation strategies are reasonably assured by historical and ongoing collaborations in the LRRW. Several agencies and local governmental units have and continue to work toward the goal of reducing pollutant loads in the LRRW. Strong partnerships between the three watershed districts, the JRWD, the TRWD, and the MSTRWD, counties, and Soil and Water Conservation District (SWCDs) have led to the implementation of conservation practices in the past, and will continue to do so into the future. Upon approval of the TMDL report and concurrently developed Lower Red River of the North WRAPS Report (HEI 2018) by the EPA and state, respectively, the JRWD, TRWD, and MSTRWD will incorporate the various implementation strategies described by this TMDL report and WRAPS report (also addresses unimpaired waters) into their Watershed Management Plans (WMPs), Overall Plans (OPs) and/or One Watershed, One Plans (1W1Ps). Two 1W1P planning regions include parts of the LRRW; neither region has a plan written as of 2018 but intend to apply for 1W1P in 2018. The JRWD, TRWD, and MSTRWD are committed to taking lead roles within their respective watershed districts during the implementation of this TMDL report and have the ability to generate revenue and receive grants to finance the implementation items. More detailed discussion of specific projects is contained in **Section 8.2**.

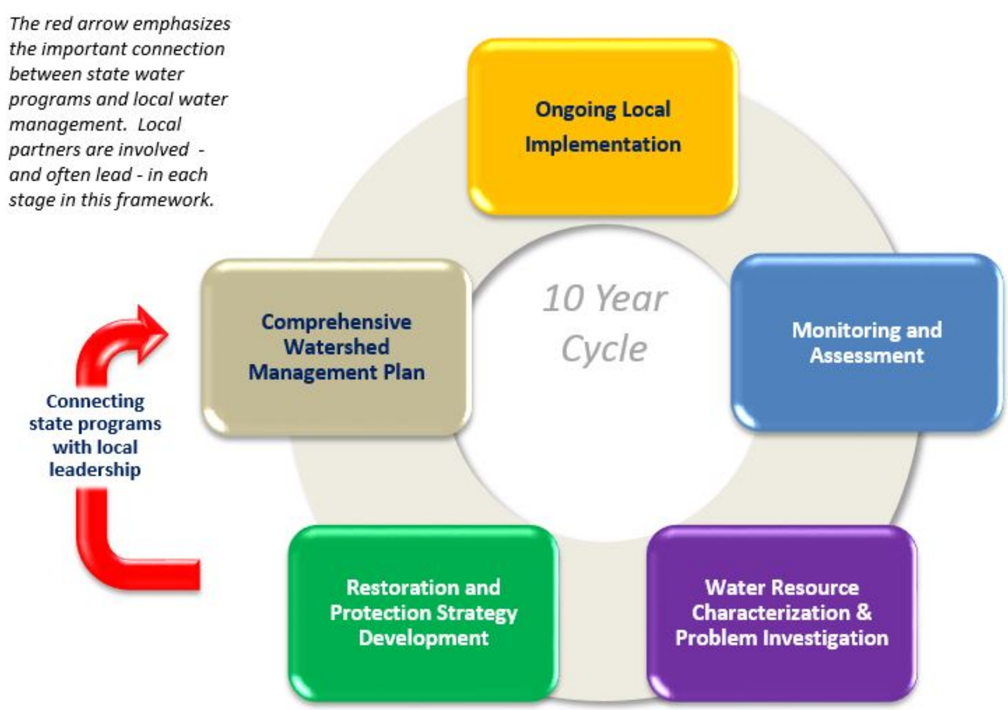

Figure 6-1: Minnesota Water Quality Framework.

In addition to commitment from local agencies, the state of Minnesota has also made a commitment to protect and restore the quality of its waters. In 2008, Minnesota voters approved the Clean Water, Land, and Legacy Amendment to increase the state sales tax to fund water quality improvements. The interagency Minnesota Water Quality Framework (**Figure 6-1**) illustrates the cycle of assessment, watershed planning, and implementation to which the state is committed. Funding to support implementation activities under this framework is made available primarily through Minnesota's Board of Water and Soil Resources (BWSR), an agency that the JRWD, TRWD, and MSTRWD have received grants from in the past.

The JRWD, TRWD, and MSTRWD have the ability to provide funding for projects consistent with those identified within their respective WMP, OP, and/or voluntary 1W1Ps. The WMP or OP is required to be updated following a 10-year cycle and future revisions will include projects and methods to make progress toward implementing the TMDLs.

6.1 Regulatory

6.1.1 Construction Stormwater

State implementation of the TMDL will be through action on NPDES Permits for regulated construction stormwater. To meet the categorical WLA that includes construction stormwater, construction stormwater activities are required to meet the conditions of the 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.

6.1.2 Industrial Stormwater

To meet the categorical WLA that includes industrial stormwater, industrial stormwater activities are required to meet the conditions of the industrial stormwater general permit or Nonmetallic Mining & Associated Activities General Permit (MNG49) under the NPDES program and properly select, install and maintain all BMPs required under the Permit.

6.1.3 Municipal Separate Storm Sewer System (MS4) Permits

There are no MS4s present in the LRRW.

6.1.4 Wastewater NPDES & SDS Permits

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

6.1.5 Subsurface Sewage Treatment Systems (SSTS) Program

SSTS, commonly known as septic systems, are regulated by Minn. Stat. §§ 115.55 and 115.56. Counties and other local government units (LGUs) that regulate SSTS must meet the requirements for local SSTS programs in Minn. R. ch. 7082. Counties and other LGUs must adopt and implement SSTS ordinances in compliance with Minn. R. chs. 7080, through 7083.

These regulations detail:

- Minimum technical standards for individual and mid-size SSTS;
- A framework for LGU to administer SSTS programs; and
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee.

Counties and other LGUs enforce Minn. R. chs. 7080, through 7083 through their local SSTS ordinance, and issue permits for systems designed with flows up to 10,000 gallons per day (gpd). There are approximately 200 LGUs across Minnesota, and depending on the location, an LGU may be a county, city, township, or sewer district. LGU SSTS ordinances vary across the state. Some require SSTS compliance inspections prior to property transfer, require permits for SSTS repair and septic tank maintenance, and may have other requirements, which are stricter than the state regulations.

Compliance inspections by counties and other LGU are required by Minn. R. for all new construction, and for existing systems if the LGU issues a permit for the addition of a bedroom. In order to increase the number of compliance inspections, the MPCA has developed and administers several grants to LGUs for various ordinances and specific actions. Additional grant dollars are awarded to counties that have additional provisions in their ordinance above the minimum program requirements. The MPCA has worked with counties through the SSTS Implementation and Enforcement Task Force (SIETF) to identify the most beneficial way to use these funds to accelerate SSTS compliance statewide.

The MPCA staff keep a statewide database of known imminent threat to public health or safety (ITPHS) systems that include “straight pipe systems”. These straight pipe systems are reported to the counties or the MPCA by the public. Upon confirmation of a straight pipe system, the county sends out a notification of non-compliance, which starts a 10-month deadline to fix the system and bring it into compliance. From 2006 through 2017, 742 straight pipe systems have been tracked by the MPCA. Seven hundred and one of those were abandoned, fixed, or were found not to be a straight pipe system as defined in Minn. Stat. 115.55, subd. 1. There have been 17 Administrative Penalty Orders issued and docketed in court. The remaining straight pipe systems received a notification of non-compliance.

6.1.6 Feedlot Program

All feedlots in Minnesota are regulated by Minn. R. ch. 7020. The MPCA has regulatory authority of feedlots, but counties may choose to participate in a delegation of the feedlot regulatory authority to the local unit of government. Delegated counties are then able to enforce Minn. R. ch. 7020 (along with any other local rules and regulations) within their respective counties for facilities that are under the Concentrated Animal Feeding Operation (CAFO) threshold. In the LRRW, the counties of Kittson and Marshall are delegated the feedlot regulatory authority. The counties will continue to implement the feedlot program and work with producers on manure management plans.

The MPCA regulates the collection, transportation, storage, processing and disposal of animal manure and other livestock operation waste. The MPCA Feedlot Program implements rules governing these activities, and provides assistance to counties and the livestock industry. The feedlot rules apply to most aspects of livestock waste management including the location, design, construction, operation and management of feedlots, and manure handling facilities.

There are two primary concerns about feedlots in protecting water:

- Ensuring that manure on a feedlot or manure storage area does not run into water and,
- Ensuring that manure is applied to cropland at a rate, time and method that prevents bacteria and other possible contaminants from entering streams, lakes, and ground water.

6.1.7 Nonpoint Source

For the two TMDLs in this report, the vast majority of the pollutant load is attributed to nonpoint sources. Thus, for TMDLs that require reductions in pollutant loads, nonpoint sources will become the main targets for reductions. The existing state statutes/rules pertaining to nonpoint sources include:

- 50-foot buffer required for the shore impact zone of streams classified as protected waters (Minn. Stat. § 103F.201) for agricultural land uses. November 1, 2017, was the deadline for compliance. Ninety-four percent of these waters had buffers as of October 5, 2017[6].
- 16.5-foot minimum width buffer required on public drainage ditches (Minn. Stat. § 103E.021). November 1, 2018, is the deadline for compliance.
  - Preliminary compliance estimates as of September 12, 2017[7] indicate that 37 of Minnesota's 87 counties are 95% to 100% in compliance with the buffer law. Compliance estimates for Kittson, Marshall, and Roseau Counties are 70% to 79%, less than 70%, and 95% to 100%, respectively.
- Protecting highly erodible land within the 300-foot shoreland district (Minn. Stat. § 103F.201).
- Excessive soil loss statute (Minn. Stat. § 103F.415).
- Nuisance nonpoint source pollution (Minn. R. 7050.0210, subp. 2).
- Other measures that may be identified in the WRAPS Report or the future 1W1P.

6.2 Non-regulatory

6.2.1 Pollutant Load Reduction

Reliable means of reducing nonpoint source pollutant loads are addressed in the Lower Red River of the North WRAPS Report (MPCA 2018), a document that is written to be a companion to this TMDL report. In order for the impaired waters to meet water quality standards, the majority of pollutant reductions in the LRRW will need to come from nonpoint sources. Additionally, the lack of riparian cover and presence of naturally occurring fine silts and clays exacerbates sediment related problems (MPCA 2013). As described in the WRAPS report, the strategies and BMPs included there have all been demonstrated to be effective in reducing transport of pollutants to surface water. The combinations of BMPs discussed

[6] http://www.bwsr.state.mn.us/buffers/Buffer_Program_Update_100517.pdf
[7] https://mn.gov/portal/natural-resources/buffer-law/map/compliance-map.jsp

throughout the WRAPS process were derived from Minnesota's Nutrient Reduction Strategy (NRS) (MPCA 2015b) and related tools. As such, they were vetted by a statewide engagement process prior to being applied in the LRRW.

Selection of sites for BMPs will be led by LGUs, including SWCDs, watershed districts, and county planning and zoning offices, with support from state and federal agencies. These BMPs are supported by programs administered primarily by the SWCDs, BWSR, and the Natural Resource Conservation Service (NRCS). Local resource managers are well-trained in promoting, placing, and installing these BMPs. State and local agencies will need to work with landowners to identify priority areas for BMPs and practices that will help reduce runoff, as well as streambank and overland erosion. These BMPs reduce pollutant loads from runoff (i.e. phosphorus, sediment, and pathogens) and loads delivered through drainage tiles or groundwater flow (e.g. nitrates).

To help achieve nonpoint source reductions, the watershed's citizens and communities will need to voluntarily adopt the practices at the necessary scale and rates to achieve the 10-year targets presented in Table 12 of the Lower Red River of the North WRAPS Report. These tables also present the allocations of the pollutant/stressor goals and targets to the primary sources, and the estimated years to meet the goal. The strategies identified and relative adoption rates developed by the WRAPS Local Work Group were used to calculate the adoption rates needed to meet the pollutant/stressor 10-year targets. In addition to public participation, several government programs are in place to support a political and social infrastructure that aims to increase the adoption of strategies that will improve watershed conditions and reduce loading from nonpoint sources.

One example of a government program available is *The Minnesota Agricultural Water Quality Certification Program* (MAWQCP). The MAWQCP is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. Those who implement and maintain approved farm management practices are certified, and in turn obtain regulatory certainty for a period of 10 years.

Through this program, certified producers receive:

- Regulatory certainty**:** certified producers are deemed to be in compliance with any new water quality rules or laws during the period of certification;
- Recognition**:** certified producers may use their status to promote their business as protective of water quality; and
- Priority for technical assistance**:** producers seeking certification can obtain specially designated technical and financial assistance to implement practices that promote water quality.

6.2.2 Prioritization

The WRAPS details a number of tools for local water planners that provide means for identifying priority pollutant sources and implementation work in the watershed. Further, LGUs in the LRRW often employ their own local analysis for determining priorities for work.

6.2.3 Funding

On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the constitution to:

- protect drinking water sources;
- protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat;
- preserve arts and cultural heritage;
- support parks and trails; and
- protect, enhance, and restore lakes, rivers, streams, and groundwater.

This is a secure funding mechanism with the explicit purpose of supporting water quality improvement projects.

Additionally, there are many other funding sources for nonpoint pollutant reduction work; they include but are not limited to the Clean Water Act Section 319 grant program, BWSR state Clean Water Fund implementation funding, and NRCS incentive programs. Programs and activities are also occurring at the local government level, where county staff, commissioners, and residents work together to address water quality issues.

6.2.4 Planning and Implementation

The WRAPS, TMDLs, and all the supporting documents provide a foundation for planning and implementation. Subsequent planning, including voluntary development of 1W1Ps for the LRRW, will draw on the goals, technical information, and tools to describe in detail strategies and actions for implementation. For the purposes of reasonable assurance, the WRAPS document is sufficient in that it provides strategies for achieving pollutant reduction goals. In addition, the commitment and support from the local governmental units will ensure that this TMDL project is carried successfully through implementation.

6.2.5 Tracking Progress

Water monitoring efforts within the LRRW are diverse and constitute a sufficient means for tracking progress and supporting adaptive management (See **Section 7**).

7. Monitoring Plan

Continued stream monitoring within the LRRW will continue primarily through the efforts of the JRWD, TRWD, and the MSTRWD.

The JRWD Overall Plan (JRWD 2004) outlines the monitoring activities within the watershed district. The JRWD coordinates and contributes resources to carry out a water quality monitoring program with the Kittson SWCD as the lead agency. Three locations on the Joe River have been monitored for various parameters, including dissolved oxygen, pH, alkalinity, temperature, ammonia, Kjeldahl and total nitrogen, ortho phosphorus, alkalinity, and fecal coliform bacteria. In addition, some water samples have been tested for the presence of pesticides. Stream flow monitoring and data collection has been undertaken by the USGS at selected points on the Red River and during periods of flooding at various other locations within the JRWD.

As outlined in the TRWD 2014 Annual Report updates to the 2004 Overall Plan (TRWD 2014), water quality, stream flow, and velocities will continue to be monitored and recorded for selected sites on the rivers, coulees, and ditches within the TRWD. Stream flows and velocities will be measured by TRWD staff at each site during runoff events and data will be reported to interested agencies and persons, including the National Weather Service, DNR, and various other state and local agencies. The long-range goal is to record data not only for the high flow events but for summer low flows as well (TRWD 2014).

As outlined in the Section 5.1.5 of the MSTRWD WMP (HEI and MSTRWD 2011), the MSTRWD has established regional assessment locations (RALs) in streams throughout the LRRW, and are currently employing a water quality monitoring program that consists of financial support to the River Watch Program and International Water Institute. Collected samples are analyzed for flow, stage-elevation, biology (index of biological integrity [IBI]), turbidity, *E. coli*, and water chemistry.

In addition to the stream monitoring sponsored by the JRWD, TRWD, and the MSTRWD, the MPCA also has on-going monitoring in the LRRW. Their major watershed outlet monitoring will continue to provide a long-term on-going record of water quality at the LRRW outlet. The MPCA will also return to the watershed under their Intensive Watershed Monitoring program in 2023 to 2025.

The lakes of the LRRW are not assessable, so there is no routine lake monitoring at this time or planned for the future.

8. Implementation Strategy Summary

8.1 Permitted Sources

8.1.1 Construction Stormwater

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

8.1.2 Industrial Stormwater

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

8.1.3 MS4

There are no MS4s in the LRRW. Therefore, no implementation strategies were developed for MS4s in the LRRW.

8.1.4 Wastewater

The current requirements of the WWTFs' NPDES Permits are sufficient for the WWTFs in the LRRW and no new implementation strategies are necessary.

8.2 Non-Permitted Sources

Water quality restoration and implementation strategies within the LRRW were identified through collaboration with state and local partners. The identified implementation strategies and priorities are discussed in the Lower Red River of the North WRAPS Report (HEI 2018) and the LRRW Biotic SID Report

(MPCA 2015a). Due to the homogeneous nature of the LRRW, most of the suggested strategies are applicable throughout the LRRW. Below is a summary of the suggested strategies needed to achieve restoration goals in the LRRW:

- Prevent or mitigate activities that will further alter the hydrology of the watershed;
- Improve storage capacity within the watershed through storage projects;
- Implement set-back dikes and side water inlets;
- Pursue opportunities and options to attenuate peak flows and augment base flows in streams throughout the watershed;
- Re-establish natural functioning stream channels wherever possible using natural channel design principles;
- Increase the quantity and quality of instream habitat throughout the watershed;
- Establish and/or protect riparian corridors along all waterways, including ditches, using native vegetation whenever possible;
- Increase the stability of streambanks throughout the watershed;
- Implement agricultural BMPs to reduce soil erosion from fields;
- Implement agricultural BMPs to reduce delivery of sediment to surface waters (i.e., grass filter strips); and
- Limit or exclude the access of livestock to waterways

The JRWD, TRWD, MSTRWD, and the Kittson, Marshall, and Roseau SWCDs have a long history of improving water quality. All three have been actively seeking grants to improve local water quality since the passage of the Clean Water, Land and Legacy Amendment, and before. The following are examples of past implementation project accomplishments by LGUs in the LRRW.

In 1963, the JRWD partnered with the Natural Resources Conservation Service (formerly Soil Conservation Service) and the Kittson SWCD to plan for flood control under the Federal Public Law 566 Program. Installation of the structures and channel work took place between 1968 and 1971. The improved system consists of 26.47 miles, which removes excess water within the JRWD. The JRWD has also been involved with a cost share program to construct farmstead ring dikes. Under this program, state funding and funding from the Red River Watershed Management Board is utilized to plan, design, and construct ring dikes around eligible farmsteads for the purpose of flood protection.

The TRWD has constructed several projects within the unnamed coulee system of the LRRW. Between 2005 and 2008, the TRWD partnered with federal, state, and local funding sources to construct a flood control project, Springbrook/County Road 61. A setback dike along 3.5 miles of ditch and a meandering channel was constructed to take the place of the ditch. The project will prevent overland flooding from channel breakouts, and created 3.5 miles of a meandering stream with grass buffer on either side. In 2009, TRWD constructed a flood control and water conveyance project for the city of Kennedy (Kennedy #6), consisting of two miles of legal ditch system to convey flows from a 50 square mile upstream drainage area through the City, minimizing the flood damages that occur. In 2013, the TRWD completed Springbrook #10 PL566, which included set back dikes and side water inlets along existing waterways.

The TRWD also operates and maintains several legal ditch systems, including Kittson County Ditch (KCD) 10, Judicial Ditch 10, Judicial Ditch 3, and KCD 7. Although these flood protection projects were implemented for flood protection, there are additional water quality benefits associated with them. Impounding water during flood periods reduces the peak flows and may reduce the sediment load in a stream. The critical flow regime for sediment in the impaired reaches is the very high flows (flood flows) (see **Table 4-3**). Reducing the peak flows, reduces the magnitude of the critical flows, therefore reduces the maximum sediment loads.

The MSTRWD has planted riparian grass buffer strips along the legal drains to improve water quality throughout the District. In 2008, the MSTRWD partnered with the state and the Red River Watershed Management Board to begin construction of the Agassiz Valley Water Resource Management Project, which combines flood control and environmental enhancement features. The project was operational in the spring of 2010.

The Marshall SWCD has a history of partnership with the USDA NRCS/Farm Service Agency to provide funded programs for conservation practice implementation, BMP implementation, and conservation easements. These programs have been delivered through the Environmental Quality Incentives Program (EQIP), the Wildlife Habitat Incentive Program (WHIP), the Conservation Stewardship Program (CSP), and the Conservation Reserve Program (CRP).

8.3 Cost

The CWLA requires that a TMDL study include an overall approximation of implementation costs (Minn. Stat. 2007, § 114D.25). Based on cost estimates from current, planned, and proposed work (listed above) in the LRRW, a reasonable estimate to continue efforts for reducing sediment and bacterial loading in the impaired reaches addressed in this report, would be $20 to $30 million dollars over 10 years. These dollars would be spent primarily on practices such as regional water retention projects, riparian vegetative buffers, sediment BMPs (water and sediment control basins and side inlets), pasture management, conservation tillage, vegetative practices, wetland restorations, and structural practices. Cost estimates for implementing practices will further be refined within the local water planning.

8.4 Adaptive Management

Adaptive management (**Figure 8-1)** is an iterative implementation process that makes progress toward achieving water quality goals while using any new data and information to reduce uncertainty and adjust implementation activities. It is an ongoing process of evaluating and adjusting the strategies and activities that will be developed to implement the TMDLs through on-going local water planning. The implementation of practicable controls should take place even while additional data collection and analysis are conducted to guide future implementation actions. Adaptive management does not include changes to water quality standards or loading capacity. Any changes to water quality standards or loading capacity must be preceded by appropriate administrative processes, including public notice and an opportunity for public review and comment.

Implementation of TMDL-related activities can take many years, and water quality benefits associated with these activities can also take many years. As the pollutant source dynamics within the LRRW are better understood, implementation strategies and activities will be adjusted and refined through local water plans and WRAPS updates to efficiently meet the TMDLs and lay the groundwork for de-listing the impaired reaches. The follow up water monitoring program outlined in **Section 7** will be integral to the adaptive management approach, providing assurance that implementation measures are succeeding in attaining water quality standards.

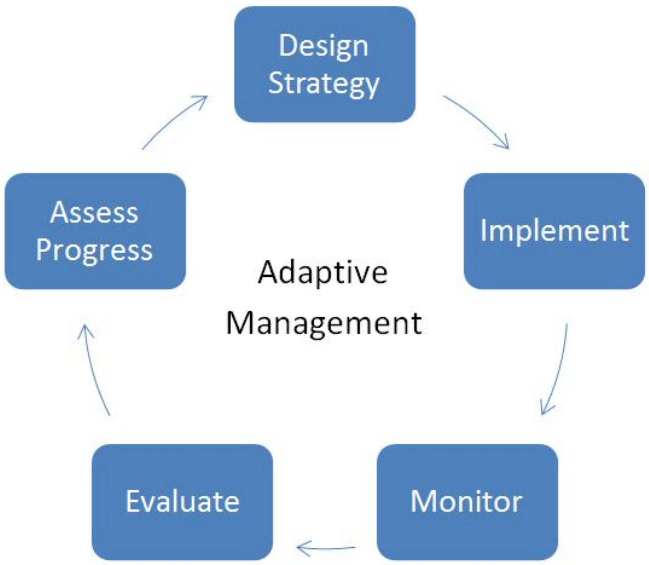

Figure 8-1: Adaptive Management.

9. Public Participation

Public participation during this TMDL process was a coordinated effort led by the JRWD, TRWD, and MSTRWD. A TMDL stakeholder group was identified early in the TMDL process and kept up to date of actions as the project proceeded. Members of the group included area landowners, representatives from the area SWCDs, counties and townships, representatives from state agencies (MPCA, DNR, BWSR), and board members of the three watershed districts. A Professional Judgement Group (PJG) meeting was held on April 11, 2011, with MPCA and local partners to discuss the results of water quality assessments on waterbodies in the LRRW. TMDL updates were regularly presented through open houses and public meetings in the LRRW, including a public information meeting at the beginning of the WRAPS project on February 26, 2013, at the Eagle's Club in Karlstad, Minnesota; project updates to the technical advisory committee on February 4, 2014, and June 9, 2015; and a project update to the Board of Managers of the Snake-Two-Joe Joint Board on November 19, 2015. In addition, the MPCA maintains a watershed webpage[8] to keep the public informed of efforts in the watershed.

Since water quality is among the ongoing priorities of the JRWD, TRWD, and MSTRWD management activities, future public participation will continue to be led by these three watershed districts. The Kittson, Marshall, and Roseau SWCDs will also continue with their public participation programs and activities. The watershed districts and SWCDs will update, educate, and engage stakeholders on water quality issues through typical communications, including plan update events and on the MSTRWD website.

Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from August 13, 2018 through September 12, 2018. There was one comment letter received and responded to as a result of the public comment period.

[8] https://www.pca.state.mn.us/water/watersheds/red-river-north-tamarac-river

10. Literature Cited

Carlyle, W. J. 1984. Water in the Red River Valley of the North. Geographical Review 74(3): 331-358.

Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States. Photogrammetric Engineering and Remote Sensing, 77(9): 858-864.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, 81(5): 345-354.

Houston Engineering, Inc. (HEI) and Middle-Snake-Tamarac Rivers Watershed District (MSTRWD). 2011. Final Ten Year Watershed Management Plan. May 2011. Available at: http://mstrwd.org/wp-content/uploads/MSTRWD-FINAL-PLAN-MAY_2011.pdf

Houston Engineering, Inc. (HEI). 2013. Watershed Conditions Report. Prepared for MPCA. Maple Grove, MN. 112pp.

Houston Engineering, Inc. (HEI). 2018. Lower Red River of the North Watershed Restoration and Protection Strategy Report. August 2018 Draft.

Joe River Watershed District (JRWD). 2004. Overall Plan of the Joe River Watershed District. Available at: http://www.mnwatershed.org/vertical/Sites/%7B8075FBF0-4136-414E-99AC-FC56C14C0AC9%7D/uploads/%7B33E513EE-0071-4533-A898-1F71A8CBC0D0%7D.PDF

Minnesota Pollution Control Agency (MPCA). 2007. Minnesota Statewide Mercury Total Maximum Daily Load. wq-iw4-01b. St. Paul, MN, March, 2007.

Minnesota Pollution Control Agency (MPCA). 2012. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. Minnesota Pollution Control Agency. St. Paul, MN

Minnesota Pollution Control Agency (MPCA). 2013. Lower Red River of the North Watershed Monitoring and Assessment Report. January 2013.

Minnesota Pollution Control Agency (MPCA). 2014a. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. 2014 Assessment and Listing Cycle.

Minnesota Pollution Control Agency (MPCA). 2014b. Required Language and Recommendations for all Total Maximum Daily Loads Developed in Minnesota. wq-iw1-53. St. Paul, Minnesota, February 2014.

Minnesota Pollution Control Agency (MPCA). 2015a. Lower Red River of the North Watershed Stressor Identification Report. October 2015. DRAFT.

Minnesota Pollution Control Agency (MPCA), 2015b. “Nutrient Reduction Strategy”. http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/nutrient-reduction/nutrient-reduction-strategy.html

Minnesota Pollution Control Agency (MPCA). 2016. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. 2016 Assessment and Listing Cycle.

RESPEC. 2014. Hydrological and Water Quality Calibration and Validation of Lower Red Watershed HSPF Model. Memorandum to Minnesota Pollution Control Agency, Detroit Lakes, MN.

Two Rivers Watershed District (TRWD). 2004. Overall Plan of the Two Rivers Watershed District. Available at: http://www.tworiverswd.com/pdf/Overall%20Plan%202004%20FINAL.pdf

Two Rivers Watershed District (TRWD). 2014. Two Rivers Watershed District 2014 Annual Report. Available at: http://www.tworiverswd.com/pdf/2014%20TRWD%20Annual%20Report%20.pdf

U.S. Environmental Protection Agency (EPA). 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006. Watershed Branch (4503T), United States Environmental Protection Agency, Washington, DC. 74 pp

Appendices

Appendix A

Lower Red River of the North Watershed Load Duration Curves Memo

MEMO

(External Correspondence)

To: Dan Money, TRWD
Tara Mercil, MPCA

From: Timothy Erickson, PE
Mark R. Deutschman, Ph.D., P.E.

Date: February 2, 2016

Subject: Lower Red River Watershed Load Duration Curves

File: 6279-002

INTRODUCTION

This memorandum summarizes the methods used and results for creating load duration curves (LDCs) for impaired stream segments (delineated by assessment unit identification [AUID] numbers) in the Lower Red River Watershed (LRRW)[9]. One segment (09020311-505) exceeds total suspended solids (TSS) standards, and available evidence supports elevated turbidity/high TSS as a stressor for aquatic macroinvertebrate/fishes bioassessments impairments in a second segment (09020311-503). Preparation of the LDCs includes computing necessary load reductions within each flow regime of the curve, which will be used to develop total maximum daily loads (TMDLs) for impaired reaches.

A list of the two AUIDs addressed in this memorandum is included in **Table 1**. Also included is the pollutant (Turbidity) that LDCs will be used to address, a list of water quality monitoring stations located along each AUID and the associated HSPF (Hydrologic Simulation Program-Fortran) model sub-basin which was used to represent flows for creating the curves (no U.S. Geological Survey [USGS] gauging sites were present for observed flow). In addition, the two AUIDs and monitoring locations are mapped in **Figure 1**.

Table 1. AUIDs associated with LDCs, pollutants, and data used.

AUID Suffix (09020311-XXX)	Reach Name	Pollutant/Stressor	Water Quality Stations	HSPF Flow RCHRES ID
503	Tamarac R.: Florian Park Reservoir to Stephen Dam	Turbidity	S002-992, S002-993, S005-569	RCHRES 360
505	Tamarac R.: Stephen Dam to Red R.	Turbidity	S002-100, S002-990, S002-991, S005-788	RCHRES 490

[9] Also known as the Red River of the North - Tamarac River Watershed

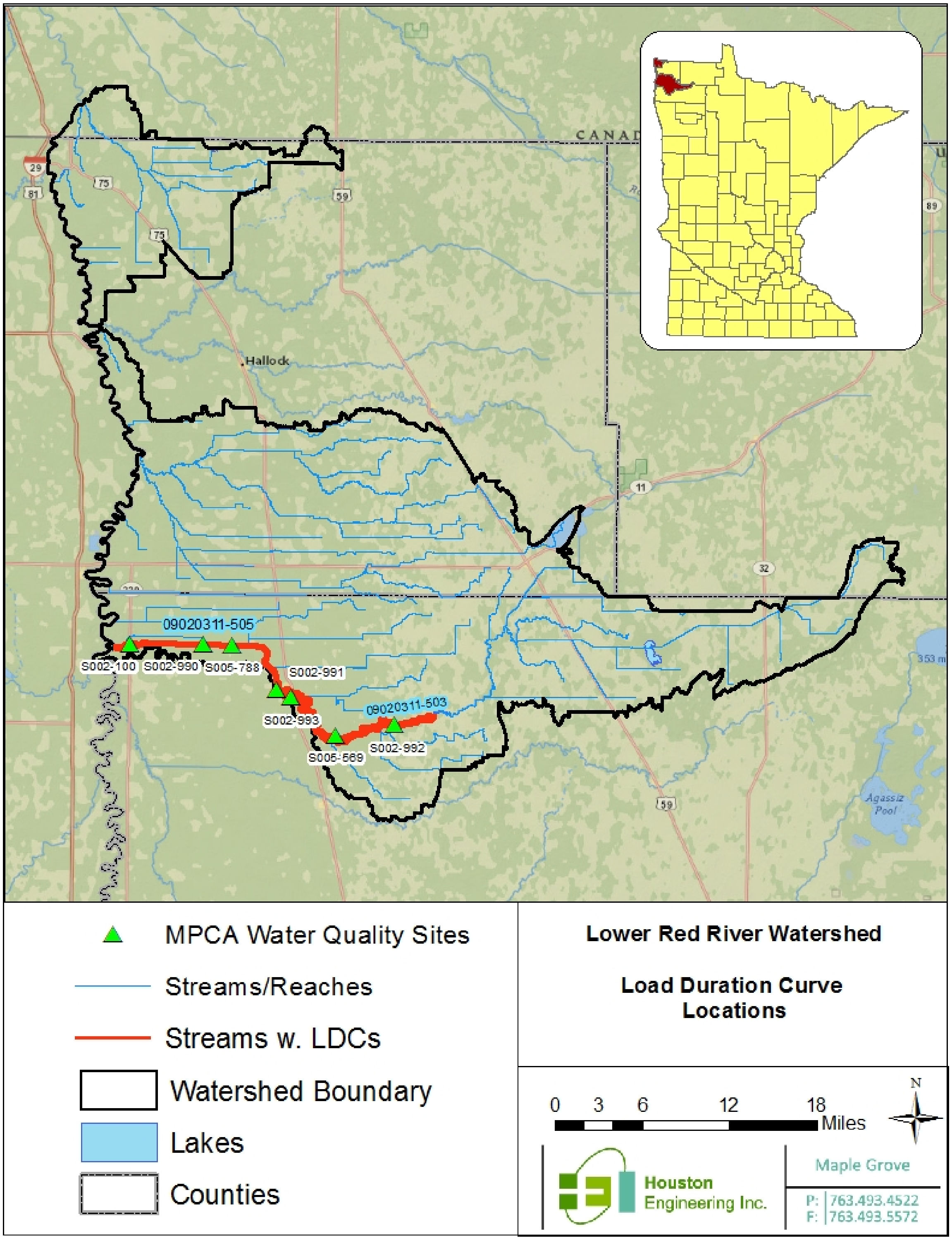

Figure 1. Map of AUIDs and water quality monitoring locations used for LDCs in the Lower Red River Watershed.

METHODOLOGY

LDCs were developed for each of the two AUIDs listed in **Table 1**. Each LDC was developed by combining the (simulated or observed) river/stream flow at the downstream end of the AUID with the measured concentrations available within the segment. Methods detailed in the U.S. Environmental Protection Agency (EPA) document *An Approach for Using Load Duration Curves in the Development of TMDLs* were used in creating the curves (EPA 2007). A summary of this methodology, as applied in the LRRW, is provided below. Full details on LDC methods can be found in the EPA guidance (EPA 2007).

Data

Observed daily flow data is limited within the LRRW and no USGS gauging stations were in reaches needing LDCs. Therefore, simulated daily mean flows from the LRRW HSPF model (RESPEC 2014) were used to create the LDCs for both AUIDs. The HSPF model simulates flows from 1995-2009. In order to best capture the flow regimes of each AUID, the period 1996 – 2009 was used in development of the LDCs and 1995 was used as a warm-up period for the model; however, simulated flow should not be considered an exact representation of actual flow (RESPEC 2014).

The water quality data used in this work was obtained from the Minnesota Pollution Control Agency (MPCA) through their EQuIS (Environmental Quality Information System) database. For the purposes of creating the curves (which will inform TMDL development), water quality data during the simulation period (1996-2009) was used. While data exists for turbidity and TSS beyond 2009, the HSPF model only estimates flows for 1995-2009.

Table 2 summarizes the water quality data used in the TSS LDCs for two AUIDs in the LRRW.

Table 2. Water quality data used for each LDC.

AUID Suffix (09020301-XXX)	Water Quality Monitoring Locations	Turbidity/ TSS Data
503	S002-992, S002-993, S005-569	2002-2009
505	S002-100, S002-990, S002-991, S005-788	2000-2009

Total Suspended Solids LDCs

The TSS LDCs were created using the Southern Region TSS standard of 65 mg/L. The TSS LDCs were calculated using the TSS data collected during the assessment period, April through September. In addition to TSS data, the useable dataset was expanded using converted turbidity data. The proposed standard only applies during the months of April through September. Therefore, the proposed TSS standard LDCs were created using turbidity/TSS data and flow data from this period.

When available, TSS was used as the preferred value for calculating solids loading. However, since turbidity data may be prevalent in the historic record, turbidity was used to expand the TSS dataset. This is consistent with MPCA guidance (MPCA 2012). To convert turbidity to TSS, paired TSS and turbidity data were analyzed and a regression was applied to find a relationship (**Figure 2**). The resulting regression equation for converting turbidity values (in NTU/NTRU) in the LRRW to TSS (in mg/L) is:

$$TSS = 1.1438 * Turbidity - 5.6379$$

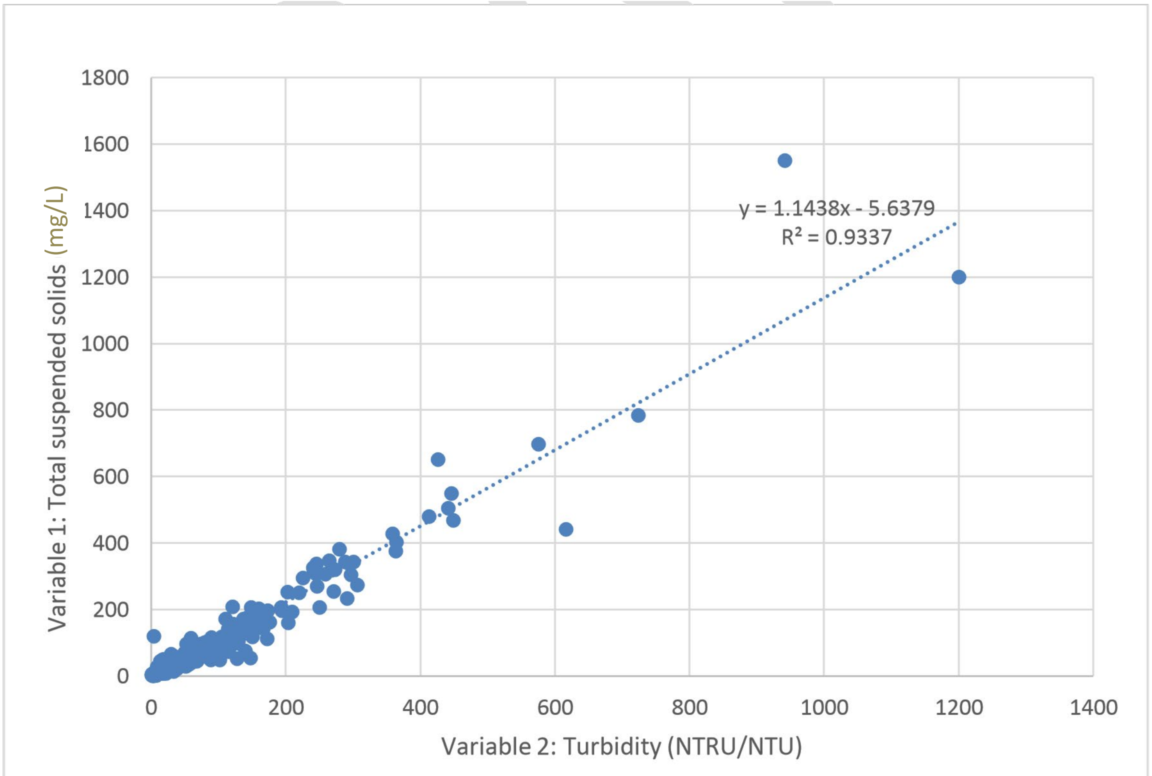

Figure 2: Relationship between Turbidity and Total Suspended Solids in the LRRW.

A 10% margin of safety (MOS) was applied to each of the "allowable" loading curves.

Flow Regimes and LDCs

A system's water quality often varies based on flow regime, with elevated pollutant loadings sometimes occurring more frequently under one regime or another. Loading dynamics during certain flow conditions can be indicative of the type of pollutant source causing an exceedance (e.g., point sources contributing more loading under low flow conditions). The LDC approach identifies these flow regimes and presents the observed and "allowable" loading within each regime, to compute necessary load reductions. To represent different types of flow events and pollutant loading during these events, five flow regimes were identified in the LRRW LDCs based on percent exceedance: Very High Flows (0%-10%), High Flows (10%-40%), Mid Flows (40%-60%), Low Flows (60%-90%), and Very Low Flows (90%-100%). An example TSS LDC (for AUID 09020311-505) is shown in **Figure 3**, identifying the flow regimes.

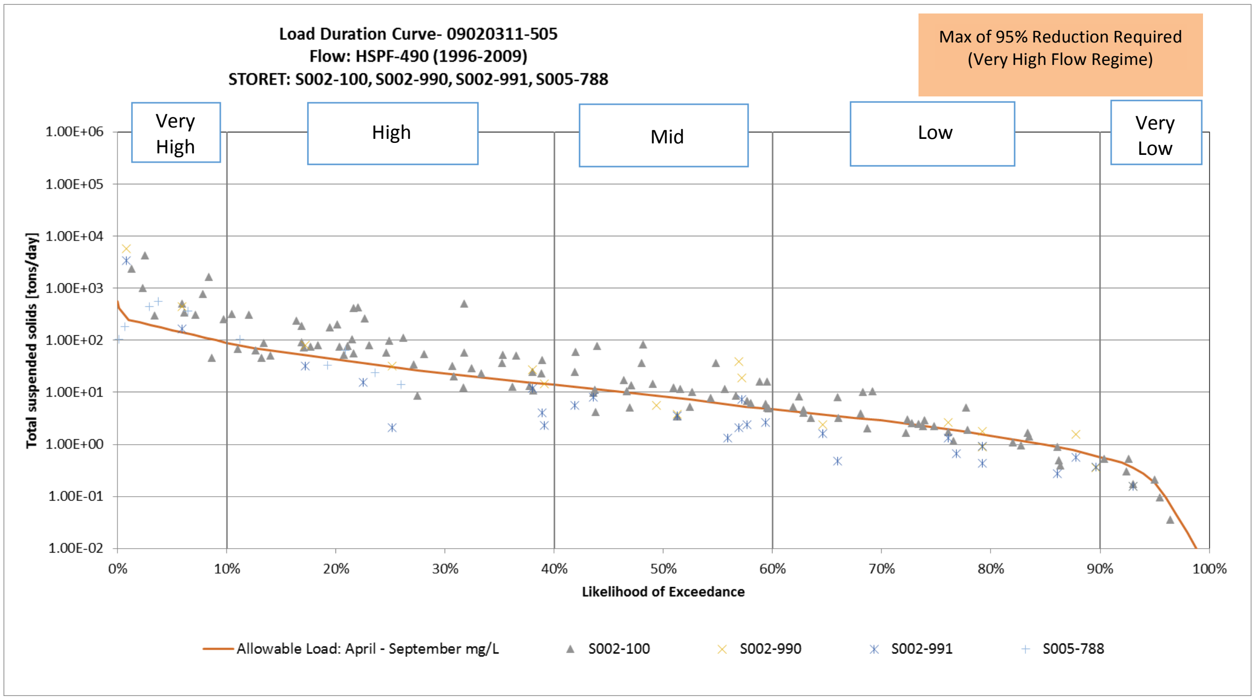

Figure 3. Example TSS LDC (AUID 09020311-505) showing flow regimes.

The example LDC in **Figure 3** was created with flow and water quality data from April through September. The percent likelihood of flow exceedance is shown on the x-axis, while the computed TSS loading is shown on the y-axis. "Allowable" loadings under each flow condition, based on the water quality standards, is shown with an orange line. Observed loads are also shown, indicated by points on the plot. Observed loads are broken out by station, allowing for a detailed examination of where loading exceedances have occurred.

RESULTS

Tamarac River
AUID 09020311-503 TSS

A TSS LDC was generated for AUID 09020311-503 in the Tamarac River and is shown in **Figure 4**. The orange line shows the allowable load for the southern nutrient region TSS standard of 65 mg/L in **Figure 4**. AUID 09020311-503 is listed on the 303(d) list as having aquatic life use impairments due to aquatic macroinvertebrate bioassessments and fishes bioassessments. The LDC was generated for TSS/turbidity as a surrogate for the biological impairments. Available evidence supports TSS as a stressor to both biological communities (MPCA 2015).

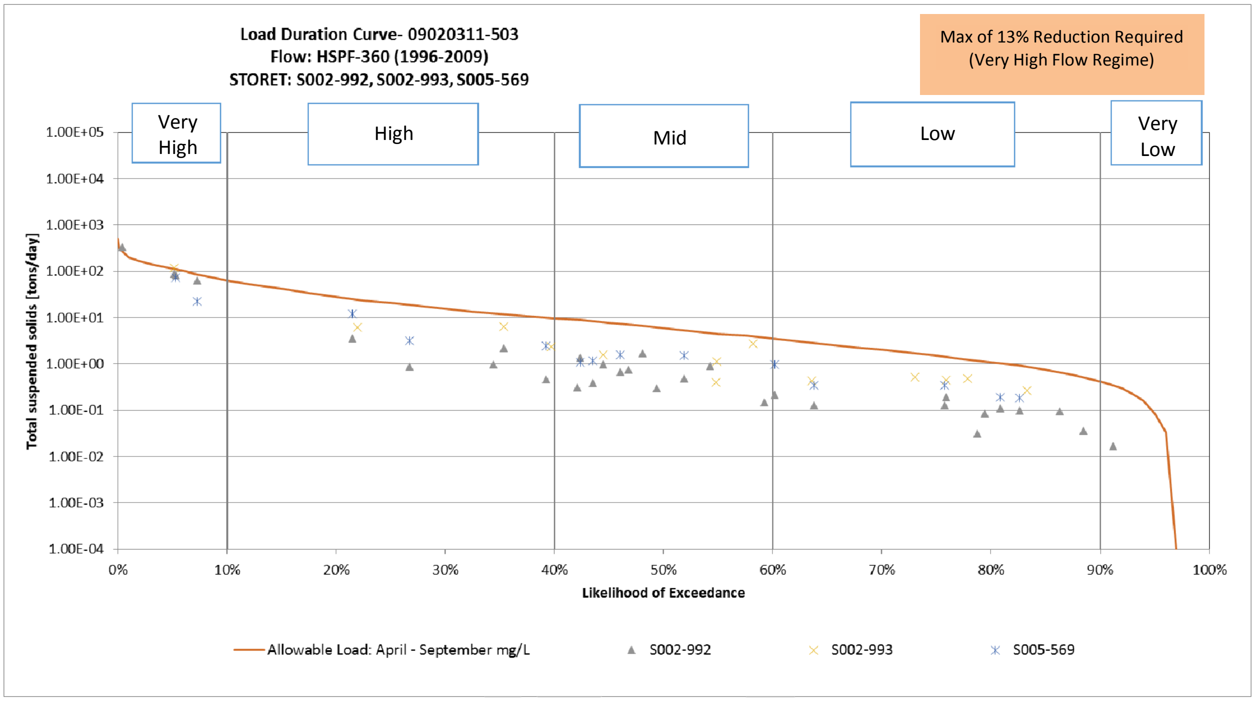

Figure 4. AUID 09020311-503 TSS LDC.

Table 3. AUID 09020311-503 TSS Load Reduction Table.

Flow Regime	Median Flow [cfs]	Observed Concentration [mg/L]	Observed Load [tons/day]	Target Load [tons/day]	Load minus MOS [tons/day]	Load Reduction [tons/day]	Percent Load Reduction
0%-10%	655.7	74.5	131.66	114.9	103.4	16.72	13%
10%-40%	118.6	28.3	9.06	20.8	18.7	-11.74	-130%
40%-60%	33.7	19.0	1.73	5.9	5.3	-4.18	-242%
60%-90%	8.7	20.6	0.48	1.5	1.4	-1.04	-216%
90%-100%	0.48	3.3	0.004	0.1	0.1	-0.08	-1866%

Table 3 shows the observed loads, allowable loads, and load reductions for the five flow regimes. As shown in **Table 3**, a maximum load reduction of 13% during very high flow conditions is required to meet the water quality standard.

Tamarac River
AUID 09020311-505 TSS

A TSS LDC was generated for AUID 09020311-505 in the Tamarac River and is shown in **Figure 5**. The orange line shows the allowable load for the southern nutrient region TSS standard of 65 mg/L in **Figure 5**. As of the proposed 2018 303(d) list, this AUID is not yet listed as having an aquatic life use impairment due to TSS, because an assessment of aquatic life use was deferred pending implementation of TALU (MPCA 2013). The LDC was still developed, because data clearly indicates exceedingly high TSS.

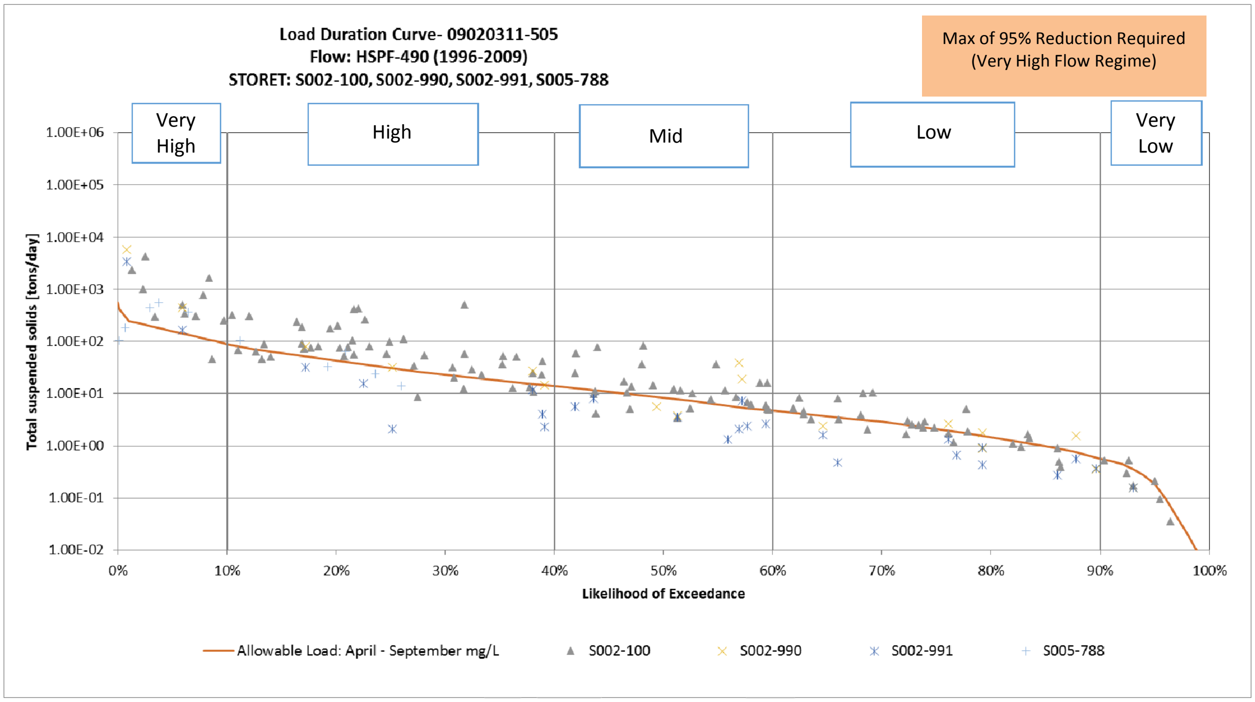

Figure 5. AUID 09020311-505 TSS LDC.

Table 4. AUID 09020311-505 TSS Load Reduction Table.

Flow Regime	Median Flow [cfs]	Observed Concentration [mg/L]	Observed Load [tons/day]	Target Load [tons/day]	Load minus MOS [tons/day]	Load Reduction [tons/day]	Percent Load Reduction
0%-10%	895.6	1270.0	3067.2	157.0	141.3	2910.2	95%
10%-40%	177.9	271.1	130.1	31.2	28.1	98.9	76%
40%-60%	47.3	299.2	38.1	8.3	7.5	29.9	78%
60%-90%	11.8	131.7	4.18	2.1	1.9	2.12	51%
90%-100%	1.06	74.8	0.21	0.2	0.2	0.03	13%

Table 4 shows the observed loads, allowable loads, and load reductions for the five flow regimes. As shown in **Table 4**, a maximum reduction of 95% is needed during the very high flow condition to meet the water quality standard.

Critical Condition

A summary of the TSS standard load reduction results can be found in **Table 5**. Results are summarized by indicating the maximum required percent load reduction for each curve and the flow regime and water quality criteria under which this maximum reduction occurred (i.e., the critical flow regime and criteria).. The critical flow regime for the two TSS LDCs is very high flow conditions.

Table 5. Maximum required sediment load reductions for the LRW.

AUID Suffix (09020311-XXX)	TSS Standard	
	Max. % Load Reduction	Critical Flow Regime
503	13%	Very High
505	95%	Very High

CONCLUSION

TSS standard LDCs were developed for two AUIDs in the LRRW based on impairment, exceedance of the standard, and/or stressor status. The curves were developed following the methods in the EPA guidance document, *An Approach for Using Load Duration Curves in the Development of TMDLs* (EPA 2007). For TSS, a 13% load reduction during very high flow conditions is necessary for AUID 09020311-503, and a 95% load reduction during the very high flow conditions for AUID 09020311-505.

REFERENCES

Minnesota Pollution Control Agency (MPCA). 2012. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. Minnesota Pollution Control Agency. St. Paul, MN.

Minnesota Pollution Control Agency (MPCA). 2013. Lower Red River of the North Watershed Monitoring and Assessment Report. January 2013.

Minnesota Pollution Control Agency (MPCA). 2015. Lower Red River of the North Watershed Stressor Identification Report. December, 2015.

RESPEC. 2014. Hydrological and Water Quality Calibration and Validation of Lower Red Watershed HSPF Model. Memorandum to Minnesota Pollution Control Agency, Detroit Lakes, MN.

United States Environmental Protection Agency (EPA). 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006. August 2007.