LOWER MINNESOTA RIVER
WATERSHED DISTRICT

October 2019 Administrator report
From: Linda Loomis, Administrator
To: LMRWD Board of Managers

In addition to items on the meeting agenda, work continues on the following District projects and issues:

## Other Work

**Minnesota River TMDLs/WRAPS**
The LMRWD reviewed the TMDL/WRAP reports for the Middle Minnesota River and the Lower Minnesota River. (LMRWD comments on the Watonwan were attached to last month's Admin report) Comments by the LMRWD are attached.

The LMRWD did not send any comments to the MPCA regarding the Greater Blue Earth/Minnesota River TSS TMDL because we had previously been able to provide feedback to the MPCA on this report before it was released for public comment.

The Board might be interested in comments from the Minnesota Corn Growers Association.

https://www.mncorn.org/2019/09/24/comments-detail-efforts-by-corn-farmers-to-protect-minnesota-river/

**Orange Line**
Construction has begun on the tunnel underneath I-494 at Knox Avenue. The ramp from south bound 35W to west bound 494 will be closed for an estimated three weeks beginning October 17the.

**MAWD**
MAWD Day at the Capital has been scheduled for March 18 and 19, 2020. The event will be held at the Double Tree in downtown St. Paul. Minnehaha Creek WD is hosting the 2020 Summer Tour for MAWD. Dates for the Summer Tour have not been set.

The Resolution Committee for MAWD recommended approval of the Resolution submitted by the LMRWD. The LMRWD will also be making a presentation at the conference on the geomorphic assessment of Trout Streams. At the September Board meeting the Board asked about the process MAWD used to determine which items on the its legislative would remain active and which ones would be placed in the "parking lot". I spoke with Emily Javens about this. She said that the MAWD legislative committee reviewed the accomplishments at the 2019 session and at each resolution that had been approved by the membership. They made recommendations to the MAWD Board of Directors and the Board went through the same process to come up with the list. She said that if the LMRWD would like an item placed on the "parking lot" moved to the priority list, the best approach would be to network with MAWD Board members. She also said that any District that wanted an item reconsidered could always write a letter or otherwise talk to the MAWD Board. She said that the legislative committee will be meeting after the Annual Conference to hold a similar discussion to include any new resolutions adopted at the Annual Meeting.

The Board will hold a work session ahead of the November Board meeting to discuss services that the LMRWD should receive from MAWD and also determine if any managers will attend the annual conference and appoint delegates to the Annual meeting.

**MAWA (Minnesota Association of Watershed Administrators)**
On October 9th, I attended a meeting of the Watershed District Administrators. Emily Javens provided an update of MAWD activities. Margaret Johnson (middle Fork Crow River WD) provided an update from the Legislative Committee of MAWD regarding the resolutions ( see previous item). There was some discussion of how BWSR intends to distribute watershed based funding money, however no one from BWSR was in attendance, so the actual proposal from BWSR was not very clear. There was also discussion regarding Watershed District offices (and I believe there will be a session at the Annual Conference regarding this); Citizen Advisory Committees, how do other districts manage these groups; Affiliations and memberships in other organizations outside of MAWD; Sharing of Watershed District Policies; and a brief presentation on a Sharepoint site that has been set up for Watershed Districts to use as a reference.

**Metro MAWD**
I attended the Metro MAWD meeting yesterday evening. Rice Creek WD gave a presentation on modeling they have done for drainage and flooding. They will be providing some of the same information at the MAWD Annual Conference at the Drainage Seminar during the pre-conference session.

Emily Javens, MAWD Executive Director, provided and update of MAWD activities - Managers should be receiving Annual Conference packet in the next 10 days. Mary Texar, Cap Region WD, reported on the most recent update to the MAWD Strategic Plan. I have been provided with a copy for the Managers to discuss at the work session before the November Board meeting. MAWD received 15 resolutions for consideration at the Annual meeting. 13 of the 15 have been recommended to move forward. MAWD is working to pull together a booklet featuring each Watershed District and WMO that is a member of MAWD. The intent of this booklet is to give information to Legislators about the work that is being done by WDs and WMOs. This is a reaction to the efforts by local developers to convince Legislators that WDs have too much authority.

Kevin Bigalke, BWSR, reported on the new system they will use to distribute Clean Water Funds to implement water improvement projects. Funds will be granted within the metro area along hydrological boundaries, rather than by County as was done in 2018. The Minnesota River will be divided into North and South Sections, so the LMRWD will only have be a party to 2 groups to determine how best to distribute funds. The formula BWSR used to determine how much money each area will be allocated is available on its website.

John Bilotta, Minnesota Stormwater Research Council, provided a brief update on what the Council has been working on. His report can be found online at:
https://www.wrc.umn.edu/sites/wrc.umn.edu/files/mn_stormwater_research_program_2017-18_highlight_report.pdf

## Watershed Plan Projects

**Eden Prairie Area #3 Stabilization: -** Staff is working to organize a meeting of all the consultants that have worked on this project for the LMRWD to discuss nest steps. The City of Eden Prairie will be invited to the meeting.

**Riley Creek Cooperative project/Lower Riley Creek restoration** - No new information has been received since the last update. Project website: http://www.rpbcwd.org/whats-happening/projects/lower-riley-creek-ecological-restoration

**Seminary Fen ravine stabilization project:** - Lisa Frenette is trying to find a time to meet with Representative Hanson to discuss this finding funds to replace the grant that was not funded. Project website: http://lowermnriverwd.org/projects/bwsr-clean-water-fund-grant-administration

**East Chaska Creek: (Carver County Watershed Based Funding):** - Staff is beginning work on the construction specifications in order to place the project out for bids. Staff will work with Barr Engineering and the City of Chaska to assist with the bidding process. Project website: http://lowermnriverwd.org/projects/east-chaska-creek-bank-stabilization

**Schroeder Acres Park (Scott County Watershed Based Funding):** This project has not begun and staff has prepared a cooperative agreement that has been reviewed by LMRWD legal counsel. The agreement has been sent to the city for review. Project website: http://lowermnriverwd.org/projects/schroeder-acres-parkeagle-creek-sub-watershed-stormwater-study

**Shakopee Downtown BMP Retrofit (Scott County Watershed Based Funding):** LMRWD legal counsel has approved the draft agreement. The City requested some minor clarifications to the agreement and LMRWD and City staffs are working on getting the agreements signed. Project website: http://lowermnriverwd.org/projects/targeted-bmps-downtown-shakopee

**PLOC (Prior Lake Outlet Channel) Restoration (Scott County Watershed Based Funding):** LMRWD legal counsel has approved the draft agreement. The City requested some minor clarifications to the agreement and LMRWD and City staffs are working on getting the agreements signed. Project website: http://lowermnriverwd.org/projects/prior-lake-outlet-channel-realignmentwetland-restoration

**Dakota County Fen Gap Analysis and Conceptual Model (Dakota County Watershed Based Funding):** Project website: http://lowermnriverwd.org/projects/dakota-county-fen-study-management-plan

**Hennepin County Chloride Project (Hennepin County Watershed Based Funding):** No new information since last update.

**Vegetation Management Plan:** No new information since last update.

**Sustainable Lake Management Plan - Trout Lakes:** This project is currently on hold while staff works on other projects.

**Geomorphic Assessment of Trout Streams:** This report was finalized this week. I will review the report and it will be available for Managers review at the November Board meeting. Presentation of this project was approved by the MAWD Conference committee.

**Spring Creek Cost Share:** Staff shared the reports with the city of Carver and spoke with Aaron Schmidt of Bolton - Menk, city engineer. We are waiting for a response from the city.

**West Chaska Creek Re-meander:** No new information to report since last update.

## Project Reviews

**MNDOT ADA Trail improvements in Mendota:** MNDOT submitted plans to the LMRWD regarding ADA improvements to its trail in downtown Mendota. The project did not meet the thresholds for a permit from the LMRWD. Staff requested that MNDOT provide all planned projects to the LMRWD at one time. LMRWD is concerned that all projects taken together would trigger the need for a permit and that to

come to the LMRWD in increments defeats the purpose of the LMRWD standards and permitting program.

**MNDOT trail drainage improvements in Lilydale:** MNDOT notified the LMRWD that it is planning to address winter drainage issues on TH 13 in Lilydale. This project does not meet the threshold to trigger a permit. The project is not in a high value resource or the steep slope overlay area. Staff did express concern to MNDOT about where the drainage will be directed and ask MNDOT to consider negative impacts from any change to surface water flows from changes to drainage patterns.

**MNDOT Trail - 494:** No new information to report since last update.

**MNDOT - TH5:** No new information to report since last update.

**City of Chanhassen - Moon Valley Gravel Pit:** No new information to report since last update.

**City of Carver - Hawthorne Ridge:** No new information to report since last update.

**Metropolitan Airport Commission - Environmental Assessment Worksheet for MSP Concourse G Infill -** No new information since last update.

**City of Burnsville - Quarry Property, LLC -** No new information on this project since last update.

**City of Carver - Levee rehabilitation -** No new information on this project since last update.

**City of Carver - Jonathan Parkway upgrades** - No new information on this project since last update.

**City of Burnsville - CenterPoint Energy Training Facility -** No new information on this project since last update.

**City of Burnsville -5337 Properties, LLC:** No new information on this project since last update.

**City of Burnsville - Freedom Enterprises, LLC:** No new information on this project since last update.

**City of Burnsville - Industrial Equities - 250 River Ridge Circle North: -** No new information on this project since last update.

**City of Burnsville - United Properties - 12400 Dupont Avenue North:** No new information on this project since last update.

**CenterPoint Energy - sign replacement:** No new information to report since last update.

**City of Burnsville - Kraemer Mining:** No new information to report since last update.

**Dakota County - MN River Greenway**: The LMRWD received a Notice of Application for wetland impacts for this project. Project website: **https://www.co.dakota.mn.us/parks/About/TrailPlanning/Pages/minnesota-river.aspx**

**City of Shakopee - Jackson Township AUAR:** No new information to report since last update.

**City of Burnsville - CenterPoint Energy Lyndale Valve Replacement Project:** No new information to report since last update.

**City of Eden Prairie - C. H. Robinson:** No new information to report since last update.

**City of Burnsville - Burnsville Sanitary Landfill:** No new information to report since last update.

**City of Eden Prairie - Peterson Wetland Bank:** No new information to report since last update.

**City of Chanhassen - TH 101 Improvements:** Since the last update, RPBCWD was advised by its legal counsel that the District cannot assign its authority to the LMRWD. The LMRWD received notice of demolition of structures that will be necessary to complete this project. The demolition in the LMRWD will impact the Steep Slope Overlay District. Staff will advise the consultant of our requirements. Project website: **https://www.highway101improvements.com/**

**Cities of Richfield/Bloomington - TH 77 & 77th Street underpass:** No new information to report since last update.

**MNDOT - I494 Brush removal:** No new information to report since last update.

**MNDOT - TH 5 Signage projects:** No new information to report since last update.

**MPCA - MN River TSS TMDL:** Staff did not submit comments on this TMDL since the District was given an opportunity to comment prior to its release.

**MPCA - Watonwan River Watershed Total Maximum Daily Load Study Draft Report and Watershed Restoration and Protection Strategy:** Comments were submitted to the MPCA.

**MPCA - Middle Minnesota River Watershed Total Maximum Daily Load Study Draft Report and Watershed Restoration and Protection Strategy:** Comments were submitted to the MPCA.

**MPCA - Lower Minnesota River Watershed Total Maximum Daily Load Study Draft Report and Watershed Restoration and Protection Strategy:** Comments were submitted to the MPCA.

**City of Bloomington - MN Valley State Trail:** No new information to report since last update. Project website: **https://www.dnr.state.mn.us/state_trails/minnesota_valley/plans.html**

**Hennepin County - CSAH 61/Flying Cloud Drive:** The most recent inspection report is attached. Shane Soukup and I attended a field inspection of the project with the Technical Evaluation Panel. The City of Eden Prairie was there as were representatives from Hennepin County, BWSR and the Contractor Ames Construction. The contractor is getting ready to button up the site for the winter and vegetation has been established on many of the disturbed areas. What the Contractor indicated is the problem now is sediment coming from upstream and filling in many of the BMPs. The pictures below are of a 10' by 16' box culvert that was vacuumed out a week before this picture was taken:

**MNDOT - I494/TH 5/TH 55 Mill & Overlay project:** No new information to report since last update. Project website: **https://www.dot.state.mn.us/metro/projects/i494invergroveheights/**

**MNDOT - I35W Bridge Replacement:** No new information to report since last update. Project website: **https://www.dot.state.mn.us/metro/projects/i35wbloomington/index.html**

**MNDOT - I494 from TH169 to Minnesota River:** MNDOT reached out to the LMRWD this week to schedule a meeting to discuss possible options for stormwater treatment. LMRWD staff is trying to get MNDOT to nail down specifics on possible options.

**Scott County - TH 41/169/78 Interchange:** No new information to report since last update. Project website https://www.scottcountymn.gov/1778/Highways-1694178-Interchange?PREVIEW=YES&PREVIEW=YES&PREVIEW=YES&PREVIEW=YES

**City of Shakopee - Amazon Fulfillment Center drainage:** A meeting has been scheduled next week by consultants for the City of Shakopee to discuss this project .

**MAC/LMRWD/MCWD boundary realignment:** No new information to report since last update.

**Fort Snelling - Dominion Housing:** The developer was hoping to have this project ready for the LMRWD Board to approve at the October Board meeting, however, they have not yet provided the District with a copy of the maintenance agreement for the BMPs that will be installed to manage storm water.

**USACOE/USFWS - Bass Ponds, Marsh & Wetland:** No new information to report since last update.
Project website: **https://www.scottcountymn.gov/1865/Bass-Ponds-EAW**

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## Upcoming meetings/events

- Upper Mississippi River Waterway Association - Thursday, October 17, 2019, 11:30pm, Lilydale Pool & Yacht Club, 1600 Lilydale Road, St. Paul, MN
- LMRWD Work Session, Wednesday, November 20, 2019, 5:30pm, County Board Room, Carver County Government Center
- River Resource Forum - no dates yet, but this usually happens in early December (may overlap with MAWD Conference
- MAWD Annual Conference - December 5 - 7, Arrowwood Conference Center Alexandria, MN
- Metro MAWD - Tuesday, January 21, 2020, 7:00pm Cap Region Watershed District, 595 Aldine Street, St. Paul
- MAWD Legislative Reception & Day at the Capitol - March 18 & 19, 2020

Young Environmental Consulting Group, LLC

# Technical Memorandum

**To:** Linda Loomis, Administrator
Lower Minnesota River Watershed Management Organization

**From:** Lan Tornes
Natural Resources Scientist

**Date:** September 19, 2019

**Re:** Review of the Middle Minnesota River Watershed Total Maximum Daily Load Study Draft Report and the Middle Minnesota Watershed Restoration and Protection Strategy

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The Lower Minnesota River Watershed District (LMRWD) requested a review and assessment by Young Environmental Consulting Group, LLC (Young Environmental) of the Draft Minnesota River – Mankato Watershed (also referred to as the Middle Minnesota River Watershed [MMRW] Total Maximum Daily Load (TMDL) Study and the Middle Minnesota Watershed Restoration and Protection Strategy (WRAPS) Draft Report. The results of that review and relevant recommendations are presented below. Technical concerns that should be addressed by the Minnesota Pollution Control Agency (MPCA) may occur when combining data from multiple sources.

1. Total suspended solids (TSS), suspended sediment, and turbidity are equivalent but not equal, interchangeable measurements. The differences begin with how the samples are collected and are increased by different analytical methods. It is acceptable to combine the data, but the reader needs to be alerted to the differences. The methods, qualifiers, and coefficients used to enhance the equivalence of the measurements must be documented.
2. The section titled Nitrate Source Summary on page 42 of the draft report proceeds to discuss total nitrogen (TN) without explaining that nitrate is one of the many forms of nitrogen found in the environment. There is a clearly defined drinking-water standard for nitrate but not for nitrogen. Combining the forms of nitrogen for discussion of environmental nitrogen makes discussion much easier, but the authors need to make the readers aware of the differences and any assumptions used when extrapolating TN occurrences to more specific forms such as nitrate.
3. Similar caution is encouraged when discussing phosphorus in the environment. Because phosphorus has an affinity for sediment particles, total phosphorus (TP) usually is associated with suspended solids and/or contained in algal cells, whereas dissolved phosphorus generally is available for immediate uptake by

aquatic organisms. This should be a consideration when assessing the mobility of phosphorus in the environment.

4. The report mentions that the watershed consists of many of the small streams that drain directly into the Minnesota River that were not routinely gaged or sampled. The Minnesota River Basin Hydrological Simulation Program—FORTRAN (HSPF) model was employed to estimate loading from many of these small streams. Although there may have been no other data sources, the authors cautioned that model results could misrepresent the actual contributions from any of the unmeasured tributaries. The TMDL load-duration curves and tables often have the caveat that the HSPF-simulated flow of zero is likely an underestimate of the actual flow conditions. This was apparent when the tributary flows were shown as no flow when low-flow or base-flow should have been present. Local stakeholders could be offended when their ungaged, unsampled stream is identified by a computer model as being impaired.
5. An analysis comparing the flow-weighted mean concentration and yield for TSS, TN, and TP determined from the HSPF model results, Watershed Pollutant Load Monitoring Network (WPLMN) data, and professional judgment regarding watershed-wide estimates is presented on page 108. Although this is an enlightening exercise, an interpretation explaining the logic and results of this comparison is absent and would help readers understand the relevance of this exercise.
6. It appears that the WRAPS report was based almost entirely on data from studies, including the watershed pollutant load monitoring network, and not so much on the work done for the companion TMDL report. There are many reasons why this might be convenient; however, the purpose of the TMDL is to provide a basis for the restoration and protection strategies provided in the WRAPS report.
7. One of the more interesting and relevant findings of the WRAPS report is the observation that the single largest fecal bacteria source in the MMRW was estimated as crop surface runoff where manure had not been incorporated. Surface runoff from crops with surface-applied manure account for an estimated 56 percent of the bacteria, whereas environmental propagation and surface runoff from crops with subsurface-applied manure were estimated at 13 and 11 percent, respectively.

Pages 3 through 25 of this memo provide a summary of pertinent information discussed in the TMDL and WRAPS reports.

**MIDDLE MINNESOTA RIVER TMDL**

Land use in the MMRW is predominantly agricultural, with the dominant crops being corn and soybeans; other crops include sugar beets and dry beans. Artificial drainage is common. Urban land use is the second major land use type and is centralized near the city of Mankato and the surrounding suburbs near the Minnesota River.

The report points out that this part of the Minnesota River is fed by many small streams that flow directly into the Minnesota River but typically are not significant enough to justify establishing long-term streamgaging stations. When streamflow cannot be reliably estimated by other means, the HSPF model[1] of the Middle Minnesota River can be used to estimate streamflow and loads.

The following table, copied from "Table 3. Water quality standards for impaired streams" in the report, illustrates the values that formed the basis for identifying the impairments. The standards were tailored to the type, location, and designated use of the water. These values also were used to develop the TMDLs for the each of the impaired water bodies. The details of how these standards were applied to each lake are described in the text and in Appendix A of the report.

**Table 3. Water quality standards for impaired streams**

| Parameter | Water Body Type | Water Quality Standard | Numeric Standard/Target |
|---|---|---|---|
| *Escherichia coli* *(E. coli)* | Class 2A and 2B streams | Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31. | ≤ 126 organisms/ 100 mL water (monthly geometric mean) ≤ 1,260 organisms /100 mL water (individual sample) |
| | Class 7 streams | Not to exceed 630 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken | ≤ 630 organisms/ 100 mL water (monthly geometric mean) |

[1] https://www.pca.state.mn.us/sites/default/files/wq-ws3-07020007c.pdf, accessed September 11, 2019.

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|---|---|---|---|
| | | during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between May 1 and October 31. | ≤ 1,260 organisms /100 mL water (individual sample) |
| TSS | Class 2B streams in South River Nutrient Region | 65 mg/L (milligrams per liter); TSS standards for class 2B may be exceeded no more than 10% of the time. This standard applies April 1 through September 30. | ≤ 65 mg/L |
| Nitrate nitrogen | Class 1B streams | 10 mg/L; 10 mg/L is a federal safe drinking water standard and is incorporated by reference into Minnesota administrative rules. | ≤ 10 mg/L |

The standards for TP in micrograms per liter (ug/L) also were tailored to lake characteristics and the environmental setting (Ecoregion) of the lake. The eutrophication standards for class 2B lakes, reservoirs, and shallow lakes are shown in the following table. The details of how these standards were applied to each of the lakes are described in the text and in Appendix A of the TMDL report.

| Parameter | Western Corn Belt Plains | | North Central Hardwood Forests | |
|---|---|---|---|---|
| | Lakes and Reservoirs | Shallow Lakes | Lakes and Reservoirs | Shallow Lakes |
| Phosphorus, total (ug/L) | ≤ 65 | ≤ 90 | ≤ 40 | ≤ 60 |

The report identifies high levels of *E. coli* bacteria, TSS, nitrate nitrogen, and TP as the causes of impairment in the watershed. The impairments are affecting aquatic life, aquatic recreation, drinking water, and limited-resource-value designated uses. In fact, 43 stream TMDLs have the following impairments: 34 from *E. coli,* 6 because of TSS, and 3 from nitrate nitrogen. Additionally, 8 TMDLs are the result of TP adversely affecting lakes.

Fecal coliform results were substituted when *E. coli* data were not available. It was determined that the ratio between fecal coliform counts and *E. coli* counts is 200/126: a plate count of 200 fecal coliform organisms per 100 milliliters (ml) is equivalent to 126 *E. coli* organisms per 100 ml. The bacteria impairments that do not have *E. coli* data were listed as impaired in 2008 based on fecal coliform data.

The report describes that the maximum recorded *E. coli* concentration per reach range from 613 to 35,000 organisms/100 ml. The frequencies of exceedance of the monthly geometric mean standard range from 33 percent to 100 percent, and the frequencies of exceedance of the individual sample standard range from 0 percent to 31 percent. There is a weak relationship between *E. coli* concentrations and flow across all the

reaches with *E. coli* impairments, and exceedances of the single-sample standard were found to occur across all flow conditions.

The highest TSS concentration per reach ranges from 160 to 5,970 milligrams per liter (mg/L), and the frequencies of exceedance range from 5 percent to 51 percent. TSS concentrations generally are highest during high flow conditions and decrease with decreasing flow.

The highest nitrate nitrogen concentration per reach ranges from 22 to 43 mg/L, and the frequencies of exceedance range from 65 percent to 83 percent. Nitrate nitrogen concentrations generally are highest during high flows with few exceedances during low flows.

The only impairments from TP in the MMRW were the result of eutrophication of several lakes. The report thus finds that enriched phosphorus from external and internal sources resulted in excess algal productivity, as measured by elevated concentrations of chlorophyll, resulting in reduced Secchi-disk transparency.

**Bacteria Source Summary**

The report explains that sources of fecal bacteria are typically widespread and often intermittent. In the MMRW, the *E. coli* standard is exceeded across all flow conditions, indicating a mix of source types. *E. coli* from livestock and subsurface sewage treatment systems (SSTSs) are the highest priority sources in the MMRW. The report also cites a study from a nearby watershed[2] that suggests birds might be a source of *E. coli* from municipal separate storm sewer system (MS4) drainages.

The report attempts to determine the likelihood that dischargers to class 7 (limited resource value) waters contributed to *E. coli* impairments in April when standards were not applicable. Discharge volumes, surface water monitoring data, and the locations of the effluent discharge points were evaluated. Because low flows in April are unlikely and bacteria die off in surface waters, wastewater effluent is not likely to be a significant source; however, there is the potential that discharge from these facilities could contribute to downstream *E. coli* impairments on class 2 waters, which have a more stringent standard, during April.

The report notes that, in the MMRW, percentages of imminent public health threats (IPHTs) potentially leaking septic systems range from 3 percent in Le Sueur County to 39 percent in Cottonwood County. The report further states that straight pipe systems

[2] M. Sadowsky, C. Staley, and S. Gruber, "Minnehaha Creek Bacterial Source Identification Study—Sources of *E. Coli* in an Urban Environment," Presentation at Minnesota Water Resources Conference, St. Paul, MN, October 18, 2017.

and earthen pit outhouses likely exist in the watershed, but their numbers and locations are unknown and were not quantified.

### Sediment Source Summary

The TMDL report also discusses suspended sediment and TSS, but it is not clear how their differences are considered in the report. A report by Gray and others (2000)[3] provides information on the relationship between these complementary measurements.

The Middle Minnesota River HSPF modeling results indicate that near-channel sources account for 72 percent of the TSS load in the MMRW, and watershed runoff accounts for most of the remainder. Runoff from cropland areas is the dominant watershed runoff source, at 27 percent of the total load. This is consistent with the observed TSS exceedances in the MMRW, which typically occur during moderately high to high-flow conditions where a high volume of water is running over cropland and through tile systems to waterways with higher erosive power than low-flow conditions. Wastewater and permitted MS4 sources contribute negligible loads at 0.1 percent and less than 1 percent, respectively. National Pollutant Discharge Elimination System (NPDES) permits limit the load or concentration of sediment, as TSS, that a municipal wastewater treatment plant may discharge, which is typically either 30 or 45 mg/L (as a calendar monthly average). Both are protective of the 65 mg/L TSS stream standard. Industrial wastewater limits also are below the stream standard. In the Minnesota River Basin, nonpoint sources are the largest sources of sediment.[4]

### Nitrogen Source Summary

The report discusses the TMDL impairments by nitrate nitrogen because nitrate has a clearly defined drinking water standard of 10 mg/L. However, nitrogen occurs in several different but related forms in the environment, each of which has its own considerations of environmental significance and concerns about toxicity. We caution the reader that the report references other information sources that describe nitrogen in terms of its total concentration, which is the sum of all its forms. Nitrate nitrogen is a component of the TN and may comprise none or all of the nitrogen measured in an environmental sample.

This report describes that, in 2013, the MPCA conducted a statewide nitrogen study, Nitrogen in Surface Waters,[5] which identifies sources of nitrogen to surface waters in each major basin in Minnesota. The Nitrogen in Surface Waters study identifies several

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[3] John R. Gray, G.D. Glysson, L.M. Turcios, and G.E. Schwarz, "Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data," USGS WRIR-4191, 2000, http://pubs.er.usgs.gov/publication/wri004191

[4] Minnesota Pollution Control Agency [MPCA], "South Metro Mississippi River Total Suspended Solids Total Maximum Daily Load" (St. Paul, MN: MPCA, 2015), Document number wq-iw9-12e.

[5] MPCA, "Nitrogen in Surface Waters" (St. Paul, MN: MPCA, the University of Minnesota, and the US Geological Survey, 2013), Document number wq-s6-26a.

potential sources of nitrogen to water bodies on a statewide level. These were the following:

- Livestock and poultry feedlots
- Municipal sewage effluents
- Industrial wastewater effluents
- Mineralization of soil organic matter
- Cultivation of nitrogen-fixing crop species (e.g., soybean, alfalfa, clover)
- Runoff/leaching/drainage of animal manure and inorganic nitrogen fertilizer
- Runoff from standing or burned forests and grasslands
- Urban and suburban runoff
- Septic system leachate and discharges from failed septic systems
- Emissions to the atmosphere from volatilization of manure and fertilizers and combustion of fossil fuels—and the subsequent atmospheric (wet and dry) deposition onto surface waters
- Activities that can mobilize nitrogen (e.g., biomass burning, land clearing and conversion, and wetland drainage)

The contributions of nitrogen for the MMRW were assumed to be equivalent to those determined for the entire Minnesota River Basin. The proportions were determined as follows:

- Agricultural drainage - 67 percent
- Agricultural groundwater - 18 percent
- Cropland runoff - 4 percent
- Point sources - 5 percent
- Atmospheric deposition - 3 percent
- Nonpoint sources – 2 percent
- Forest – 1 percent

With the predominance of agricultural land use in the MMRW, agricultural drainage is likely the largest contributor of nitrogen to streams and other surface water sources.

**Lake Phosphorus Source Summary**

There are no permitted wastewater facilities or regulated MS4s contributing water to the impaired lakes, so these are not considered for TMDL evaluation. Although discussed in the report, it is not clear whether regulated construction and industrial stormwater are considered for the TMDL. There is one NPDES permitted confined animal feeding operation (CAFO) in the impaired lakes watersheds. The phosphorus source assessment assumes that the permitted CAFO is in compliance and not contributing TP to the impaired lake watershed.

Phosphorus loads from unregulated watershed runoff were estimated using the Minnesota River Basin HSPF model. Loads from tile drainage were not explicitly quantified in the HSPF model but are implicitly included in the overall load estimates.

Phosphorus loads from septic systems were estimated with a spreadsheet approach using the MPCA's "Detailed Assessment of Phosphorus Sources to Minnesota Watersheds".[6] To estimate internal loads, an additional phosphorus load was added to the phosphorus budgets to calibrate the lake response models, and these loads were attributed to internal loading. The contribution of TP from upstream lakes was calculated from the average summer lake concentration multiplied by the average flow at the lake outlet. Phosphorus loading from atmospheric deposition to the surface area of impaired lakes was estimated using the average for the Minnesota River Basin, which is 0.42 kilograms per hectare per year.

Load duration curves were developed for each impairment for the applicable stream reach or lake. The caveats specific to each of the impairments and how they were dealt with were discussed in the report and are summarized below. For all impairments addressed in this TMDL study, natural background sources were implicitly included in the load allocation (LA) portion of the TMDL allocation tables, and TMDL reductions should focus on the major anthropogenic sources identified in the source assessment.

One of the considerations for *E. coli* is that persistent, resident strains of *E. coli* have been identified in streams in the MMRW.[7] Other than an interesting complication, it was not evident whether this was a consideration in developing the *E. coli* TMDLs. The source assessment exercises indicate that natural background inputs are generally low compared to livestock, cropland, and failing SSTSs. Background sources are implicitly included in the LA.

For TSS, the loading capacity (LC) was calculated as flow multiplied by the TSS standard (65 mg/L). The wasteload allocation (WLA) was the result of multiplying the flow contribution from a given source x 65 mg/L (or the NPDES permit concentration). After allocations to wastewater, regulated stormwater and the MOS were determined for each reach and flow zone, and the remaining LC was allocated to the LA. The LA includes nonpoint pollution sources that are not subject to permit requirements, including near-channel sources and watershed runoff. The LA also includes natural background sources of sediment. These source assessment exercises indicate that natural background inputs are generally low compared to cropland and near-channel sources.

The LC for nitrate nitrogen was calculated as flow multiplied by the nitrate standard (10 mg/L). There are no permitted wastewater facilities or permitted MS4s discharging to nitrate-impaired segments; therefore, no WLAs are provided for these sources. The LA

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[6] Barr Engineering, "Detailed Assessment of Phosphorus Sources to Minnesota Watersheds" (Saint Paul, MN: MPCA, 2004).

[7] R. Chandrasekaran, M.J. Hamilton, P. Wang, C. Staley, S. Matteson, A. Birr, and M.J. Sadowsky. "Geographic Isolation of *Escherichia coli* Genotypes in Sediments and Water of the Seven Mile Creek—A Constructed Riverine Watershed." *Sci. Total Environ* 538 (2015): 78–85.

for each nitrate TMDL was calculated as the loading capacity minus the MOS minus the WLAs.

The TMDLs for phosphorus in lakes were developed using the BATHTUB[8] lake quality model. The models within BATHTUB inherently include an internal load that is typical of lakes in the model development data set. The data suggest that internal loads are greater than the average rates inherent in BATHTUB, and additional internal loads were included during model calibration. After the model was calibrated, the TMDL scenario was developed by reducing phosphorus load inputs until the lake TP standard was met. The total load to the lake in the TMDL scenario represents the loading capacity, and the percent reduction needed to meet the TMDL was calculated as the existing load minus the loading capacity divided by the existing load. It was determined that no MS4s, construction and industrial WLAs, or feedlots were discharging to the lake watersheds.

**TMDL Summaries**

A copy of "Table 18. Summary of load reductions per impaired waterbody" from the Middle Minnesota River TMDL report is presented below. It shows the percent reduction needed for each of the identified impairments to be compliant with the TMDL developed for that constituent. Organized by watershed group, the table shows that the estimated percent reductions needed to meet the TMDLs range from 12 percent to 96 percent.

Two reaches with TSS impairments (County Ditch 46A and Seven Mile Creek) do not require TSS reductions to meet their TMDL. These reaches were originally listed in 2006 based on turbidity data; however, there is a lack of current data to delist water bodies from the impaired waters list. The report states that the MPCA will reevaluate these reaches during the next impairment assessment for this watershed when more data are expected to be available.

**TMDL Report Table 18. Summary of load reductions per impaired waterbody**

| Watershed Group | Waterbody Name | Reduction (percent) | | | |
|---|---|---|---|---|---|
| | | ***E. coli*** | **Total Suspended Solids** | **Nitrate Nitrogen** | **Total Phosphorus** |
| Minnesota River–New Ulm | Crow Creek | 91 | – | – | – |
| | Birch Coulee Creek | 66 | – | – | – |
| | Purgatory Creek | 87 | – | – | – |

[8] W. W. Walker, "Empirical Methods for Predicting Eutrophication in Impoundments" (Vicksburg, MS: US Army Corps of Engineers Waterways Exp. Sta., 1987). Report 4, Applications Manual, Technical Report E-81-9.

| | | | | | |
|---|---|---|---|---|---|
| | Wabasha Creek | 90 | – | – | – |
| | Three-Mile Creek | 27 | – | – | – |
| | Unnamed creek | 81 | – | – | – |
| | Fort Ridgley Creek | 47 | – | – | – |
| | Spring Creek (Judicial Ditch 29) | 70 | – | – | – |
| | Spring Creek | 81 | – | – | – |
| | County Ditch 13 | 83 | – | – | – |
| | County Ditch 10 (John's Creek) | 90 | – | 52 | – |
| | Little Rock Creek (Judicial Ditch 31) | 79 | – | – | – |
| | Eight-Mile Creek | 78 | – | – | – |
| | Huelskamp Creek | 69 | – | – | – |
| | Fritsche Creek (County Ditch 77) | 69 | – | – | – |
| | Heyman's Creek | 76 | – | – | – |
| Little Cottonwood River–Nicollet | Altermatts Creek | 12 | – | – | – |
| | Little Cottonwood River | 80[a] | 58 | – | – |
| | Little Cottonwood River | 72 | 78 | – | – |
| | Morgan Creek | 66 | – | – | – |
| | Unnamed creek | – | – | 57 | – |
| | Swan Lake Outlet (Nicollet Creek) | 84 | – | – | – |

| | | | | | |
|---|---|---|---|---|---|
| | County Ditch 56 (Lake Crystal Inlet) | 80 | – | – | – |
| | Mills Lake | – | – | – | 74 |
| | Loon Lake | – | – | – | 56 |
| | Minneopa Creek | 87 | 35 | – | – |
| Mankato–St. Peter | Unnamed creek | 92[a] | – | – | – |
| | Unnamed creek | 75[a] | – | – | – |
| | Unnamed creek | 84[a] | – | – | – |
| | Unnamed creek | 88[a] | – | – | – |
| | Unnamed ditch | 95[a] | – | – | – |
| | Wita Lake | – | – | – | 75 |
| | County Ditch 46A | 85 | –[b] | – | – |
| | Seven Mile Creek | 73 | –[b] | – | – |
| | Unnamed creek (Seven Mile Creek Tributary) | 88 | – | – | – |
| | Seven Mile Creek | 40 | 96 | 75 | – |
| | Duck Lake | – | – | – | 72 |
| | George Lake | – | – | – | 69 |
| | Washington Lake | – | – | – | 60 |
| | Henry Lake | – | – | – | 91 |
| | Shanaska Creek | 60 | – | – | – |
| | Rogers Creek (County Ditch 78) | 71 | – | – | – |
| | Scotch Lake | – | – | – | 82 |

[a] *E. coli* data either do not exist or are limited. The percent reduction was calculated based on *E. coli* data from 2000–2005 and/or fecal coliform data translated to *E. coli* concentration.

[b] This impairment was originally listed in 2006 based on turbidity data; however, the TSS data presented in this report do not show impairment. The MPCA will reevaluate

the reach in the next impairment assessment for this watershed.
—Water bodies indicated with "–" are not impaired by the indicated pollutant.

The table shows that *E. coli* is most often the constituent that causes stream impairment in the Middle Minnesota River. The load duration curves, provided in Appendix A of the report, indicate that exceedances of the *E. coli* standard occur across all flow regimes. This report states that the load reductions needed should address multiple sources of *E. coli*.

Table 18 shows that four streams in the MMRW are impaired by TSS. The report describes that most of the exceedances of the TSS standard occur during moderately high to high-flow conditions. High TSS concentrations under high flows are typically due to upland runoff and near-channel sources and are associated with precipitation and/or snowmelt events.

Three streams are impaired by excessive nitrate nitrogen concentrations. The report explains that most of the exceedances of the nitrate standard also occur during moderate to high flows, indicating that the reductions will be needed from sources such as agricultural drainage.

Excessive TP impairs only lakes in the watershed and is the only source of lake impairment. The report states that reductions in phosphorus are determined on an average annual basis and will need to come primarily from cropland runoff and internal loading.

This report considers the effect of future growth in the MMRW. New or expanding permitted MS4 wasteload allocations may require adjustments of the TMDLs. New or expanding wastewater treatment facilities also may require revisiting the load calculations.

This report mentions that the TMDL needs to provide reasonable assurance that water quality targets will be achieved through the specified combination of point and nonpoint source reductions reflected in the LAs and WLAs. Regulatory approaches are assigned to the MPCA to assure that permitted MS4 sources remain in compliance and implement best management practices to reduce pollutants. The report provides examples of efforts to reduce pollutants from non-permitted sources. The MPCA Feedlot Program implements rules governing the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes. SSTSs are regulated through Minnesota statutes, which include the following:

- Minimum technical standards for individual and mid-size SSTS
- A framework for local units of government to administer SSTS programs
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee
- Various ordinances for septic installation, maintenance, and inspection

The Buffer Law requires the following:

- For all public waters, the more restrictive of either
  - a 50-foot average width, 30-foot minimum width, continuous buffer of perennially rooted vegetation, or
  - the state shoreland standards and criteria
- For public drainage systems established under Minnesota statutes a 16.5-foot minimum width continuous buffer

Compliance with the buffer law in the MMRW is at least 70 percent. Most counties are estimated to have at least 80 percent compliance. In Le Sueur county, compliance is estimated to be 95–100 percent.

Minnesota's Agricultural Water Quality Certification Program is a voluntary program for farmers who implement and maintain approved farm management practices. The report identifies this as another opportunity to reduce pollutants from unregulated sources.

Minnesota's soil erosion law, which dates to 1984, sets forth a strong public policy stating that a person may not cause excessive soil loss. The law was entirely permissive, however, in that it only encouraged local governments to adopt soil erosion ordinances and could not be implemented without a local government ordinance. The soil erosion law was changed in 2015 when several revisions were made by the legislature and approved by the governor to broaden its applicability.

The MPCA has developed the Sediment Reduction Strategy for the Minnesota River Basin and South Metro Mississippi River[9] to establish a foundation for local water planning to reach sediment reduction goals developed as part of the TMDLs. The Sediment Reduction Strategy outlines a milestone goal of reducing sediment in the Minnesota River by 25 percent by 2020 and by 50 percent by 2030, with the goal of meeting TMDL sediment reduction requirements by 2040. It also provides peak flow reduction goals to further address sediment reduction:

- Reduce two-year annual peak flow rates by 25 percent by 2030 and
- Decrease the number of days the two-year peak flow is exceeded by 2 percent by 2030

The Minnesota Nutrient Reduction Strategy[10] guides activities that support nitrogen and phosphorus reductions in Minnesota water bodies and those downstream of the state. The Nutrient Reduction Strategy was developed by an interagency coordination team

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[9] MPCA, "Sediment Reduction Strategy for the Minnesota River Basin and South Metro Mississippi River" (St. Paul, MN: MPCA, 2015), Document number wq-iw4-02, https://www.pca.state.mn.us/sites/default/files/wq-iw4-02.pdf.

[10] MPCA, "The Minnesota Nutrient Reduction Strategy" (St. Paul, MN: MPCA, 2014), Document number wq-s1-80.

with help from public input. Fundamental elements of the Nutrient Reduction Strategy include the following:

- Defining progress with clear goals
- Building on current strategies and successes
- Prioritizing problems and solutions
- Supporting local planning and implementation
- Improving tracking and accountability

In addition to these statewide efforts, this report describes local water planning, including work that has been done at the county level such as Soil and Water Conservation Districts. This report also presents information about the Minnesota Board of Water and Soil Resources, which is advocating a One Watershed One Plan (1W1P) approach so county boundaries are not an issue when management plans relate more to watersheds than to political boundaries.

Many other local groups were identified for their participation and contributions, including considerable assistance from the Minnesota State University, Mankato. A list of organizations and stakeholders is available in the Middle Minnesota River Watershed Directory: Creating Connections.[11] The purpose of this directory is to increase public awareness of the MMRW and its tributaries. The directory highlights key existing organizations, their work, the resources they can offer, and their contact information to better facilitate implementation in the watershed. The report then proceeds to discuss some of the outreach and education programs that are being conducted and the importance of education in fostering improved resource management.

**Recommended Monitoring**

The report describes a monitoring plan that provides an overview of what is expected to occur at many scales in multiple watersheds within the MMRW. Monitoring is needed to determine whether water bodies are meeting water quality standards, and to track trends, assess potential sources of pollutants, and determine the effectiveness of implementation activities in the watershed. The six basic types of monitoring are baseline, implementation, flow, effectiveness, trend, and validation.

Several ongoing monitoring programs are discussed that are relied upon to meet the monitoring needs for the watershed. Minnesota's Watershed Approach[12] is a long-term program that monitors impaired watersheds throughout the state on a rotational basis.

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[11] https://www.pca.state.mn.us/sites/default/files/wq-ws1-06.pdf, accessed September 3, 2019.

[12] https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality, accessed September 3, 2019.

The MPCA's WPLMN[13] measures and compares data on pollutant loads from Minnesota's rivers and streams and tracks water quality trends. The Discovery Farms Minnesota[14] program is a farmer-led effort that collects farm- and field-scale monitoring data under real-world conditions. Other programs that involve tracking tillage and monitoring wastewater discharges are also described in the report.

**Implementation Strategy Summary**

The implementation strategy summary serves as an inception for the WRAPS report. It provides an overview and perspective of the statewide approach to water quality monitoring. The WRAPS documents are designed to serve as a framework for the locally supported watershed management plans that focus on local priorities and knowledge to identify locally based prioritized, targeted, and measurable actions to implement the strategies. The report states that the development of the WRAPS report for the MMRW was done concurrently with the TMDL report, and the implementation strategies in that report will heavily influence and support implementation of this TMDL.

The WRAPS report goes on to describe implementation strategies for permitted sources, including construction stormwater, industrial stormwater, MS4s, and municipal and industrial wastewater facilities. Because these are covered under various permitting systems, it is expected that they will maintain compliance under those permits, thus meeting their wasteload allocations. The applicability of each permitted source is relevant only if it discharges the constituent that is causing the identified impairment.

Options for controlling nonpermitted sources, including human and agricultural sources, were presented. Most of the human sources are related to septic systems that may need maintenance, upgrading, or education. Methods of reducing agricultural sources—including buffer strips, clean water diversion, access control/fencing, and runoff and waste storage—are related to the pollutant they will target.

The direct and indirect controls for reducing near-channel sediment in the MMRW were also discussed. Direct controls for near channel sediment sources include practices such as limiting ravine erosion using a drop structure or energy dissipater or controlling stream bank or bluff erosion through stream channel restoration. Indirect controls for sediment loss typically involve land management practices and structural practices designed to temporarily store water or shift runoff patterns by increasing evapotranspiration at critical times of the year, as well as reducing the erosive power of streamflow on stream banks and bluffs.

Methods to reduce the loading of phosphorus to lakes were also discussed, noting that external loading should be given priority if it is moderate to high. These would be

[13] https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring, accessed September 3, 2019.
[14] https://discoveryfarmsmn.org/, accessed September 3, 2019.

followed by efforts to control internal sources, including water level drawdown, chemical treatment, and biomanipulation.

The cost of various implementation strategies was estimated and presented, ranging from $25 to $45 million over the next 20 years. This range reflects the large amount of uncertainty in implementation costs but does not include required buffer installation and replacement of the IPHT systems.

The report explains that civic engagement and public participation were a major focus during the Middle Minnesota Watershed project related to WRAPS and the TMDL study. The MPCA worked with staff from eight counties and SWCDs in the watershed to promote water quality, survey and interview landowners, and create opportunities to explore the social dynamics in the watershed. Local partners, state agency staff, and consultants worked on eight projects to promote civic engagement and collaboration related to WRAPS and TMDL work in the area. The report goes on to list opportunities and constraints for water quality improvements in the watershed.

**MIDDLE MINNESOTA RIVER WRAPS**

The WRAPS report for the MMRW was prepared concurrently with the TMDL and builds on more information than was included in the TMDL. It discusses both pollutants and stressors. It deals primarily with issues related to aquatic recreation and aquatic life in streams and lakes. It does not consider the suitability of water for drinking, irrigation, or navigation.

The following table, adapted from the WRAPS report, summarizes the primary findings from that report. Habitat characteristics and factors that relate to the viability of aquatic life were added even though they were not already provided from the TMDLs.

| **Parameters** (Pollutant/ stressors) | **Watershed-Wide Goal** (Average for watershed) | **Range of Subwatershed Goals** (Estimated only when TMDL data are available) | **10-Year Target** (for 2029) | **Years to Reach Goal** (from 2019) |
|---|---|---|---|---|
| Altered Hydrology | 25% reduction in peak and annual river flow | Not estimated (TMDLs not completed on this parameter) | 5% decrease | 50 |
| | Increase dry season river base flow where identified to support aquatic life | | Increase | 30 |
| Nitrogen | 60% reduction in river concentration/loads | Protect up to a 78% reduction | 10% decrease | 55 |

| | | | | |
|---|---|---|---|---|
| Habitat | 25% increase in Stream Habitat Assessment score | Protect up to a 181% increase | 9% increase | 35 |
| Phosphorus | 50% reduction in lake and stream concentrations/loads | Protect up to an 83% reduction | 10% decrease | 50 |
| Sediment | 50% reduction in restoration areas (1/4 of watershed). No increase in protection areas (3/4 of watershed) | Protect up to an 88% reduction | 12% decrease | 40 |
| Bacteria | 60% reduction in river concentrations/loads | 10% to 87% reduction | 13% decrease | 40 |
| Connectivity | Address human-caused issues (dams, culverts) as identified in SID and where practical/feasible | Not estimated (TMDLs not completed on this parameter) | 9% decrease | 45 |
| **Parameters Impacted/Addressed by the Above Pollutants and Stressors** | | | | |
| Fish and Macro-invertebrate Index of Biotic Integrity | Each parameter's goal is to meet the water quality standard and support downstream goals. Because these parameters are a response to (caused by) the above pollutants/stressors, the above watershed-wide and sub-watershed goals are indirect goals for these parameters and are more usable for selecting strategies than direct goals for these parameters. | Not estimated (TMDLs not completed on these parameters) | Meet other 10-year targets | 45 |
| Eutrophication | | | | 50 |
| Dissolved Oxygen | | | | 45 |
| Temperature | | | | 45 |

**Altered Hydrology**

The WRAPS report points out that sources of altered hydrology are common throughout the MMRW; landscape and climate changes, crop and vegetative changes, and soil and drainage changes. Two of the most substantial aspects of altered hydrology in the MMRW are altered streams and tile drainage. The report notes that 30 percent to 60 percent of the landscape is tile drained, and 65 percent of stream miles are altered. In particular, the headwater portion of streams tends to be extensively altered, causing direct and indirect impacts to the immediate and downstream reaches. Without

extensive mitigation of these altered hydrologic parameters, stream flow is negatively altered.

The authors of the report made numeric estimates of the MMRW's land use contributions to water bodies using a water portioning calculator. These results were qualified using additional lines of evidence and local professional judgment. Presenting the following proportions in a graphic, the report conveys that cultivated cropland use in the watershed contributes the most water to water bodies:

- Crop Tile Drainage – 40 percent
- Crop Surface Runoff – 23 percent
- Crop Groundwater – 20 percent
- Other Land Uses – 10 percent
- Urban and Developed – 7 percent

Based on these findings related to altered hydrology, the report suggests that "decreases in the total annual flow should focus on decreasing peak flows, increasing base flow, and maintaining the dynamic properties of the natural hydrograph, which are important for channel geomorphology, vegetation, and aquatic life. Strategies to accomplish these tasks must increase evapotranspiration, and store and infiltrate water on the landscape to increase groundwater contributions (base flow) to streams during dry periods."

**Nitrogen**

The report describes the nitrogen cycle and clearly states that the different nitrogen forms are addressed together in the report as the sum of the forms, or the TN. Nitrogen was the second most commonly identified stressor, behind altered hydrology. Nitrogen as a stressor and/or pollutant was identified in 33 stream reaches, ruled out in 2, and was inconclusive in 17. The report conveys that nitrogen is a pollutant in 3 of the 33 streams where it is a stressor. The concentration and yield of TN is high relative to other streams in greater Minnesota but comparable to streams in the Minnesota River watershed and adjacent watersheds in southern Minnesota.

Nitrogen is discussed as a pollutant for drinking water supplies. Because both Mankato and St. Peter obtain their drinking water from shallow wells or aquifers, they are subject to recharge from surface water containing elevated concentrations of TN.

The report provides a numeric estimate of the MMRW's nitrogen sources, determining that 70 percent of the nitrogen originates from crop tile drainage, and 13 percent comes from crop groundwater. The remaining sources each account for less than 5 percent of the nitrogen.

The authors illustrate nitrogen-reduction goals on a complex map of the watershed. The information conveyed includes multiple categories and various systems that might be stressed. The overall watershed-wide reduction goal in the MMRW is a 60 percent

reduction, and the sub-watershed goals, for areas where it is quantifiable, range from 15 percent to 78 percent.

### Habitat

Habitat is identified in the report as the physical stream habitat affecting aquatic life. Of the biologically impaired stream reaches, degraded habitat was identified as a stressor in 28, ruled out in 12, and inconclusive in 12. The specific aquatic habitat issues affecting aquatic life identified in the Middle Minnesota River Watershed Stressor ID Report[15] (SID) show a complex, interconnected set of factors that are driven by primarily two stressors: altered hydrology and degraded riparian area and vegetation. The report states that issues leading to excess sediment are often due to unstable channel morphology, which is driven by altered hydrology and poor riparian conditions. Degraded riparian conditions are also related to insufficient vegetation, which results from excessive stream bank erosion, crops and other land uses being too close to the stream and pasturing on the stream bank. Without an adequate riparian buffer, issues such as excessive streamflow, which causes stream instability and sediment problems, are magnified because the stream banks lack the strength to resist erosion.

### Connectivity

For the WRAPS report, connectivity refers to the upstream to downstream connectedness of a stream. Both human-made (e.g., perched culverts) and natural (e.g., waterfalls) barriers can obstruct the movement of migratory fish and invertebrates, resulting in degraded population and community structures. This stressor also can negatively affect the stream by affecting its sediment, habitat, and chemical characteristics. Lack of connectivity as a stressor was identified in 24 stream reaches, ruled out in 24 stream reaches, and inconclusive in 4 stream reaches. The connectivity issues identified in the MMRW, as reported in the SID, include dams, perched culverts, altered hydrology, beaver dams, and natural waterfalls.

The goal for connectivity in the MMRW is to—where it is relevant and feasible—mitigate or remove longitudinal connectivity obstacles for fish passage, including the protection of natural waterfalls. This goal is revisable and will be revisited in the next iteration of the watershed approach.

### Phosphorus

The report explains that excess phosphorus influences aquatic life by changing food-chain dynamics, affecting fish growth and development, and decreasing dissolved oxygen when excess plant growth decomposes. It also affects aquatic recreation in lakes by fueling algae growth and making waters undesirable or even dangerous to swim in due to the potential presence of toxic blue-green algae. Eutrophic conditions

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[15] https://www.pca.state.mn.us/sites/default/files/wq-ws5-07020007a.pdf, accessed September 4, 2019.

must be observed in addition to high phosphorus concentrations to identify phosphorus as a pollutant or stressor. The report simplifies the phosphorus–eutrophic relationship and refers to it simply as phosphorus.

Of the lakes monitored to determine if phosphorus was an impairment, nine were impaired, three were supporting of their intended use, and seven were inconclusive. Of the biologically impaired stream reaches, phosphorus as a stressor was identified in 13, ruled out in 1, and inconclusive in 38. The Minnesota River reaches in the MMRW were assessed separately and are excluded from the report.

Assessments in the report estimate that the sources of phosphorus in the MMRW primarily come from crop surface runoff. It also notes that the phosphorus leaving crops is mostly from applied fertilizer or manure. Crop surface runoff accounts for 50 percent of the TP, whereas the remaining sources identified each account for less than 10 percent of the remaining TP. The report specifically ignores internal TP loading to lakes during this assessment because the original source of that TP likely was from the watershed. Once the TP is in the lake, it becomes part of the persistent internal load of the lake.

**Dissolved Oxygen**

Low or widely fluctuating concentrations of dissolved oxygen (DO) can have detrimental effects on many fish and invertebrate species. Low DO affects aquatic life primarily by limiting respiration. Of the stream reaches monitored to assess DO as a pollutant, zero were impaired, 16 were supporting, and 70 were inconclusive. Of the biologically impaired stream reaches, DO as a stressor was identified in 18, ruled out in 9, and inconclusive in 25.

The report describes that low DO concentrations are often caused by excessive oxygen consumption because of decomposition of excess plant matter, too little re-oxygenation, or warm water temperatures that reduce the solubility of DO. Widely fluctuating diel DO levels can be the result of excessive photosynthesis during daylight followed by excessive respiration at night.

**Sediment and TSS**

TSS is primarily composed of mineral sediments but often includes plant matter and other organic materials. All forms of suspended solids are grouped for the report. Of the stream reaches monitored for TSS, 6 were impaired, 16 were supporting, and 59 were inconclusive. Of the bio-impaired stream reaches, TSS as a stressor was identified in 11, ruled out in 7, and could not be determined in 34.

The primary sources of sediment are upland areas, the stream channel, and ravines. Upland sediment sources include farm fields and gullies, sediment from roads and developed areas, and other surface erosion. Stream bank, ditch bank, and bluff erosion are sources of channel sediment and can include channel beds, sand bars, and other areas adjacent to water bodies. Altered hydrology has likely increased stream flow,

contributing to excessive bank/bluff erosion. Because of the elevation drop in the MMRW, ravines are common in some areas. Although ravine erosion is natural, it can be accelerated by drainage from farms, cities, developments, and roads.

The report estimated that the proportions of sediment delivered to streams in the MMRW are as follows:

- Channel erosion – 43 percent
- Ravine erosion – 25 percent
- Crop surface erosion – 20 percent
- Urban and developed – 6 percent
- Tile and open intakes - 4 percent
- Pastured land/stream banks - 2 percent

**Temperature**

The report discusses temperature as an impairment when it becomes excessively warm. Warm water contains less DO than cold water and can directly affect fish and invertebrate viability. Cold-water trout streams have a lower threshold to be considered stressed or impaired by water temperatures. Five stream reaches were assessed for temperature: two were impaired, and three were inconclusive. Seven Mile Creek and Spring Creek were the only streams determined to be stressed by water temperatures.

The report also identifies interconnected stressors, including altered hydrology, turbid waters due to eutrophication and/or excess sediment, and degraded habitat (decreased riparian vegetation and shade) for both stressed stream reaches. Point sources do not appear to be a source of thermal stress to aquatic life in this watershed, according to the report.

**Bacteria**

Stream reaches were monitored to assess whether *E. coli* or fecal coliform bacteria were a pollutant. Overall, 34 were impaired, 5 were inconclusive, and none of the reaches were supporting their intended use. Although there were many confounding factors, including survival and reproduction of bacteria in situ, the single largest fecal bacteria source in the MMRW was estimated to be crop surface runoff where manure has not been incorporated. Surface runoff from crops with surface-applied manure accounted for an estimated 56 percent of the bacteria; environmental propagation and surface runoff from crops with subsurface-applied manure were estimated at 13 and 11 percent, respectively. The remaining sources, including animal and human waste, were estimated to contribute 5 percent or less.

**Restoration and Protection**

The WRAPS report advocates different approaches to address water quality impairments. One approach is a layered concept based on

1. building soil health, followed by

2. controlling water within the fields, then
3. controlling water below fields, and finally
4. riparian management.

Another approach focuses on nutrient management and advocates the following:

- increase fertilizer use efficiencies
- increase and target living cover
- increase field erosion control
- increase drainage water retention

A third approach recommends layered strategies including

1. upland: cover crops and nutrient management
2. tile treatment using treatment wetlands and controlled drainage
3. in-stream using woody debris and stream geomorphology restoration

The report provides a series of reference documents that will assist with the implementation of programs to adopt and enhance best management practices (BMPs) in a variety of settings: (a) agricultural BMPs because the MMRW land use and pollutant sources are generally dominated by agriculture and (b) urban, residential, and septic system BMPs because developed areas (including cities and towns) and rural residents all affect water quality. Stream and ravine erosion should be controlled by addressing altered hydrology given that wide-scale stabilization of eroding stream banks and ravines is cost prohibitive. Culverts, bridges, and connectivity barriers need to be assessed on a case-by-case basis to correctly size, remove, or otherwise mitigate the connectivity barriers. Lake watershed improvement strategies should protect and restore lakes by minimizing pollutant contributions from the watershed, as well as addressing sources adjacent to and within the lake. Computer models could provide scientifically based estimates of the pollutant reduction effectiveness of different land-management and BMP approaches. Models can represent complex natural phenomena with equations and numeric estimates of natural features, which can vary substantially between them.

The report explains that a growing body of evidence suggests that a citizen-based approach is likely the most feasible means to successfully achieving clean water in the voluntary-adoption system. Specifically, the transition to more sustainable practices must be developed, demonstrated, and spread by trusted leaders within the community. When leaders embrace a transition, communities are more likely to accept and adopt the transition. When leaders and communities develop solutions, they are likely to intertwine financial security and environmental stewardship—instead of viewing them as conflicting goals. In this way, the community is more likely to improve water quality while securing sustainable farms and cities for future generations.

The report describes and discusses a series of public outreach and education efforts that have been conducted with stakeholders in the watershed. They show different

approaches and techniques to garner public involvement and acceptance of new watershed management techniques that are intended to improve watershed health and reduce adverse effects downstream. The importance of public support is underscored by the consideration that most of these conservation efforts are minimally funded—and often are voluntary.

The WRAPS report points out that the highest priority aspects of water quality protection in the MMRW include the following:

- Maintain a high level of perennial vegetation on the landscape, especially adjacent to water bodies and in areas with high slopes and with highly erodible soils.
- Mitigate altered hydrology by adding storage, infiltration, and evapotranspiration. There are several ways to accomplish this, such as by adding more living vegetation to the landscape in early summer and late fall through cover crops; implementing no-till and strip till; adding water retention structures or wetlands to intercept and infiltrate water from drainage projects; diversifying crop rotations; and restoring stream buffers, wetlands, and grasslands.
- Maintain and spread the good things happening on the landscape: keep practices and BMPs in place and work to spread their adoption.

The report provides a table (“Table 20: Priority areas to restore and protect surface water quality in the Middle Minnesota River Watershed”) that lists priority areas with prioritizing criteria and supporting information such as applicable WRAPS data, information how to use those criteria, and examples. Rather than the WRAPS report dictating what specific areas of the watershed should be worked on first, local partners are encouraged to identify priority areas based on which of these prioritizing criteria is most beneficial from a local perspective. The priority areas should be further refined, and specific projects and practices targeted within the selected priority areas in local planning.

The report presents a multi-page strategies table (Table 22) that summarizes the conditions, goals, 10-year targets, and proposed years to reach the goal. The table is intended to suggest the strategies and estimated adoption rates needed to achieve the goals in the MMRW. A summary of Part A of that table is presented above, accompanying the discussion of the primary findings from the WRAPS report. That summary does not include the strategies and estimated adoption rates needed to achieve the goals.

Part B of the table presents a suite of strategies and practices that the report envisions are cumulatively capable of meeting the 10-year targets for the MMRW. The strategies are presented according to land use and provide target adoption rates by both watershed area and the equivalent number of acres. This level of new adoption advances the landscape and water bodies toward clean water, consistent with the total

years to achieve watershed restoration. This table suggests an adoption rate to meet the goals, estimates the effectiveness of the practice, and identifies the responsible parties. The suggested adoption rates are for new projects and assume existing practices will be maintained.

An accompanying table (Table 23) identifies strategies, and the corresponding practices associated with those strategies, along with the Natural Resources Conservation Service practice code. This is a tool to further define what is proposed in the previous report table.

The report has four appendices that provide additional information related to the main report. Each of these appendices has supporting information that might be helpful to readers looking for additional background information. The information also might provide a deeper understanding of the relation between changing agricultural practices, their relative benefits, and how they might negatively or positively affect crop productivity and profitability.

Appendix 4.1 provides watershed conditions and background information. It contains monitoring and assessment results by stream reach and by lake, a summary of the MPCA Watershed Pollutant Load Monitoring Network data, a geographic information system analysis of altered hydrology, and a summary discussion of nitrogen in groundwater by the Minnesota Department of Health.

Appendix 4.2 provides information related to source assessment. The lines of evidence justifying the identified sources are summarized in a chart. A summary column in the chart titled “Preliminary Professional Judgement Source Assessment” displays a pie chart for each of the identified impairments—streamflow, TSS, TP, nitrogen, and bacteria—and includes the source proportions for each of the impairments. That summary column builds on many studies, including the HSPF model source assessment for the Middle Minnesota River (model years 1996–2012), 2013–2017 Discovery Farms data for the tiled farms, data collected during 2009–2013 for the WPLMN, and specific source assessment analyses from selected studies and reports.

Appendix 4.2 also provides calculators for bacteria source assessment and water portioning. It summarizes point sources and stressor sources in the watershed and identifies sources of information for the presettlement landscape map. An interpretation of the feedlot statistics is included. Regulated facilities that do not discharge to surface water are listed. The estimated sub-watershed yields from the HSPF model runs are listed. Data from the calculation of evapotranspiration rates are presented.

Water quality goals and related information are summarized in Appendix 4.3. Calculations for lake and stream TMDLs are summarized. An analysis comparing the flow-weighted mean concentration and yield for TSS, TN, and TP determined from the HSPF model results, the WPLMN data, and professional judgment regarding watershed-wide estimates is also presented. Although this is an enlightening exercise, we did not find an interpretation explaining the logic and results of this comparison.

Appendix 4.3 concludes with a graphic of the Minnesota State Nutrient Reduction Strategy, which recommends a 20 percent reduction in TN and a 45 percent reduction in TP by the year 2025 from the average established during the 1980–1996 baseline.

Information related to strategies and priorities is presented in Appendix 4.4 The results of a series of runs using selected agriculture-related sediment- and nutrient-reduction assessment models are summarized. Lake restoration and protection strategies focused on the watershed, lakeshore, and in-lake applications are described. The results of a lake TP sensitivity analysis are provided. Variously numbered tables categorize and summarize the findings of reports discussing the effectiveness of various sediment- and nutrient-reduction strategies that are applicable to upper-Midwest watersheds. Additional information relates the effectiveness of various land treatments for reducing nutrient applications compared to changes in crop yield. Other tables estimate the cost of implementing various land-management practices. The notes and assumptions used to calculate the table of strategies is presented. A multipage table provides a list of tools, resources, and internet links for use in prioritizing and targeting watershed and resource management practices that could be used to improve watershed and stream quality.

The Middle Minnesota River Watershed TMDL and WRAPS reports are effective at identifying the impairments adversely affecting the water quality in the watershed. They present an understanding of what is needed to improve resource quality and set meaningful goals and timelines to achieve those goals. Finally, a variety of tools and approaches are suggested that could provide resource managers and stakeholders with the means to correct the impairments affecting watershed health within the suggested timelines.

Young Environmental Consulting Group, LLC

# Technical Memorandum

**To:** Linda Loomis, Administrator
Lower Minnesota River Watershed District

**From:** Lan Tornes
Natural Resources Scientist

**Date:** September 18, 2019

**Re:** Review of Lower Minnesota River Watershed Total Maximum Daily Load Study Draft Report and the Lower Minnesota River Watershed Restoration and Protection Strategy

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Young Environmental Consulting Group, LLC (Young Environmental), as requested by the Lower Minnesota River Watershed District (LMRWD), has reviewed and assessed the Lower Minnesota River Watershed Total Maximum Daily Load (TMDL) Study Draft Report and the Lower Minnesota Watershed Restoration and Protection Strategy (WRAPS). The results of that review and relevant recommendations are presented below.

Impaired water bodies assessed for this effort include Bevens, Carver, Chaska, Silver, Buffalo, High Island, Sand, Eagle, Nine Mile, Riley, and Le Sueur Creeks; Rush and Credit Rivers; many ditches and unnamed streams and tributaries; and many lakes. Bluff Creek already has had two approved TMDLs and, for that reason, was only mentioned in this TMDL report.

The TMDL and WRAPS reports are a useful contribution to our understanding of surface-water impairments in the watershed. TMDL reports methodically identify the constituents causing the impairments and the sources and amounts that are causing the impairments of identified surface waters in the watershed. TMDL reports also establish approaches for resolving those impairments. The methods employed to develop the TMDLs in this report are based on established guidelines. Deviations or assumptions are well documented and appear to be based on sound judgment. For example, there were some difficulties combining land use and land cover data from two different sources in rural versus metropolitan areas, but they were successfully dealt with in this report and the methods clearly documented. Other than report size, it was not clear why the TMDL report was divided into three parts. However, that does affect the effectiveness or applicability of the TMDLs.

The WRAPS report outlines impairments identified by the TMDL reports and adds other waters impaired by measurements not included in the TMDL process but that have been identified as adversely affecting stream health. It includes the results of a stressor identification process and other monitoring and assessment programs. Through this approach, the WRAPS report intends to protect waters that are not yet impaired. The WRAPS report proposes tools and strategies to address those impairments and provide the most expeditious improvements in the quality of resources for effort expended.

Important findings from the TMDL and WRAPS reports suggest the following:

- The most widespread impairments come from total suspended solids (TSS).
- The primary source of TSS is nearby channel/bank erosion, especially at knickpoints, where streams are trying to establish equilibrium with the steep topography.
- Implementing land use and other management practices that reduce the magnitude and duration of peak flows will have the greatest effect in reducing TSS in streams and other receiving waters.
- Increased runoff volumes over the last several decades are not solely the result of increased precipitation.

The need to reduce runoff is also suggested by sources of *Escherichia coli (E. coli)* bacteria impairment. The Municipal Separate Storm Sewer System (MS4) permitted sources are implicated as a substantial source of *E. coli* impairment. Eagle Creek, a designated trout stream classified as a high-value resource, appears to be affected primarily by MS4 runoff. The TMDL report suggests that the origin of the *E. coli* in MS4 runoff is animal waste, including birds (waterfowl) and pets.

Public participation and stakeholder education are frequently cited as a means of improving the quality of resources in the watershed. The report encourages continuing to foster relationships with adjacent watershed districts and soil and water conservation districts. The Nine Mile Creek and Riley Purgatory Bluff Creek Watershed Districts were specifically mentioned as having well designed watershed management plans and monitoring programs.

The reports were well developed, with no apparent flaws, and, therefore, we have no comments for the Minnesota Pollution Control Agency (MPCA) to address. Pages 3 through 21 of this memo provide a summary of pertinent information discussed in the TMDL and WRAPS reports. We do, however, recommend the following actions for the LMRWD to consider:

- Partner with the MPCA, the city of Savage, and other stakeholders to identify and reduce *E. Coli* discharge to Eagle Creek.
- Continue the partnership with the Nine Mile Creek and Riley Purgatory Bluff Creek Watershed Districts and provide resources as needed to combat impairments within their jurisdictions because everything ultimately flows into the Minnesota River.

**Lower Minnesota River Watershed TMDL Part 1: Southern and Western Watersheds (wq-iw7-49b)**

This 469-page document serves as an introduction to parts 1, 2, and 3 of the TMDL and includes a map (Figure 1) and a table (Table 1), not shown here, that convey all the approved, deferred, delisted, and developed TMDL listings for lakes, streams, and ditches in the Lower Minnesota River Watershed ("the watershed"). The impairments included are for total phosphorus (TP), TSS, *E. coli*, and dissolved chloride. Part 1 describes the logic behind the TMDL process for each of the impairments and serves as a helpful primer for the TMDL neophyte. It astutely describes the TMDL for a water body as a "pollution diet."

An important observation when dealing with many streams tributary to the Lower Minnesota River is that they will continue to down-cut as they try to establish a stable knickpoint in relation to the valley that was carved by glacial river Warren when it drained prehistoric Lake Agassiz. This continued downcutting has resulted in unstable stream channels that enhance the transport of TSS and associated contaminants downstream.

Because the watershed transitions from rural in the west to urban in the east, the land use information needed for TMDL assessments comes from different sources, thus providing different categories and levels of information. The challenge of blending and showing different coverages for land use was successfully dealt with. The differences are rather stark on the land use maps and are evident in Figures 13 (Carver and Bevens Creeks), 14 (Le Sueur Creek), and 15 (Sand Creek), which are not shown here. The following Table 12, adapted from the report, illustrates the conversions that were made to accommodate the differences in coverage between the National Land Cover Data with the land use data provided by the Metropolitan Council of the Twin Cities for the Twin Cities metropolitan area (TCMA).

**Table 12. Translation of land cover to land use for watersheds that cross the TCMA**

| **Land Cover** | **Land Use** |
|---|---|
| Barren Land | Undeveloped |
| Cultivated Crops | Agricultural |
| Deciduous Forest | Undeveloped |
| Developed, High Intensity | Residential/Developed |
| Developed, Low Intensity | Residential/Developed |
| Developed, Medium Intensity | Residential/Developed |

| | |
|---|---|
| Developed, Open Space | Residential/Developed |
| Emergent Herbaceous Wetlands | Undeveloped |
| Evergreen Forest | Undeveloped |
| Hay/Pasture | Agricultural |
| Herbaceous | Undeveloped |
| Mixed Forest | Undeveloped |
| Open Water | Open Water |
| Shrub/Scrub | Undeveloped |
| Woody Wetlands | Undeveloped |

Existing streamflow records were used to calculate constituent loads when reliable data were available. The watershed version of the Hydrological Simulation Program–Fortran (HSPF) was used to estimate streamflow and loads for ungaged streams in the watersheds. HSPF has been used successfully for many streams and other TMDLs in watersheds of the Minnesota River. The Spreadsheet Tool for Estimating Pollutant Load was then used to evaluate phosphorus loads in watershed runoff to the impaired lakes

The report appears to make a common error equating suspended sediment (SS) with TSS. It is not clear whether SS, TSS, and measurements of turbidity, which is sometimes used as a surrogate for TSS, were somehow combined to enrich the data set. Although they are similar and strongly related, they should not be assumed to be equivalent measurements.[1] If they were combined, the coefficients used to make them equivalent should be presented. For example, the Rush River, between it's middle and south branches, has no TSS data yet is listed as being impaired for TSS. Apparently, this is the result of high turbidity or reduced transparency. Beyond that concern, the report has well documented methods. It is noted that all the samples collected along an impaired stream reach were combined. This has the effect of enriching the data set while reducing the complexity of calculating multiple TMDLs for the same stream reach. Several sources of loading are discussed in the TMDL report. Some of the sources are regulated with permitted discharges. Others are unregulated and have loading that had to be calculated using existing data—or estimated. Wastewater treatment plants (WWTPs) discharge regulated amounts of nutrients, bacteria, and TSS. Agricultural runoff from cropland contains unregulated amounts of nutrients, bacteria, and TSS that

[1] J. R. Gray, G.D. Glysson, and D.S. Mueller, "Comparability and Accuracy of Fluvial-Sediment Data: A View from the U.S. Geological Survey: Proceedings of the American Society of Civil Engineers, Hydraulic Measurements and Methods Symposium," USGS, July-August, 2002, http://water.usgs.gov/osw/techniques/asce.pdf.

were estimated for the TMDLs. Discharge from many municipal areas is regulated under the MS4 program and can contain permitted discharges of nutrients, bacteria, TSS, and chloride. Other sources of wastewater from construction and industrial discharge are also considered in the TMDL reports. The TMDL reports also include a margin of safety (MOS) that is set at 10 percent for chloride and 5 percent for TP, TSS, and *E. coli*.

Many lakes in the watershed are impaired from excessive TP and possibly other pollutants. All the lakes are in the upper reaches of each of the watersheds above the Minnesota River Valley, and none of the lakes assessed for this TMDL are within the boundaries of the LMRWD. Many of the lakes are a relevant source of nutrients and TSS to some of the impaired streams and are addressed as part of the TMDL for many of the streams.

The constituents found to exceed TMDLs in streams addressed in Part 1 were TP, TSS, *E. coli*, and chloride.

The TP concentrations in the impaired streams were almost consistently above the 150 micrograms per liter (µg/L) south river nutrient standard. According to the Minnesota Pollution Control Agency (MPCA), 70–80 percent of the annual TP load moves during mid-March to mid-July.[2] Upstream water bodies (lakes) account for as much as 82 percent of the TP source, and they were a significant source for most streams. Noncompliant wastewater treatment systems (leaking septic systems) were also identified as a potential source; the average percent of septic systems that are considered imminent public health threats ranged from 3 percent in Dakota county to 39 percent in Sibley county during 2000–2009. Not all these systems contribute to nearby waters, but they are a threat. The TP load from near-channel sources was estimated to be 20 percent of the total load, based on simulations.

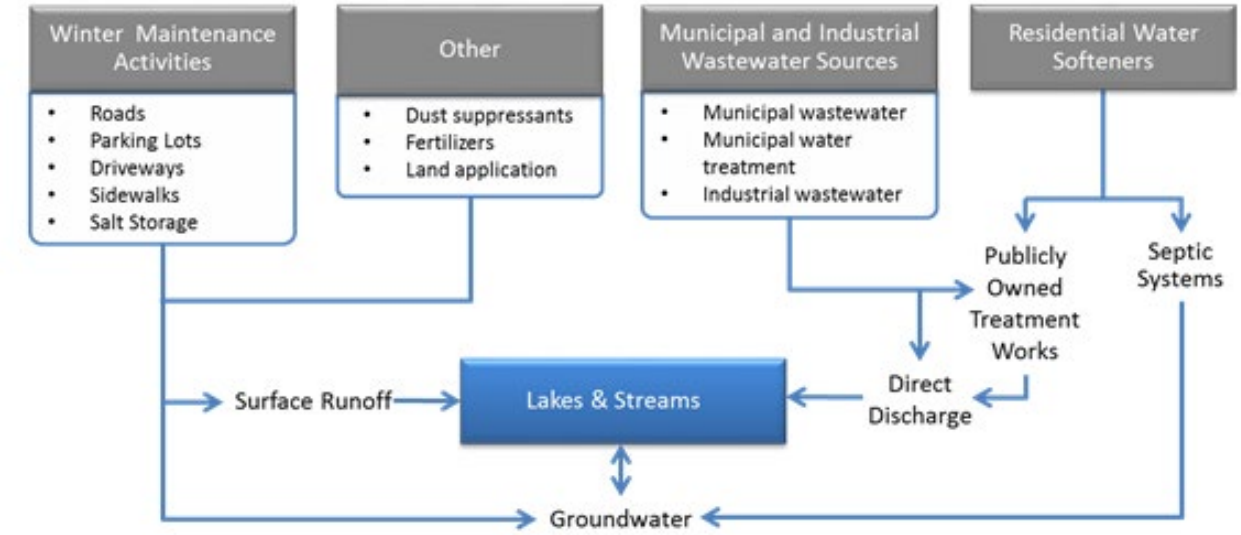
The TSS concentration in streams averaged less than the 65 milligrams per liter (mg/L) standard but is listed as impaired because the streams carry large amounts of TSS during higher flows. Information from multiple sources was used to estimate that at least 63 percent and usually 83 percent of the TSS in streams originated near the stream channel. The HSPF model suggested that near-channel sources accounted for about 83 percent of the TSS load. However, the percentage TSS from near-channel sources in many tributary streams was less.

The report states that *E. coli* counts typically were highest in smaller streams. However, *E. coli* counts also were high in the Middle Branch of the Rush River. In many streams, *E. coli* counts were high across many flow zones, indicating a mix of sources. In some streams, *E. coli* counts were higher during lower flows, suggesting point sources rather than runoff. Counts often were highest in September, when flows were typically low and water temperatures were moderate. In many streams, the highest priority source of *E.*

[2] Minnesota Pollution Control Agency [MPCA], *The Minnesota Nutrient Reduction Strategy* (St. Paul, MN: MPCA, 2014) Document number wq-s1-80.

*coli* was individual wastewater treatment systems, posing an imminent public health threat and often exceeding livestock as a priority source. For some streams, stormwater runoff containing waste from wildlife and pets was the dominant source.

For the protection of cool and warm water sport fish, streams and lakes are considered impaired for chloride when the concentration exceeded 230 mg/L. Several streams in the watershed are impaired by chloride and have approved TMDLs. The Credit River is the only stream lacking an approved TMDL for chloride and is the only stream listed in this TMDL as impaired by chloride. Chloride comes from many sources but most of it in the local area is anthropogenic. This report provides a graphic on p. 121 and shown below showing sources of chloride and pathways. It provides an overview to resource managers suggesting sources of chloride that could be addressed to reduce chloride impairments in receiving waters.




**Stream TMDLs for Total Phosphorus**

Several sources were considered when determining the load allocation (LA) for the TP-impaired TMDLs. Lake TMDL's were used as the basis for LA to impaired streams from those lakes. The wasteload-allocation (WLA) calculations for the WWTPs was an involved series of calculations with documented assumptions. The resulting numbers seem reasonable. Transport losses of TP at the downstream reaches of Sand Creek were accounted for using a special formula for wasteload allocation. This appears to be a way to reduce the load of TP resulting from sedimentation and other factors that remove TP from the system.

The load reductions needed to meet the stream eutrophication or TP TMDLs are shown in the following table, recreated from table 63 in the TMDL report:

**Table 63: Summary of total phosphorus percent load reductions by impaired stream**

| Impairment Group | Reach Name | Reach Description | Total Phosphorus Reduction (%) |
|---|---|---|---|
| Carver/Bevens | Bevens Creek | Headwaters (Washington Lk 72-0017-00) to 154th St | 61 |
| | Carver Creek | MN Hwy 284 to Minnesota R | 60 |
| Sand/Scott | Sand Creek | T112 R23W S23, south line to -93.5454 44.5226 | 67 |
| | Sand Creek | -93.5454 44.5226 to Raven Str | 67 |
| | Sand Creek | Porter Cr to Minnesota R | 67 |

The authors of the TMDL report made several recommendations to meet the TP TMDL goals listed in the report. For Bevens Creek to meet the TMDL during low flow, the Hamburg WWTP needs to meet its WLA, which is consistent with the recommendation in the draft report titled “Minnesota River Eutrophication TMDL”. During moderate to high flows, phosphorus reductions need to come from the watershed. Washington Lake, located on Bevens Creek just upstream of the impaired reach, is a major contributor of TP during the growing season. The TMDL for Carver Creek also could be met when TMDLs for Miller Lake are met. No other reductions are needed after Miller Lake meets the 60 µg/L standard.

Three reaches along Sand Creek were identified as impaired, and each was given its own TMDL, and the reductions needed to meet those TMDLs are more complicated. Impaired lakes contribute a TP load when their outflows are elevated, and WWTPs are a problem when they are not meeting their WLAs during lower flows. One benefit of having multiple TMDLs along a stream is that when the upstream reach is meeting its load expectations, the downstream reaches likely will be compliant.

**Stream TMDLs for TSS**

Several important factors were considered while developing the TSS TMDLs. An “unallocated load” was developed to account for conditions when the stream reach already has better quality than its TMDL criteria in a given flow regime. This is intended to prevent degradation of a high-quality stream reach that is already exceeding

expectations. Natural background sources are implicit in the LA, so they did not warrant their own allocation.

The load reductions needed to meet the stream TSS TMDLs range from 2 percent to 89 percent, as shown in the following table, which is recreated from table 69 in the TMDL report. Some streams were assigned TMDLs without any samples for TSS concentration, so reductions are not applicable. Additionally, 14 stream reaches were assigned TMDLs, including reaches within the Rush, High Island, and Sand Creek watersheds.

**Table 69: Summary of TSS percent load reductions by impaired stream**

| Impairment Group | Reach Name | Reach Description | TSS Reduction (percent) |
|---|---|---|---|
| High Island/ Rush | Rush River | M Br Rush R to S Br Rush R | – [a] |
| | Rush River | S Br Rush R to Minnesota R | 89 |
| | High Island Creek | JD 15 to Bakers Lk | – [a] |
| | High Island Ditch 2 | Unnamed cr to High Island Cr | – [a] |
| | Buffalo Creek | 276th St /Co Rd 65 to High Island Cr | 83 |
| | High Island Creek | -94.0936 44.6181 to Minnesota R | 74 |
| Carver/ Bevens | Unnamed creek (East Creek) | Unnamed cr to Minnesota R | 2 |
| Le Sueur/ Minnesota | Robert Creek | Unnamed cr to unnamed cr (at Belle Plaine Sewage Ponds) | 72 |
| Sand/Scott | Sand Creek | T112 R23W S23, south line to -93.5454 44.5226 | 27 |
| | Sand Creek | -93.5454 44.5226 to Raven Str | 61 |
| | Sand Creek | Raven Str to Porter Cr | – [a] |
| | Porter Creek | Fairbanks Ave to 250th St E | 60 |

| | | | |
|---|---|---|---|
| | Porter Creek | Langford Rd/MN Hwy 13 to Sand Cr | 47 |
| | Sand Creek | Porter Cr to Minnesota R | 89 |
| [a] TSS data not available during TMDL time period (2006–2015) | | | |

Based on the assumptions made for the TMDLs, once the WLAs have been distributed and the 5 percent margin of safety taken into account, the remainder is given to the LA. The LA is the unregulated TSS sources identified as including near-channel and runoff sources. In one impaired Sand Creek reach, the LA comprised nearly 101,000 of the 108,000 mg/L loading capacity during very high flows. The TMDL duration curves for many impaired stream reaches suggest that reducing peak runoff may have the greatest effect on reducing the LA part of the TMDLs.

**Stream TMDLs for *E. coli***

Thirty-six stream reaches were assigned *E. coli* TMDLs. The load reductions needed to meet the stream *E. coli* TMDLs range from 8 percent to 91 percent. The smallest improvement is needed for Eagle Creek, which is a spring-fed stream with a small range in streamflow. It exhibits an unusual load-duration curve that is almost flat throughout the flow regimes. Eagle Creek is a designated trout stream and classified as a high-value resource; its TMDL summary table (Table 119 in the report) shows several permitted MS4s that are part of its WLA, demonstrating that they are part of the source of impairment. On stream reaches where WWTPs are a factor, the *E. coli* TMDL considers them as a permitted source that may not require improvement. Leaky septic systems may be an unquantified source during lower flow, and many of them are being addressed outside of the TMDL process. Because *E. coli* often is associated with runoff, controlling wild and domestic animal waste from urban and rural surfaces may be an effective means of control for some areas.

**Stream TMDLs for Chloride**

The Credit River is the only water body listed for chloride impairment, and that listing is applicable only November–March. The target concentration for chloride is 230 mg/L. Chloride impairment of the Credit River was determined based on five samples that exceeded the target concentration. The following table (Table 121 in the TMDL report) summarizes the loading capacity for the Credit River:

**Table 121. The TMDL for the Credit River**.

| TMDL Parameter | Chloride Load (lbs/day) |
|---|---|
| Loading Capacity | 65,563 |

| | | |
|---|---|---|
| WLA | Total WLA | 22,368 |
| | Burnsville City MS4 (MS400076) | 22,368 |
| | Credit River Township MS4 (MS400131) | |
| | Dakota County MS4 (MS400132) | |
| | Lakeville City MS4 (MS400099) | |
| | MnDOT Metro MS4 (MS400170) | |
| | Prior Lake City MS4 (MS400113) | |
| | Savage City MS4 (MS400119) | |
| | Scott County MS4 (MS400154) | |
| | Spring Lake Township MS4 (MS400156) | |
| Load Allocation | Total LA | 36,639 |
| | Unregulated Runoff | 31,308 |
| | Natural Background | 5,331 |
| Margin of Safety | | 6,556 |

No permitted wastewater sources discharge chloride into the Credit River. The loading capacity of the Credit River was determined to be 65,600 pounds per day, with about 1/3 coming from nine MS4 communities and the remainder from unregulated runoff, background, plus a 10 percent margin of safety.

Sources of chloride in watershed runoff to the Credit River include runoff from winter snow and ice maintenance activities, agricultural lands, and dust suppressants. The TMDL authors went to great lengths to develop reliable estimates of road-salt applications in the Credit River watershed based on land use and published application rates. Agricultural cropland may also be a source of chloride to the Credit River. Fertilizers and biosolids from food processing and publicly owned treatment works also contain chloride. Chloride from water softeners generally is discharged into the sanitary sewer—where it becomes part of the WWTP waste stream—or septic systems—where it may seep into the groundwater and is not directly considered in the TMDLs.

**TMDL Discussion**

The goals set forth in the TMDL reports are described as being attainable and sustainable. Tools are described that will support needed improvements. The

cooperation of principal responsible parties, including the MPCA, MS4 entities, and agricultural interests are encouraged to support the TMDL goals. The report suggests that it is possible to exceed the goals by controlling effluent variability. This is consistent with the observation that reducing high flows will reduce much of the loading, especially where near-stream sources of pollutants such as TSS are a problem.

Various conservation-easement programs are described as useful means of improving stream water quality. The report states that, as of August 2018, there were 65,339 acres of short-term conservation easements such as the Conservation Reserve Program and 38,173 acres of long-term or permanent easements (i.e., Conservation Reserve Enhancement Program, Reinvest in Minnesota, Wetland Reserve Program) in the nine counties that are located within the watershed.

Monitoring will be done to establish baselines, assess compliance, identify sources, track implementation, and evaluate effectiveness of implementation. The MPCA, the Metropolitan Council of Environmental Services (MCES), and local watershed districts are credited with contributing to this effort.

Because development is likely to continue adjacent to the TCMA, it is worth noting how the TMDL report addresses development within the watershed. For new development projects, the MPCA's current phase II MS4 general permit requires no net increase from pre-project conditions (on an annual average basis) of stormwater discharge volume and stormwater discharges of TSS and TP. For redevelopment projects, the MPCA's current phase II MS4 general permit requires a net reduction from pre-project conditions (on an annual average basis) of stormwater discharge volume and stormwater discharges of TSS and TP. These provisions in the MS4 permit will prevent increases in annual loading in TSS and TP. Controlling *E. coli* in runoff from MS4 watersheds should reduce impairments in receiving waters. Controlling chloride in the Credit River is less clearly understood and is based more on optimizing salt-application techniques while monitoring chloride levels in the river.

The TMDL report continues by describing and promoting management practices that can improve stream-water quality while controlling pollutant loads. Agricultural sources are discussed in detail. The Minnesota Stormwater Manual[3] is an effective reference for controlling stormwater runoff. Subsurface sewage treatment system upgrade, replacement, and maintenance are discussed, along with the operation of water softeners and public education. Because lakes were identified as significant sources of TP loads, the means of controlling internal TP loading are also discussed.

The authors of this report tried to determine and convey the costs to implement the activities outlined in the TMDL strategy, presumably for the benefit of resource managers who need to fund these projects. The costs are estimated to be about $42 million to $69 million over the next 20 years. That includes $7 to $14 million for WWTPs to achieve effluent limits consistent with the WLAs presented in this report. The range

[3] https://stormwater.pca.state.mn.us/index.php?title=Main_Page, accessed August 28, 2019.

reflects the level of uncertainty in the source assessment and addresses the high priority sources. The cost includes increasing local capacity to oversee implementation in the watershed and the voluntary actions needed to achieve necessary TMDL reductions.

This report closes with a brief summary of public participation in the TMDL. Comments on the TMDL were encouraged from July 22, 2019, through Sept. 20, 2019.

**Lower Minnesota River TMDL Part 2: Northern Watersheds: The Riley Purgatory Bluff Creek and Nine Mile Creek Watersheds (wq-iw7-50b)**

This report provides TMDLs for 13 lakes impaired by excess TP, two streams impaired by *E. coli,* and one stream impaired by both *E. coli* and TSS. In the discussion, TMDLs often were grouped primarily by the watershed district that has jurisdiction over the impaired water rather than other characteristics. This seemed unusual, except from a watershed-management perspective. The Riley-Purgatory-Bluff Creek Watershed District and Nine Mile Creek Watershed District are the organizations most instrumental in managing and monitoring water resources in this part of the watershed.

Land use in the watersheds discussed in this Part 2 is mostly single-family residential, with considerable open space. Roadways, retail spaces, and light industry comprise a small portion of the land use.

Riley Creek exceeded the 65 mg/L TSS criteria in 59 percent of its samples, leading to its listing as an impaired stream. Purgatory Creek exceeded the criteria in only 4 percent of its samples, which is considerably less than the 10 percent limit constituting impairment.

This report describes that the cause of the Riley Creek TSS impairment is mostly from stream bank and near-channel sources of sediment. Seven of the nine reaches of Riley Creek downstream of Lake Riley were rated as having high to severe levels of erosion and channel instability. The report notes that, for Purgatory Creek, “the results are limited in that most of the historic sampling has occurred upstream of significant near-channel sources of erosion and mass wasting, including landslides.”

The TSS TMDL addresses the fishes and macroinvertebrate impairment listings for this reach of Riley Creek. A separate report titled Lower Minnesota Watershed Stressor Identification Report[4] evaluated all the biota impairments in this major watershed. TSS was the only pollutant among the candidate stressors to be found conclusively contributing to the biota impairments for Riley Creek. The TMDL determined that an 88 percent overall reduction in TSS is needed to overcome the impairment of this reach. The summary of the TSS LA shows that most of the load during high flows comes from the watershed, suggesting stream bank erosion is the primary source of TSS. This

[4] MPCA, *Lower Minnesota River Watershed Streams Stressor Identification Report* (St. Paul, MN: MPCA, 2018) Document number wq-ws5-07020012c.

report goes on to state that improvements in stormwater management should help reduce sediment contributions from near-channel sources.

The *E. coli* chronic impairment standard for Class 2B waters states that a stream reach is impaired if the geometric mean of no less than five samples within a calendar month exceeds 126 organisms per 100 milliliters. The acute impairment standard applies when 10 percent of samples taken within any calendar month individually exceed 1,260 organisms per 100 milliliters. Regarding *E. coli* bacteria, the reach of Nine Mile Creek downstream of Marsh Lake, the reach of Purgatory Creek downstream of Staring Lake, and the reach of Riley Creek downstream of Riley Lake are impaired based on the Class 2B chronic impairment standard. None of the stream reaches evaluated are impaired based on the Class 2B acute impairment standard.

Several references are cited discussing the persistence and growth of *E. coli* bacteria in a variety of settings including soil, beach sand, and sediments throughout the year in the north central United States, without the continuous presence of sewage or mammalian sources. Although interesting to consider, it is not clear whether this is a significant source of impairments in streams evaluated for this report. Sources of *E. coli* impairment in streams evaluated for this report are likely MS4-permitted urban sources, including pet waste and waterfowl. Construction, industrial, and wastewater sources are not considered pertinent. Individual sewage treatment systems and feedlots are not known to be a source of pollution in the watersheds.

This report explains that because *E. coli* monitoring data at the lake outlets was not collected from the Riley-Purgatory Creek or Nine Mile Creek watersheds, a load duration curve was developed by multiplying the flow duration curve by an *E. coli* concentration of 11 organisms per 100 milliliters. This value represents the average outflow concentration of Gray's Bay Dam from the Minnehaha Creek *E. coli* TMDL.[5] The reductions needed to meet the TMDL for each of the impaired stream reaches are 41 percent for Nine Mile Creek, 68 percent for Purgatory Creek, and 81 percent for Riley Creek.

Natural background sources of pollutants were not explicitly considered in this TMDL. They were not found to be significant and are implicitly included in the LA part of the TMDL.

This report addresses the regulatory approaches by explaining the requirement that communities having MS4 permitted sources to prepare a stormwater pollution prevention plan for managing stormwater under their jurisdiction. This TMDL assigns TSS, TP, and *E. coli* WLAs to all regulated MS4s discussed.

This report also mentions the Nine Mile Creek Watershed District and the Riley-Purgatory-Bluff Creek Watershed District as being successful in preparing relevant watershed management plans and having adequate funding through levies that support

[5] MPCA, *Minnehaha Creek E. coli Bacteria/Lake Hiawatha Nutrients Total Maximum Daily Load* (Tetra Tech, 2013).

their work. They also perform outreach and education programs that are intended to maintain and enhance the quality of resources. These organizations are likely to be instrumental in fostering and documenting progress toward achieving the goals enumerated in the TMDL report. This recognition suggests that they set a good example for other watershed districts and should be strong partners in future endeavors with support from Minnesota state environmental agencies.

Gross cost estimates were made to meet the requirements of the TMDL. Although lakes are a local concern, the estimated cost to remove the amount of phosphorus needed to meet the TMDL is $5.3 million per year. It is estimated that it will cost $30 million to stabilize the erosional areas of the lower valleys of Riley and Purgatory Creeks. The costs to implement the activities to address *E. coli* impairments are approximately $4 million to $8 million.

This report includes only one appendix. It discusses the model parameters and how they were applied or adapted to streams and lakes in the study area. The P8 model was used to simulate runoff from urban areas. The appendix deals primarily with the application of the model to TMDL lakes.

**Lower Minnesota River Watershed TMDL Part 3: Northern Watersheds: Carver County Six Lakes (wq-iw7-51b)**

The third TMDL report focuses on selected lakes impaired by TP in Carver County and within the watershed. The lakes include Gaystock, Maria, Hazeltine, McKnight, Jonathan, and an unnamed lake that was given the name “Grace” in the report. The report states that its goal is to quantify the pollutant reductions needed to meet state water quality standards for nutrients and spur action to address the impairments. This part of the metro area is experiencing moderate to high levels of development, and there is increasing public awareness of water quality issues.

However, this report does not discuss whether downstream waters have been adversely affected by outflow from these lakes. Many of the lakes are part of a chain of lakes that feed into one another. Based on the discussion in parts 1 and 2 of this TMDL, the effect of these lakes on downstream waters, when relevant, was accounted for in the load allocations for those TMDLs.

**Lower Minnesota River Watershed Restoration and Protection Strategy Report (WRAPS)**; **Document Number: wq-ws4-58a**

The WRAPS report serves to at least partially address the US Environmental Protection Agency’s (EPA’s) Nine Minimum Elements of Watershed-Based Plans. Addressing those elements helps to qualify applicants for Clean Water Act Section 319 implementation funds.

The watershed WRAPS report appears to base its findings primarily on information collected for the intensive watershed monitoring (IWM) program rather than on information provided by the TMDL process. In 2014 and 2015, the MPCA along with local partners conducted an IWM in the watershed to assess the aquatic life and aquatic

recreational use status of a significant portion of the lakes and streams. The IWM would provide a more uniform set of data collected during a defined time span that would simplify data interpretation throughout the watershed. The results of the TMDL studies can supplement data collected for the IWM. The IWM was not mentioned as part of the TMDLs—probably because the IWM was a short-term study, whereas the TMDLs are based on data collected over a longer time period and are likely to provide better average, baseline information.

Of streams that were assessed for the WRAPS report, 84 percent show impairments of aquatic life (including suspended sediment, nutrient enrichment or eutrophication, and impaired biota), and 95 percent have impaired aquatic recreation based on the presence of *E. coli*. Aquatic recreation impairment of lakes is less common, with 55 percent of those monitored indicating eutrophication impairment.

Many streams were assessed using data from field surveys to develop Index of Biotic Integrity (IBI) scores for macroinvertebrates and for fish assemblages. Overall stream aquatic biology is poor in the watershed. Impairments were identified in all sub watersheds. Of the 87 reaches assessed for fish, 65 do not meet the standards, and of the 70 reaches assessed for macroinvertebrates, 56 do not meet the standards.

Impairments for both TSS and TP were prevalent, with 58 percent and 50 percent of the assessed reaches impaired for these measurements, respectively. Of the streams assessed for chloride, 24 percent are impaired. Aquatic recreation is impaired in 55 of the 58 stream reaches assessed, which typically results from the presence of *E. coli*.

Table 1 of the WRAPS report is a detailed, comprehensive, multi-paged summary, not included here, that shows the assessment status of stream reaches throughout the watershed. It shows whether the reach is impaired or meets the criteria for aquatic life, including IBI scores for macroinvertebrates and fish, dissolved oxygen, turbidity/TSS, river eutrophication, and chloride. A column indicating aquatic recreation suitability, labeled *E. coli*, is also provided. If the parameter was not assessed, the field is blank.

Many lakes were assessed for the IWM; most were in the eastern portion of the watershed. All but one of the lakes were situated in the upper elevation, upstream parts of the tributary streams, and none were within the boundaries of the LMRWD. Only 45 percent of the lakes assessed meet the aquatic recreation standards, whereas 57 percent do not meet the standards for aquatic life/fish IBI standards. None of the lakes assessed are impaired by elevated chloride concentrations. Table 2 Assessment status of lakes in the lower Minnesota River Watershed, not included here, shows the assessment status of the lakes is provided in the WRAPS report.

Trends in constituent concentrations were addressed. TSS and TP data for streams were examined, and no trends were observed. Lake transparency was examined for trends, with mixed results, but no consistent upward or downward trends were found. A variety of factors were identified that could temporarily influence lake-water clarity, including the infestation of aquatic species such as zebra mussels.

The WRAPS report evaluates stressors and sources. Stressor identification (SID) is an important part of this work. The Lower Minnesota River Watershed Stream Stressor Identification Report[6] is cited as the source of the full results and evaluation of individual stream reaches.

Key overall findings and conclusions from the SID work include the following:

- Nearly all reaches have multiple stressors. In only 3 of the 74 reaches evaluated are no conclusive stressors identified.
- Insufficient/degraded habitat is the most prevalent stressor, occurring in 76 percent of the reaches. Altered hydrology is next highest, at 65 percent. The pollutant-related stressors are also significant, with eutrophication (from phosphorus) affecting 62 percent of the reaches, and nitrate and TSS affecting 54 percent. Low DO, which may in some cases be pollutant-driven, occurs in 32 percent of the reaches.
- Nitrate nitrogen is most prevalent as a stressor in streams of intensely agricultural areas.

Long-term stream flow monitoring of the Minnesota River at Jordan showed a significant change in flows beginning in the early 1980s. The Minnesota Department of Natural Resources, using a double mass curve, evaluated the relationship between precipitation and discharge data over time.[7] The evaluation showed that as precipitation increases, more water enters the river via runoff (shown in Figure 10 of the report; not included in this memorandum). Although the Minnesota River at Jordan receives water from the entire basin, similar results were seen for High Island Creek streamflow. We were unable to find the link for this important observation, but a similar assessment compiled by the Freshwater Society[8] shows that the streamflow at Jordan has increased substantially during the last several years. The Freshwater Society assessment suggests that agricultural practices and increasing precipitation are contributing to the increased runoff and that it constitutes a serious problem for the Minnesota River and associated water bodies.

The WRAPS report states that although the increase in precipitation is one reason for the increase in runoff, Lenhart et al.[9] concluded that the increase in annual precipitation alone cannot explain the large increase in the average annual stream flows. Changes in soil organic matter (SOM), cropping rotations, drainage, and impervious surfaces all have a significant contribution to the increase in runoff. SOM plays a significant role in the ability of the soil to allow water infiltration and to hold water. The National Resource Conservation Service estimates that for every 1 percent increase in SOM in the top six

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[6] MPCA, *Lower Minnesota River Watershed Streams Stressor Identification Report,* 2019. https://www.pca.state.mn.us/sites/default/files/wq-ws5-07020012c.pdf, accessed September 17, 2019

[7] Minnesota Department of Natural Resources, 2017 (This citation from the WRAPS report could not be found in the reference list or in a Google search).

[8] http://freshwater.org/wp-content/uploads/2017/01/ChangeInMinnRiverReport_8.5x11.pdf, accessed August 27, 2019.

[9] C.F. Lenhart, H. Peterson, J. Neiber, "Increased Streamflow in Agricultural Watersheds of the Midwest." *Watershed Science Bulletin*, Spring (2011): 1–7.

inches of soil, an additional 27,000 gallons of water per acre could be held in the soil profile. SOM losses have been estimated to be about 50 percent in areas of aggressive land cultivation.

Changes in cropping practices have also been implicated in adverse effects on stream hydrology. Corn and soybeans, which have been the predominate crop in the area since the 1960s, transpire the most during July–August when precipitation is less, which could draw down late summer base flow. Previously grown crops, including hay, alfalfa, and small grains, transpire earlier in the season when moisture is more available. Tile drains, adding ditches, and straightening streams to help keep soils dry all have been implicated in causing more erosion downstream. It is estimated that 63 percent of watercourses in the watershed are considered altered and 19 percent remain natural. A considerable discussion of the effects of tile drainage on stream hydrology suggests that beyond the tiled field the overall effects are difficult to assess. Tile drainage leads to decreased evaporation and an increase in the total amount of water that reaches streams.

The discussion of dissolved oxygen impairment, which is a stressor in 25 stream reaches and is summarized in Table 3: Summary of stressors and probable sources identified in biologically-impaired stream reaches in the WRAPS report, concludes with an assertion about streamflow that is relevant to stream health in general. Implementing changes in the total annual streamflow should focus on decreasing peak flows, increasing base flow, and maintaining the dynamic properties of the natural hydrograph, which are important for channel geomorphology, vegetation, and aquatic life. Strategies to accomplish these tasks must increase evapotranspiration and store and infiltrate water on the landscape to increase ground water contributions (base flow) to streams during dry periods.

Table 3 of the report, not shown here, presents a summary of stressors identified in biologically impaired stream reaches in the watershed. The impairments include dissolved oxygen, eutrophication, nitrate nitrogen, TSS, chloride, habitat, connectivity, and altered hydrology. Table 4: Summary of candidate stressors for lakes with biological impairments to lake fish communities is provided for stressors affecting lakes, but the list is less complicated.

Upgrades and improvements to WWTPs have reduced the phosphorus loading from a high of 138,422 kg per year in 2001 to 50,331 kg in 2018. Most of the reductions were realized in improvements from two facilities—the Blue Lake and Seneca WWTPs operated by the MCES—but other facilities have also shown reductions. TSS and total nitrogen loading from permitted facilities has remained relatively constant since 2000.

Confined animal feeding operations and other livestock facilities are addressed because they pose a threat to streams even when they are licensed. Although most of the larger operations are not permitted to discharge any amount of runoff, they typically apply the wastewater to fields where it may become a pollutant. The WRAPS report provides various suggestions for ensuring incorporation into the soil and avoiding seasons when

the soils may have insufficient assimilation capacity and pollutant runoff could be a problem.

Figure 26 (Number of SSTS that are compliant, failing or IPHT by county) of the WRAPS report is a bar chart that summarizes the estimated number of septic systems in each county, with an estimate of how many are compliant and how many are not. It shows a wide range in compliance. Le Sueur County shows more than 8,000 systems and the graphic shows 100 percent compliance. Rice County shows over 10,000 systems but more than half are failing, and about 1,000 are considered imminent public health threats. McLeod County, with slightly more than 4,000 systems, also shows more than half are failing, and a large portion are health threats. The failing systems ultimately could be a source of contaminants to nearby water bodies.

The WRAPS report reiterates from the TMDL reports the amounts of TSS carried by streams. In most streams, 83 percent of the TSS originates from near-channel erosion. In Sand Creek, 63 percent of the TSS is estimated to originate from near-channel erosion, whereas 36 percent originates from cropland. The highest loading months are April–June, carrying nearly 64 percent of the annual load. The Minnesota River Basin Sediment Delivery Analysis[10] provides additional details about the sources and delivery of sediment and other forms of TSS from the watershed to receiving waters. It also identifies practices that could be employed to reduce sediment erosion and transport. A before-and-after bar chart (Figure 31, Comparison of TSS yields, above and below knickpoints in streams in Southern Minnesota) is provided showing nearly an order-of-magnitude change in sediment yield for the Rush River and High Island Creek above and below the knickpoints where the streams drop into the Minnesota River Valley. A subsequent graphic (Figure 32, TSS loading on High Island Creek above the knickpoint near Arlington and below near Henderson) shows an even larger difference in loads above and below the knickpoint of High Island Creek in June 2013.

Surface soil erosion was evaluated in considerable detail. Wind erosion can account for the loss of soils and delivery to ditches and stream channels in parts of the watershed. Cover crops are recommended to reduce soil exposure. Sheet and rill erosion caused by direct precipitation and runoff also were also identified, and parts of the watershed were found to be more prone to this type of erosion than others. Reducing erosion is encouraged through the application of no-till or reduced-tillage practices that help keep the soil in place while providing other soil-enhancing benefits. Tillage Transect Surveys have been conducted periodically, as funding allowed, and show that, from 1989 through 2007, intensive tillage has declined, whereas reduced and conservation tillage has increased. The results from recent satellite surveys of percent residue on cropland are provided, but the reader is cautioned that these data are inconclusive at this early stage and are not comparable to earlier methods of assessing tillage practices.

The WRAPS report lists several strategies summarizing ways to reduce sediment in the watershed that are listed in the Sediment Reduction Strategy for the Minnesota River

[10] https://www.pca.state.mn.us/sites/default/files/wq-iw7-47p.pdf, accessed August 27, 2019.

Basin and South Metro Mississippi River.[11] The Sediment Reduction Strategy concludes that the implementation of upland best management practices (BMPs) without addressing hydrology (flow reduction) will result in not meeting sediment reduction goals. A revision to the Sediment Reduction Strategy is in progress and will be released in 2020. Figure 38 (Modeled HSPF outputs indicating subwatershed TSS yields) shows sediment yields from upland areas by watershed. This could be a useful tool for focusing management practices in areas having the largest sediment yields.

Potential sources of *E. coli* were identified to help focus control efforts. Permitted wastewater was identified as a low-priority threat, and it only affected a few streams. Controlling *E. coli* in stormwater runoff from urban catchments was considered a priority, but it is almost exclusively associated with wildlife and pet waste. Priority also was given to livestock and subsurface sewage treatment systems that were classified as an imminent public health threat.

Regarding TMDLs, as mentioned, the WRAPS report identifies upstream lakes as a major source of TP to impaired stream reaches, usually exceeding the amount coming from agricultural sources. In the impaired Carver Creek reach, 81 percent of the TP comes from upstream lakes, whereas only 12 percent comes from agricultural sources. A significant source of TP in many lakes in the watershed comes from internal loading, which mostly is the recycling of phosphorus associated with bottom sediments that can be released during anoxic conditions. The WRAPS report cautions, however, that internal loading in lakes is poorly understood, and that a report leading to a better understanding of the processes governing internal phosphorus loading is forthcoming.

A graphic (Figure 40 Modeled HSPF outputs indicating subwatershed TP yields) was provided in the WRAPS report showing TP yields from upland areas by watershed. This could be a useful tool for focusing management practices in areas with the largest TP yields.

The WRAPS report also discusses nitrogen in the watershed and notes its significant contribution to the Gulf of Mexico hypoxic zone. This report sums all forms of nitrogen into total nitrogen (TN). This is acceptable because nitrogen in water can take on many forms—ammonia, organic, nitrite, and nitrate—and its proportions vary depending on environmental conditions. However, it is not clear that only ammonia is the form toxic to fish and other aquatic organisms and that blue-baby syndrome is caused specifically by nitrate nitrogen. Nitrite nitrogen is also toxic, but it is unstable and rarely found in natural conditions. These forms of nitrogen generally comprise a small portion of the total nitrogen in streams.

This report further conveys that cropland drainage and cropland groundwater are the dominant source of TN in the Minnesota River Basin, and when combined they contribute 85 percent of the TN in the basin in an average flow year. It also notes that "the watershed estimated loading was 19,956,095 pounds per year of TN, which is 7.3%

[11] https://www.pca.state.mn.us/sites/default/files/wq-iw4-02.pdf, accessed August 27, 2019.

of the total Minnesota TN load to the Mississippi River." This report goes into further detail about nitrogen fertilizer use and possible ways to optimize its use and reduce the amount that leaves croplands.

There appear to be some irregularities on pages 61 and 62 in the provided text and graphics of the report. A sentence prematurely terminates in the middle of page 61. Figure 45 is covering most of figure 46 on page 62, which affects the discussion of nitrate concentrations in groundwater, although the accompanying table (Table 12 Nitrate Township Testing Program results) probably conveys the important information.

The WRAPS report quotes the Minnesota Nutrient Reduction Strategy[12]: "While progress can be made with existing BMPs for nitrogen reduction, achieving nitrogen goals for the Mississippi River will also require research and development of new BMPs and adjustment to some current BMPs to make them more widely applicable." It suggests that a time frame to achieve provisional nitrogen reduction goals should be extended to between 2035 and 2045.

The WRAPS report also describes several approaches intended to focus efforts where they can provide the greatest benefit for the effort. The Environmental Benefits Index could identify areas along streams and upland areas with high erodibility. A phosphorus sensitivity significance index could identify lakes that are unimpaired but at the greatest risk of becoming impaired. Areas with restorable wetlands could also reduce pollutants carried to streams and other waters. The benefits and relative effectiveness of various buffer and riparian corridor configurations are described.

This report discusses many opportunities for landowners and other stakeholders and notes the need to encourage public participation. The best management practices include the following:

- Improved crop nutrient management (fertilizer, soil, manure)
- Riparian buffers (50 ft)
- Conservation tillage (>30 percent residue cover) on lands > 2 percent slope
- Alternative drain-tile intakes (e.g. perforated riser pipe)
- Cover crops with corn and soybeans
- Perennial crops for harvest
- Water and sediment control basins

The WRAPS report provides a 45-page table (Table 14: Strategies and actions proposed for the Lower Minnesota River Watershed) showing a detailed description of strategies and actions proposed for water bodies in the watershed. Table 14 includes the water body name and description, the pollutant/stressor, current water quality conditions (concentration/load/biota scores), and the final water quality goal (percent/load to reduce/biota score target). Table 14 then lists the strategies to achieve

[12] MPCA, "Minnesota Nutrient Reduction Strategy," 2014, https://www.pca.state.mn.us/water/nutrient-reduction-strategy

the final water quality goal, the strategy type, the best management practice, and the estimated reduction in the TSS or TP load.

The watershed WRAPS report concludes with a discussion of monitoring to measure success. Six types of monitoring are listed as being important to measuring success: baseline, implementation, flow, effectiveness, trend, and validation. The report also describes the existing monitoring networks that can form the basis for many of the recommended monitoring types.

The watershed TMDL reports and WRAPS report represent a significant contribution to our understanding of surface water. The TMDL reports identify the source and contributions of impairments to surface water and establish goals to resolve those impairments. The WRAPS report identifies impairments, including those that are not mandated by TMDL guidelines, and proposes tools to address those impairments. As the name suggests, the WRAPS report describes strategies to provide the most expeditious improvements in the quality of resources for effort expended.

# Memorandum

Young Environmental Consulting Group, LLC

**DATE:** October 8, 2019 *(Email transmittal)*

**TO:** Linda Loomis – Administrator, LMRWD

**FROM:** Shane Soukup, Water Resources Scientist

**SUBJECT:** Stormwater Visit Summary
October 4, 2019, 7:00 a.m.–8:20 a.m.
CSAH 61 – Flying Cloud Drive
Owner – Hennepin County and Contractor – Ames Construction

**WEATHER:** 45°F, overcast – per Weather Underground

## SITE CONDITIONS/PHASE

Construction was active for roadbed preparation, retaining walls, erosion and sediment control, and so on. The bridge is now open and usable. Current construction is underway on the western edge of the project and includes grading and preparation for road paving. There are also new areas of excavation near the Lions Tap restaurant on the eastern edge of the project. Road is fully paved from Spring Road to approximately 1 mile east of the construction trailer.

## PRESENT

Shane Soukup – Young Environmental Consulting Group

## PURPOSE

To observe stormwater management/erosion control techniques being implemented by Ames Construction on the reconstruction of Flying Cloud Drive/County State Aide Highway (CSAH) 61 from Highway 101 to Charlson Road in the cities of Eden Prairie and Chanhassen and in Carver and Hennepin counties.

## GENERAL NOTES/OBSERVATIONS

- Planned to meet with Gerry Shimek of the United States Fish and Wildlife Service at 7 a.m. at the construction trailer. Mr. Shimek noted to commence the site inspection whether or not he was there. Waited 15 minutes at the construction trailer for Mr. Shimek and commenced the inspection at 7:15 after he did not arrive.
- Checked construction trailer and took photos of the inspection log and rain log.
- Crews began working as the site visit commenced.
- Drove west on Flying Cloud Drive from the construction trailer approximately 0.2 miles, where crews were grading in preparation for paving. The active construction made it unsafe. Circled back around to Spring Road and traveled east to approximately 0.7 miles east of Dell Road.

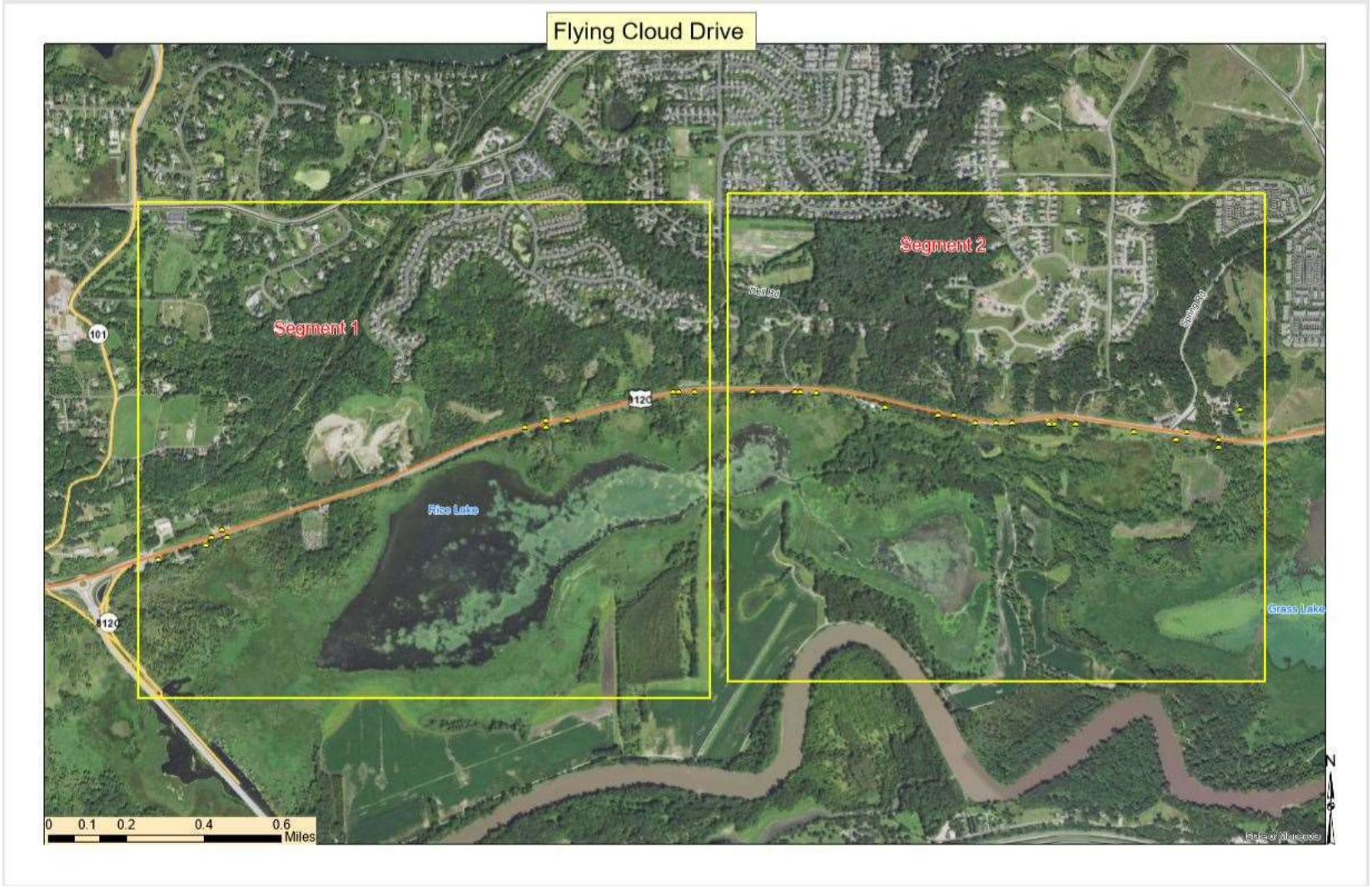
- Pictures were taken of the different best management practices (BMPs), such as plastic and rock, being used to prevent and/or minimize sediment and other construction material from reaching adjacent water resources (Rice Lake, Grass Lake, Riley Creek, and Minnesota River).
- Evidence of seed being applied to areas of concern highlighted in the most recent report and recently graded slopes (see photos).
- New infiltration features are in place and have been seeded (see photos).
- Signs of erosion and sluffing on landside slopes (photos 83 and 84). These slopes have had exposed soil for over 14 calendar days.
- Silt fence appears to require maintenance with sediment and water over ½ its height (photos 50 and 51).

**RECOMMENDATIONS**

- Stabilize landside slopes (photos 83 and 84).
- Maintain and repair BMPs that have failed.
- Keep drainage areas clear of debris.
- Attend weekly project construction management meetings as schedule allows, as well as the CSAH 61 Encroachments – Status Check meeting on Monday, October 14th at 1 p.m.
- As project nears completion, complete one more scheduled inspection as well as an inspection in late autumn to determine how the site has been prepared for winter.

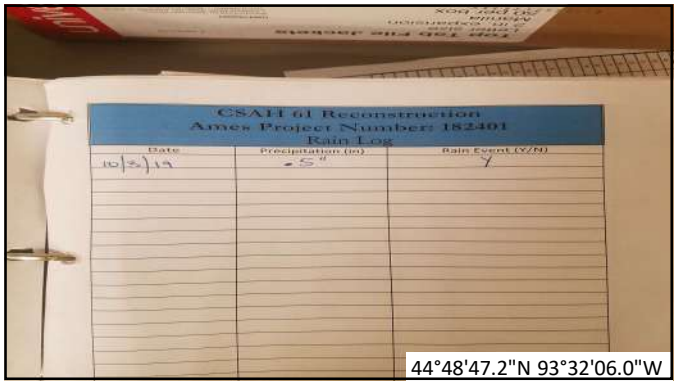
Young Environmental Consulting Group, LLC

Below is a map indicating where photos were taken. Photos include observations, coordinates, and an arrow indicating north (lower right corner).




Flying Cloud Drive Segment 1
Halla Nursery Dr E
Great Plains Blvd
101
Deerbrook Dr
Trails End Rd
Settlers Ct
Vogel Farm Tr
Overland Tr
Frontier Pl
Lakota La
Longhorn S
Flying Cloud
Rice Lake
Photo No. 1-7
Photo No. 8-9
Photo No. 10-13
Photo No. 14-15
Photo No. 16-18
Photo No. 19-23
Photo No. 24-26
Photo No. 27-29
Photo No. 30
Photo No. 31-34
Photo No. 35-38
Photo No. 39-40
0 0.05 0.1 0.2 0.3
Miles
N


Flying Cloud Drive Segment 2
Dell Rd
Sky Ln
Beverly Dr
Eden Prairie Rd
Spring Rd
Cheery Ln
Photo No. 41-42
Photo No. 43-47
Photo No. 52-55
Photo No. 57-58
Photo No. 67-68
Photo No. 72-75
Photo No. 77-80
Photo No. 97
Photo No. 95-96
Photo No. 48-49
Photo No. 50-51
Photo No. 56-62
Photo No. 63-66
Photo No. 69-71
Photo No. 76
Photo No. 81-84
Photo No. 85-89
Photo No. 90-91
Photo No. 92-94
Riverview Rd
Rice Lake
0 0.05 0.1 0.2 0.3 Miles
N


CSAH 61 Reconstruction
Ames Project Number: 182401
Rain Log
Date
Precipitation (in)
Rain Event (Y/N)
10/3/19
.5"
Y
44°48'47.2"N 93°32'06.0"W

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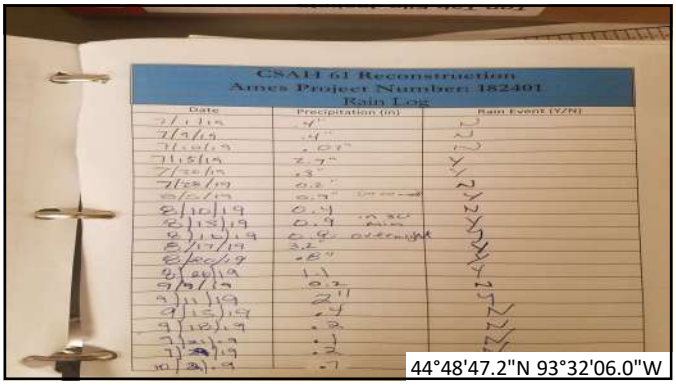
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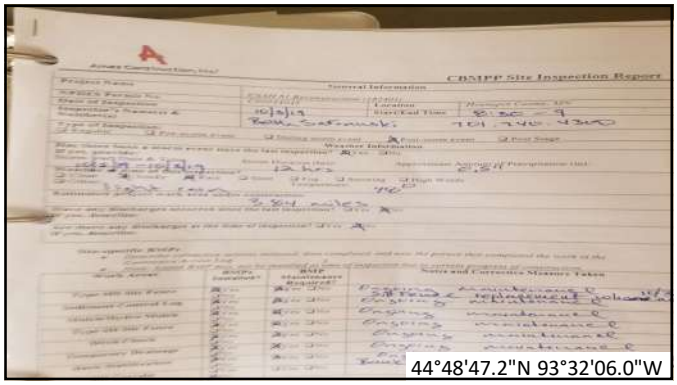
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Ames Project Number: 182401
Rain Log
Date
Precipitation (in)
Rain Event (Y/N)
10/3/19
.5"
Y
44°48'47.2"N 93°32'06.0"W

3


Seed applied to recently graded areas
44°48'44.6"N 93°32'20.6"W

4


Seed applied to recently graded areas
44°48'47.2"N 93°32'06.1"W

5


Seed applied to recently graded areas
44°48'46.7"N 93°32'06.5"W

6


Seed applied to recently graded areas
44°48'47.2"N 93°32'06.1"W

7


Seed applied to recently graded areas
44°48'49.9"N 93°31'57.5"W

8


Seed applied to recently graded areas
44°48'50.0"N 93°31'57.4"W

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44°48'50.1"N 93°31'56.4"W

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Seed applied to recently graded areas
44°48'50.1"N 93°31'56.4"W

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44°48'50.1"N 93°31'56.4"W

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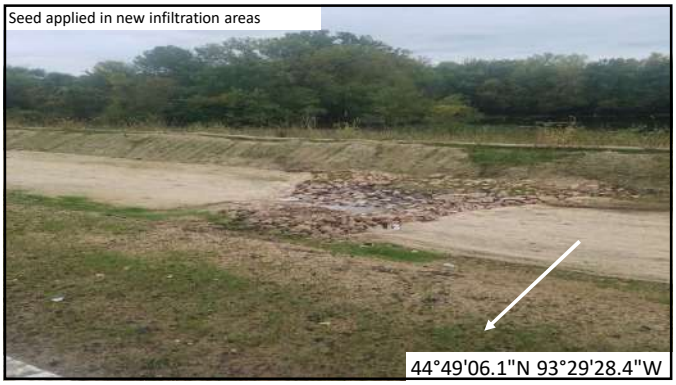


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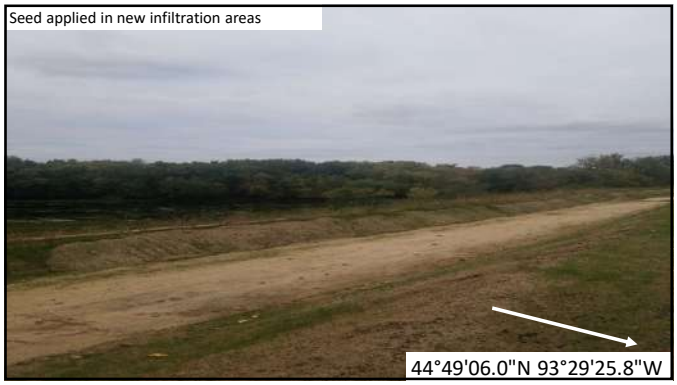


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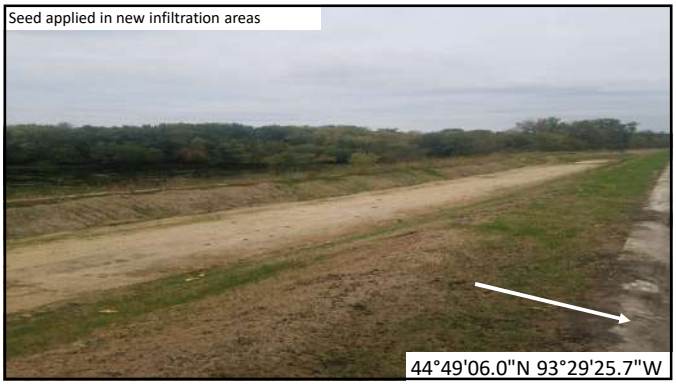


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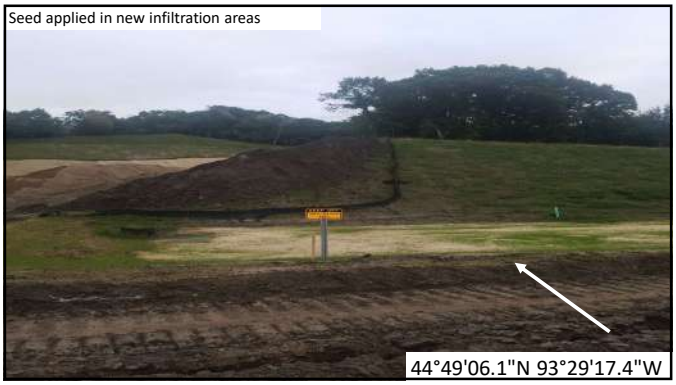


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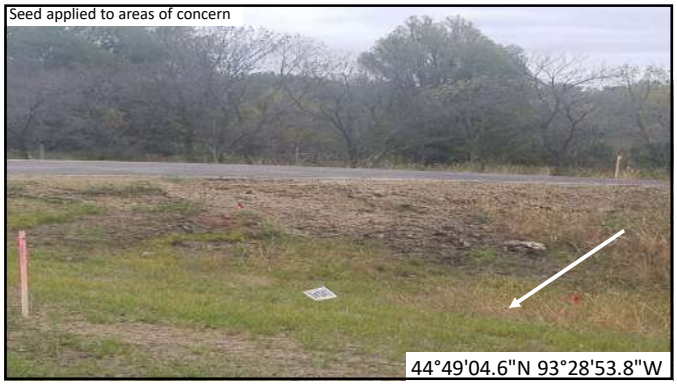


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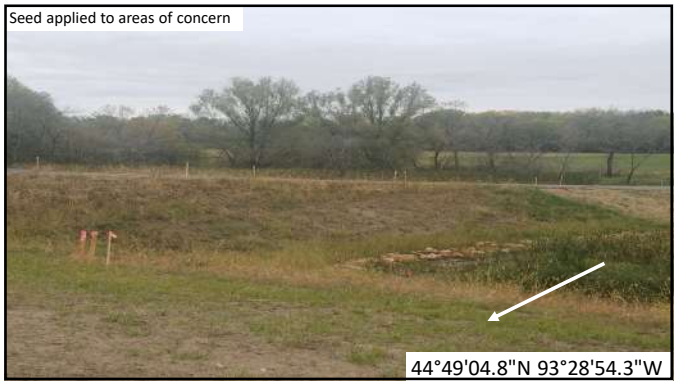


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