Watershed nutrient loads

2022 (Interim)

# Watershed nutrient loads to accomplish Minnesota's Nutrient Reduction Strategy Goals

Interim Guidance for Watershed Strategies and Planning

MINNESOTA POLLUTION CONTROL AGENCY

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# Overview

**Purpose**

The primary purpose of this guidance document is to provide updated nutrient load reduction estimates needed from each watershed to collectively reduce Minnesota's nutrient contribution to waters outside of the state. The load reductions are needed so that Minnesota can do its part to restore and protect the downstream waters such as the Gulf of Mexico, Lake Winnipeg and the Great Lakes. A secondary purpose is to provide information on how to estimate best management practice (BMP) combinations and levels of adoption that will achieve specific watershed nutrient load reductions. The primary audiences for this information are those working on watershed and regional water quality plans and strategies.

**Background and context**

Minnesota has agreed with other states to do its part to help reduce nutrient loads downstream of Minnesota, such as the nutrients causing the large hypoxic zone in the Gulf of Mexico and eutrophication problems in Lake Winnipeg. Minnesota is one of twelve states committed to working together on the Gulf of Mexico Hypoxia Task Force. Minnesota has also committed to work with North Dakota and Canada on the International Red River Watershed Board, each doing its part to reduce nutrients that ultimately reach Lake Winnipeg and contribute to the massive algae blooms.

Of course, Minnesota has its own waters needing nutrient reduction. The nutrient reduction work we complete for Minnesota waters has cascading benefits that begin within our local watersheds, and then additionally provide benefits to in-state major rivers and lakes, waters in neighboring states and provinces, and all the way down to the Gulf of Mexico to the south and Lake Winnipeg/Hudson Bay to the north.

To achieve downstream nutrient reduction, Minnesota's 2014 Nutrient Reduction Strategy (NRS) calls for each eight-digit Hydrologic Unit Code major watershed (HUC8) to voluntarily do its part to cumulatively achieve goals for the Mississippi River, Red River and Lake Superior. If each watershed reduces a fraction of its reducible or anthropogenic nutrient loads, then downstream nutrient goals can be met and local waters within HUC8s will be markedly improved.

The 2014 NRS provided limited guidance on the magnitude of load reductions needed from each HUC8 watershed to achieve milestone targets for downstream waters. Since the 2014 NRS, Minnesota has improved monitoring and modeling information, enabling the State to develop improved estimates of nutrient load-reduction planning targets for each HUC8 watershed outlet. These updated watershed load reduction targets are more realistic since they are established with an assumption that we cannot expect to achieve load reductions from our "natural" lands, and additionally they are developed with considerably more monitoring and more advanced modeling as compared to the preliminary HUC8 load reduction guidance in the 2014 NRS. While the 2014 NRS focused on the milestone goals for 2025, the updated loads in this guidance focus on the final goals.

The load reduction goals are currently called "interim," since they were developed mid-way between the original 2014 NRS and the updated/revised NRS expected in 2024. The revised NRS will incorporate these load reduction targets, after first checking for any additional watershed modeling updates. While some adjustments to these "interim" load goals may be made in the revised NRS, major changes to these load targets are not expected.

### Using this guidance at the watershed scale

The improved HUC8 outlet load reduction targets provided in tables 3-9 are intended to help watershed planners more accurately understand their part of what it will take for Minnesota to achieve long-term final-goal nutrient load reductions for downstream waters. The load reduction planning goals described below are intended to be one consideration, among many, that will inform long-term land-cover and BMP implementation needs (rural and urban) when Watershed Restoration and Protection Strategies (WRAPS) and associated plans are updated. These planning goals should be viewed as approximate, recognizing that the modeling and monitoring that supports these goals varies across the state. Updates and improvements to monitoring and modeling will allow the state to refine the load reduction needs over time.

While the focus of this guidance is on local efforts to address downstream needs, this guidance is not intended to supersede local priorities, strategies and plans. Instead, downstream considerations should be recognized, along with local priorities, when local watersheds re-examine their priorities and needs for long-term best management practice (BMP) adoption. For example, when planning for nitrogen reductions, people living and working in the watershed may establish a top priority of improving drinking water nitrate in source water protection areas. This is an excellent place to initially focus efforts. Many of the same actions to address the local drinking water needs will also reduce nitrogen loads going to downstream waters; however, additional BMP adoption will usually be needed for the downstream water concerns. In many cases, broad adoption of non-structural in-field practices across the watershed (i.e. reduced tillage, precision nutrient applications, cover crops, conservation rotations, etc.), along with wastewater nutrient discharge reductions, will be needed to meet the final nutrient goals.

### Assessing Progress

The MPCA will continue to monitor long-term progress toward Minnesota's commitments to the Gulf of Mexico, Lake Winnipeg and other downstream waters such as Lake Pepin. Because the loads vary greatly from year to year due to weather and other factors, progress evaluations will be based on *long-term* monitoring and modeling (i.e. ten-year periods). Additionally, as monitoring results increase, we will be able to re-calibrate models and improve the estimated load reduction needs. The load reduction planning targets should be re-calculated periodically to account for actual progress in changing loads, as well as improvements and updates in our calibrated modeling results.

# Basin scale nutrient load reduction needs for downstream waters

Minnesota's Nutrient Reduction Strategy (NRS), developed and adopted by 11 organizations in 2014 (https://www.pca.state.mn.us/water/nutrient-reduction-strategy), emphasizes the importance of improving nutrient pollution for the benefit of Minnesota's waters and those downstream of Minnesota. The state-level strategy calls for reducing nutrient levels by 10 to 20% over much of the state between 2014 and 2025, with 45 to 50% reductions by 2040 (Table 1).

**Table 1. Goals and milestones outlined in the Minnesota Nutrient Reduction Strategy.**

| Major basin | Milestone<br>2014 to 2025 | Final Goal<br>2025 to 2040 |
|---|---|---|
| **Mississippi River** (Also includes Cedar, Des Moines, and Missouri Rivers) | **12%** reduction in phosphorus from the baseline loads | Achieve **45%** total reduction from 1980-1996 baseline and meet in-state lake and river water quality standards |
| | **20%** reduction in nitrogen | Achieve **45%** total reduction from 1980-1996 baseline |
| **Red River**<br>(Lake Winnipeg Basin) | **10%** reduction in phosphorus | Achieve final reductions identified through joint efforts with Manitoba (about 50% from the 1998 to 2001 period) |
| | **13%** reduction in nitrogen | |
| **Lake Superior** | Maintain protection goals, no net increase from 1970s | |
| **Groundwater/Source Water** | Meet the goals of the 1989 Groundwater Protection Act | |

Since the 2014 NRS, Minnesota has markedly increased river monitoring and associated annual nutrient load calculations. These new data were used to update SPARROW and Hydrologic Simulation Program – FORTRAN (HSPF) models. The SPARROW model was updated in 2019 (Robertson and Saad, 2019), and HSPF model applications have now been developed and calibrated for most HUC8 watersheds in Minnesota.

To estimate how much load reduction is still needed in our major rivers that leave the state, we added-up all of the recent-decade modeled HUC8 watershed loads delivered to the Minnesota state border and compared those loads to the original major river NRS load goals. The modeled watershed loads represent averages over the most recently modeled 10-year period. A 10-year period was believed to be a long enough time to include a wide-range of hydrologic conditions. Where HSPF models were absent, other monitoring and modeling was used to estimate load averages for a similar period of time, as described in a detailed description of the methods (attachment A) based on the work of Schlea et al. (2020).

The modeled HUC8 nutrient loads reaching state lines were summed for major drainage basins, including: 1) Mississippi River, 2) Red River, 3) Rainy River (Lake of the Woods), and 4) Lake Superior, as represented in table 2. By comparing the summed recent loads to the original baseline loads and goals identified in the NRS, we assessed how much additional nutrient reductions are still needed at the state line.

The results (Table 2) indicate that most of the long-term nitrogen load reduction for the Mississippi and Red Rivers is still needed (still needing about 42% reductions from recent loads). For phosphorus, approximately 27-29% reductions (from recent loads) are needed in the Mississippi and Red River watersheds. Rainy River and Lake Superior watersheds need phosphorus reductions of 8.1 and 3.5%, respectively.

The 2014 NRS did not establish specific goals for HUC8 watersheds in the Rainy River, deferring to the eventual Lake of the Woods TMDL for establishing TP load targets. The TP load goal of 218 MT for the Rainy River basin was computed from the Lake of the Woods TMDL (2018) by summing the allowable Minnesota TP loads to the lake for wastewater, tributaries, lakeshed, and septic systems categories (Schlea at al. 2020). Allowable TP loads for Canadian sources, shoreline erosion, atmospheric deposition, and internal loading were not included as they were not considered to be part of the Minnesota HUC8 watershed loading to Lake of the Woods. The combined watershed TP load reduction targets would reduce the recent load of 237 MT down to the goal of 218 MT. Numeric TN goals have not been established for the Rainy River major basin.

**Table 2. Recent load estimates, final goals and remaining reductions for the Minnesota portion of four major basins, for total phosphorus (TP) and total nitrogen (TN) in units of Metric Tons (MT).**

| Description | Mississippi River<br>Upper Mississippi, Minnesota, St. Croix<br>Cedar, Des Moines, Missouri | | Red River | | Rainy River | Lake Superior |
|---|---|---|---|---|---|---|
| | TP | TN | TP | TN | TP | TP |
| Recent sum of modeled loads at state line (MT) | 3,478 | 87,271 | 991 | 8,247 | 237 | 257 |
| Final goal at state line (MT) | 2,544 | 50,089 | 700 | 4,763 | 218* | 248 |
| % load reduction still needed to meet final goals | 26.9% | 42.6% | 29.4% | 42.3% | 8.1%* | 3.5% |

*Rainy River load goals were based on a preliminary Lake of the Woods TMDL and will be adjusted to the final TMDL.

*What about Lake Pepin*? A question sometimes arises whether the level of change needed to meet the phosphorus reduction goals to Lake Pepin is similar to what is needed for our Mississippi River/Gulf of Mexico downstream commitments. An analysis further described in Attachment A, shows that the total phosphorus (TP) reduction needs for the Lake Pepin Watershed Phosphorus Total Maximum Daily Load (TMDL) are currently about the same as what is needed for downstream Mississippi River/Gulf of Mexico TP reduction planning goals. Similar levels of effort in the upstream watersheds will accomplish both the in-state Lake Pepin goal and Minnesota's part in achieving the multi-state TP reductions for the Gulf of Mexico.

*What about Lake Superior Nitrogen?* Numeric total nitrogen (TN) goals were not established in the NRS for the Lake Superior Basin, but a previously established narrative goal of sustaining 1979 loads was included in the NRS. Aggregated HUC8 watershed modeled loads across the Lake Superior basin showed an average TN load of 4658 MT (average of the most recent 10 years of HSPF modeling for these watersheds). Since we don't currently have estimates for the 1979 baseline load, this recently modeled load could represent a proxy baseline load that should not be exceeded into the future by the combined Minnesota tributaries into Lake Superior.

*What about Ground Water nitrate?* Groundwater nitrate levels often exceed drinking water standards in wells throughout the state, and nitrate in some surface water community drinking water sources also exceeds drinking water standards. Addressing these local health concerns is often considered by local watershed planners to be a higher priority than addressing waters downstream from Minnesota. Fortunately, the in-field practices that address groundwater nitrate in source water protection areas (i.e. fertilizer and manure efficiency, cover crops and perennials in rotations) will also benefit downstream waters. The intent of these guidelines is to outline the total load reductions needed from all nitrogen pathways (groundwater, surface runoff, tile water, and point source discharges), and part of the groundwater baseflow nitrogen load reduction will come from reducing groundwater nitrate in source water protection areas.

# HUC8 watershed nutrient load reduction planning goals for downstream waters

The estimated load reductions from each HUC8 watershed needed to collectively meet our nutrient reduction needs at the state lines were calculated for each watershed outlet. In aggregate, achieving each watershed reduction planning goal would enable Minnesota to meet NRS goals, while at the same time also addressing many nutrient reduction needs within the HUC8 watersheds. These voluntary targets should be considered when watershed managers re-evaluate their needs, goals, priorities and plans. The planning goals included in this document should be considered approximate due to inherent uncertainties and complexities with watershed modeling and monitoring.

The goals at the state border cannot be achieved unless each watershed does its part. The watershed load reduction planning goals were set equitably, such that each HUC8 within a major river basin would reduce a similar fraction of its reducible/anthropogenic nutrient load. While adjustments were made to account for in-stream nutrient losses between each watershed and the state line, the nutrient reduction planning goals were not developed to set disproportionately higher reduction goals for watersheds closer to the state line as compared to those further from the state line.

The HUC8 watershed outlet nutrient reduction planning goals were calculated using the following analyses (each described in detail and shown with maps in **Attachment A**):

- **HSPF load averages** – Average modeled loads over the most recently modeled 10-year period in each watershed. Where HSPF models were absent, other monitoring and modeling was used to estimate load averages for a similar period of time.
- **Reducible load averages** – The HSPF-modeled loads were divided into estimates of non-reducible loads (reflecting natural land uses) and reducible loads (nutrient loads coming from land uses most directly affected by people). The load reduction planning targets were developed as a fraction of the reducible loads only.
- **Watershed outlet loads that reach state lines** – The HUC8 planning goals take into account estimates of in-stream losses between the HUC8 outlet and state lines based on SPARROW modeling results. By accounting for in-stream losses, the sum of the reduction goals at HUC8 outlets equal the nutrient reduction needs at the state line. This was accomplished in an equitable way so that watersheds further from state line are not expected to reduce more nutrients than a similar watershed further upstream.

The watershed loads and load reduction targets were established such that contributions from all the watersheds in the basin would meet the remaining large river NRS nutrient load reductions identified in Table 2. A detailed description of the methods and process used to estimate loads and load reduction targets for each watershed are described in Attachment A, which incorporates the work of Schlea et al. (2020) and includes additions and edits by MPCA.

To find the load reduction target in your watershed of interest, go to the table that aligns with the major river basin where the watershed is located, as follows:

**Mississippi River Basin watersheds** – nitrogen (Table 3) and phosphorus (Table 4)
**Red River Basin watersheds** – nitrogen (Table 5) and phosphorus (Table 6)
**Lake Superior watersheds** – nitrogen (Table 7) and phosphorus (Table 8)
**Rainy River watersheds** – phosphorus (Table 9)

In Tables 3 to 9, the two green shaded columns are of particular importance to consider for watershed planning. The column, “final goal loads at the HUC8 outlets” reflect the annual river nutrient loads (long-term average) consistent with achieving the final NRS goals. The column, “Load reduction at HUC8 outlet to meet the final goal,” represents the load *reduction* amount needed from the recent decade to achieve the final load goal. These load reduction amounts (in Metric Tons per year, on average) to reach the final load goals are also shown in Figures 1 and 3, respectively for TN and TP, and are shown as a percentage of recent annual loads in Figures 2 and 4.

The load reduction planning goals can be divided into interim or milestone targets that are a fraction of reductions needed for the final goal. For example, the 2014 NRS emphasized a 20% TN reduction milestone for the Mississippi River Basin by 2025, on the way to a final 45% reduction by the year 2040.

Because the load reduction amounts are based only on the anthropogenic/reducible nutrient sources, watersheds with mostly natural areas show a lower overall percent reduction target (percent of the combined reducible and non-reducible sources) as compared to watersheds with few natural areas. It is important that watersheds with relatively low reducible loads emphasize protection of their existing water resources so that pollution does not increase. More information about how natural and reducible source loads were determined is described in Attachment A.

The HUC8 watershed scale was chosen to generally align with Minnesota’s Watershed Approach used in developing WRAPS and Comprehensive Local Water Plans. In watersheds such as the Mississippi River - Twin Cities, plans are often developed by watershed management organizations for smaller subwatersheds within the HUC8 watershed. In such instances, the percent reduction targets in tables 3 to 9 can be applied to recent 10-year average loads at the subwatershed outlets.

Some load reductions may already have been achieved during recent years that were not included as part of ten-year modeling periods used in this analysis. Also, in some watersheds the modeling was calibrated with limited monitoring information. Since monitoring information has continued to increase, our ability to improve modeling results is also increasing. For example, the Zumbro River Watershed average annual phosphorus loads were originally estimated through modeling to be 526 MT, based on the 2000-09 period. With river monitoring increases in the Zumbro River watershed and subsequent re-calibrating of the model (2009-18), a more recent estimate of a 10-year modeled average annual load is 372 MT. Since improved monitoring results will become available over time and models will be updated, the loads and planning goals in tables 3-9 should be periodically updated.

**Figure 1. Average annual HUC8 watershed TN load reductions (MT) at the watershed outlet to meet the final target loads at state lines.**

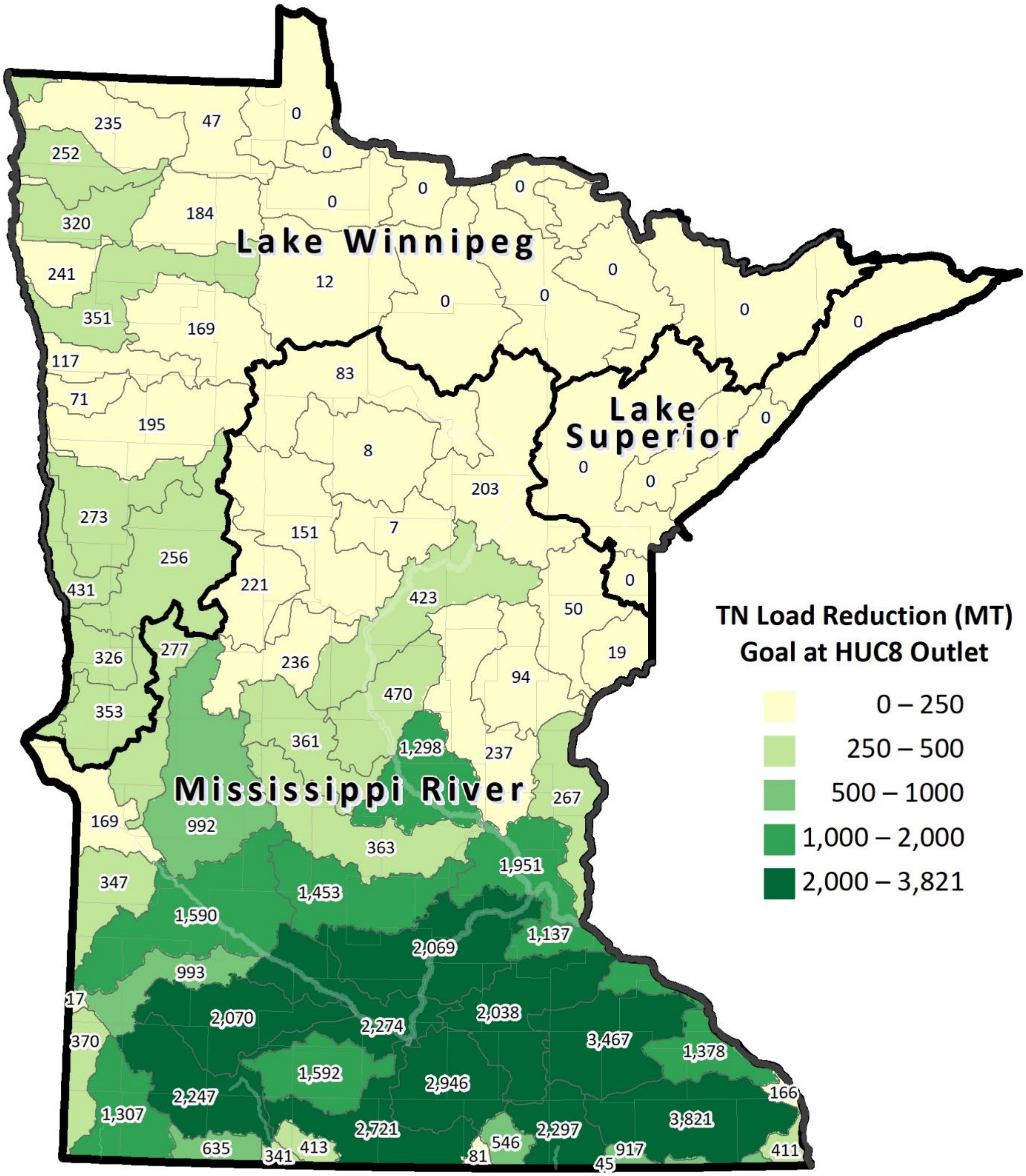

**Figure 2. Percent of recent average annual HUC8 watershed TN load to be reduced to meet the final target loads. Note that this is a percent of the total N loads that reach the HUC8 outlet.**

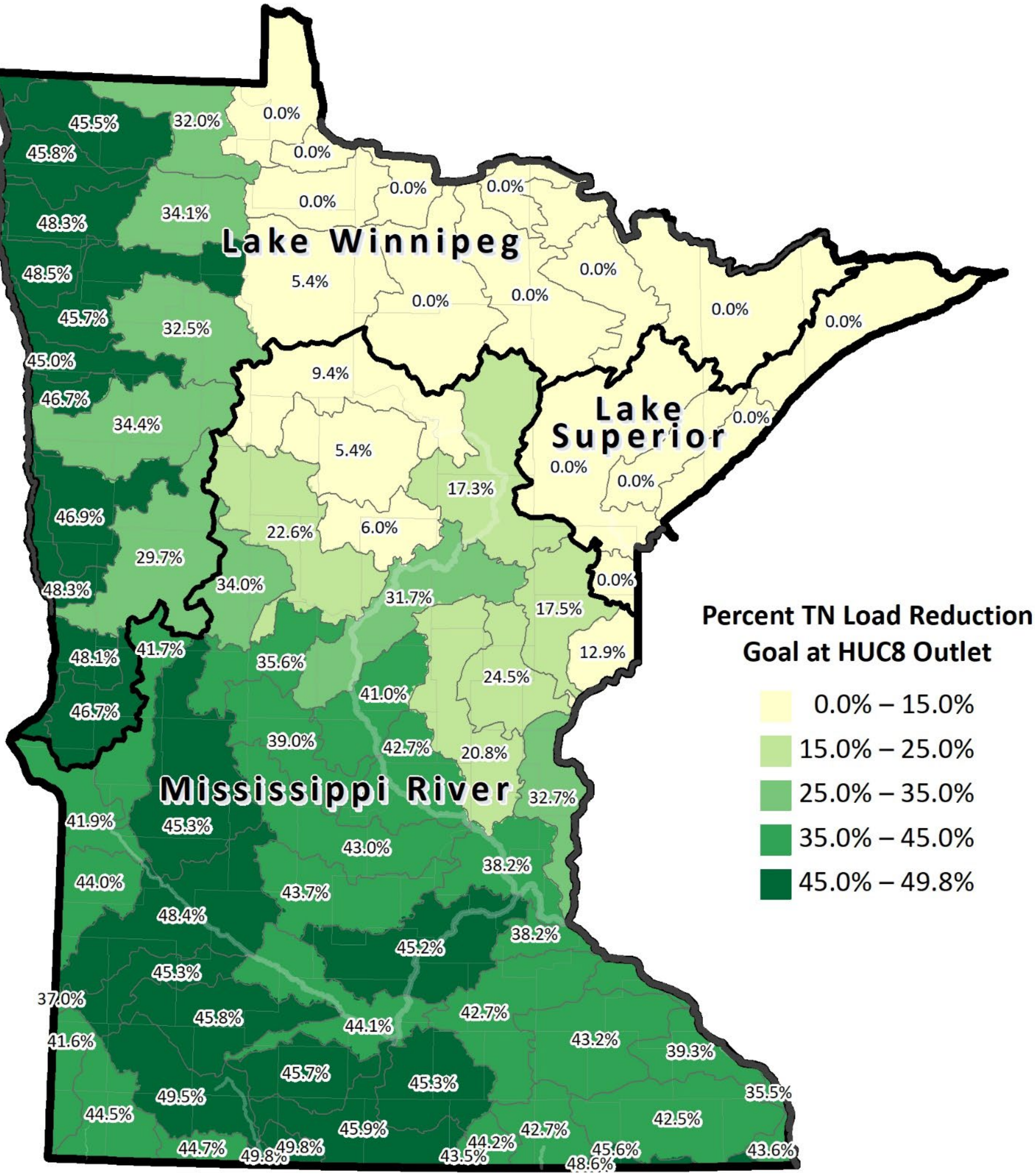

**Figure 3. Average annual HUC8 watershed TP load reductions (MT) at the watershed outlet to meet the final target loads at state lines.**

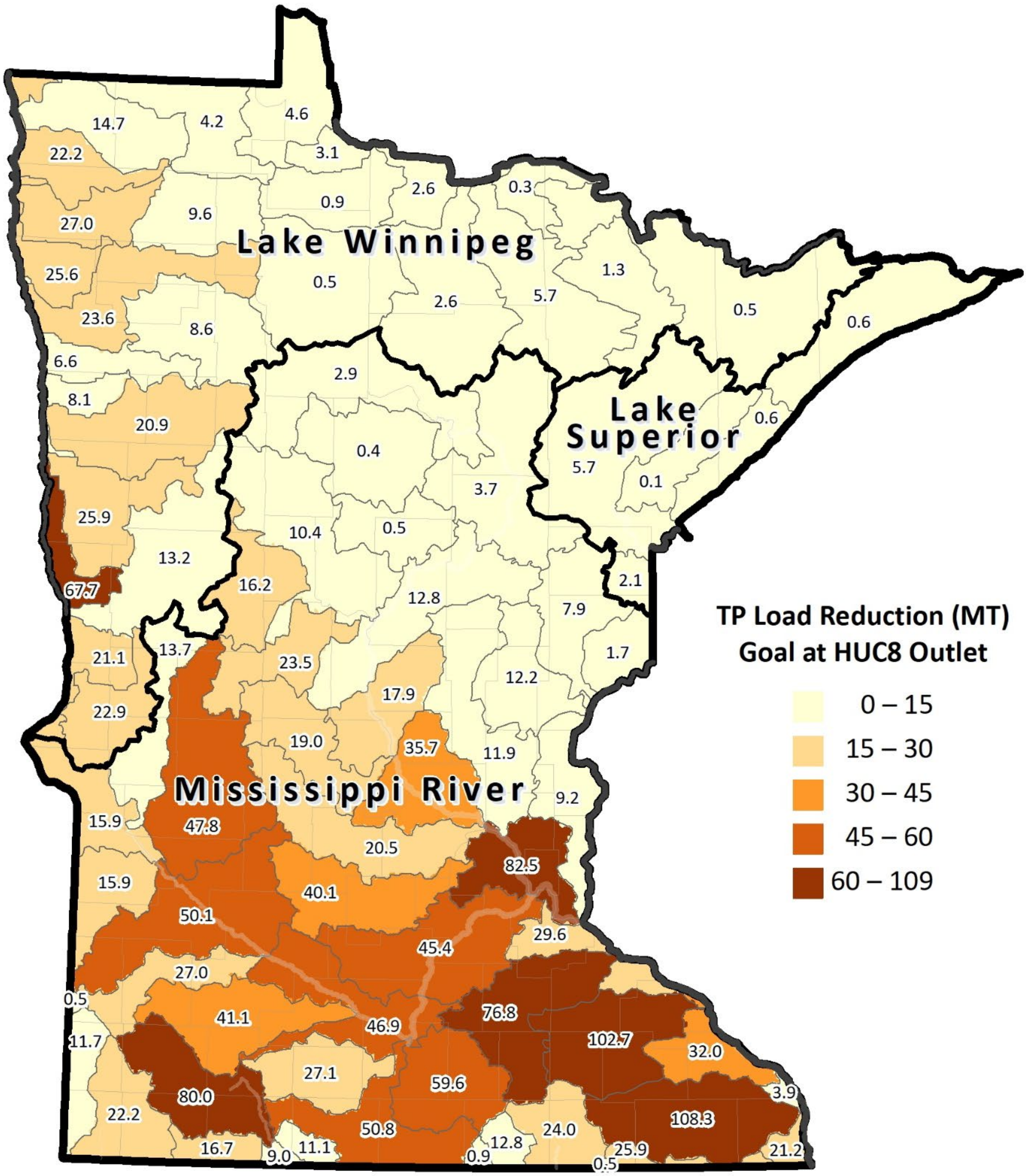

**Figure 4. Percent of recent average annual HUC8 watershed TP load to be reduced to meet the final target loads. Note that this is a percent of the total P loads that reach the HUC8 outlet.**

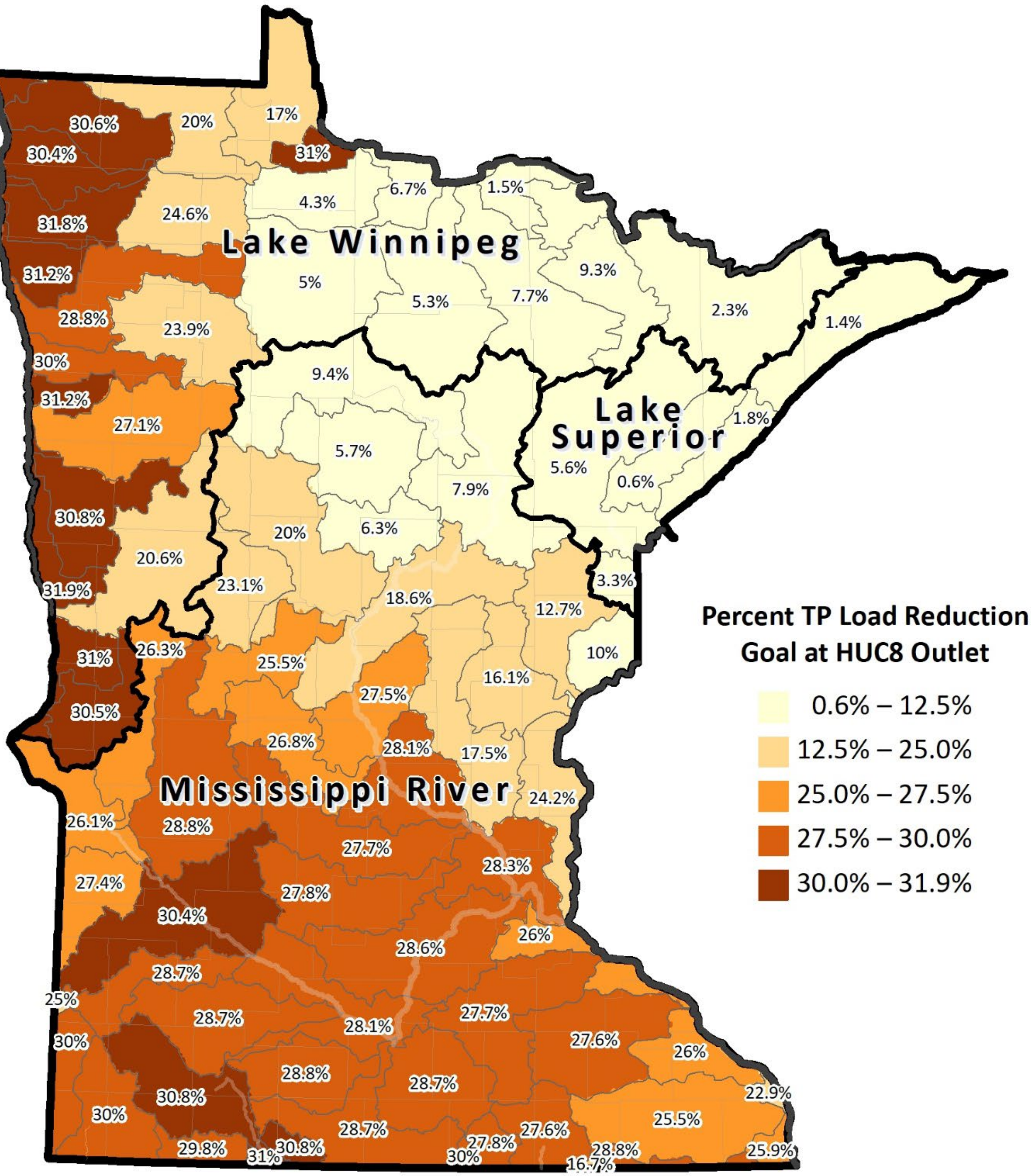

**Table 3. Mississippi River Basin HUC8 watershed TN load goal recommendations and load reduction targets to meet the final 2040 NRS goal.**

| HUC8 Name | HUC8 Number | Recent avg TN load at HUC8 outlet (MT/yr) | Final goal TN load at HUC8 outlet (MT/yr) | TN Load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total HUC8 loads) |
|---|---|---|---|---|---|
| Mississippi River - Headwaters | 07010101 | 881 | 798 | 83 | 9.4% |
| Leech Lake River | 07010102 | 146 | 138 | 8 | 5.5% |
| Mississippi R. - Grand Rapids | 07010103 | 1173 | 971 | 203 | 17.3% |
| Mississippi River - Brainerd | 07010104 | 1334 | 912 | 423 | 31.7% |
| Pine River | 07010105 | 123 | 116 | 7 | 6.0% |
| Crow Wing River | 07010106 | 668 | 517 | 151 | 22.6% |
| Redeye River | 07010107 | 650 | 429 | 221 | 34.0% |
| Long Prairie River | 07010108 | 663 | 426 | 236 | 35.6% |
| Mississippi River - Sartell | 07010201 | 1146 | 676 | 470 | 41.0% |
| Sauk River | 07010202 | 925 | 564 | 361 | 39.0% |
| Mississippi River - St. Cloud | 07010203 | 3040 | 1742 | 1298 | 42.7% |
| North Fork Crow River | 07010204 | 845 | 482 | 363 | 43.0% |
| South Fork Crow River | 07010205 | 3323 | 1870 | 1453 | 43.7% |
| Mississippi River - Twin Cities | 07010206 | 5109 | 3157 | 1951 | 38.2% |
| Rum River | 07010207 | 1140 | 903 | 237 | 20.8% |
| Minnesota River - Headwaters | 07020001 | 403 | 234 | 169 | 41.9% |
| Pomme de Terre River | 07020002 | 664 | 387 | 277 | 41.7% |
| Lac Qui Parle River | 07020003 | 788 | 441 | 347 | 44.0% |
| MN R. - Yellow Medicine River | 07020004 | 3286 | 1696 | 1590 | 48.4% |
| Chippewa River | 07020005 | 2190 | 1198 | 992 | 45.3% |
| Redwood River | 07020006 | 2189 | 1197 | 993 | 45.3% |
| Minnesota River - Mankato | 07020007 | 5154 | 2879 | 2274 | 44.1% |
| Cottonwood River | 07020008 | 4523 | 2453 | 2070 | 45.8% |
| Blue Earth River | 07020009 | 5934 | 3213 | 2721 | 45.9% |
| Watonwan River | 07020010 | 3484 | 1892 | 1592 | 45.7% |
| Le Sueur River | 07020011 | 6506 | 3560 | 2946 | 45.3% |
| Lower Minnesota River | 07020012 | 4581 | 2512 | 2069 | 45.2% |
| Upper St. Croix River | 07030001 | 149 | 130 | 19 | 12.9% |
| Kettle River | 07030003 | 284 | 234 | 50 | 17.5% |
| Snake River | 07030004 | 382 | 288 | 94 | 24.5% |
| Lower St. Croix River | 07030005 | 817 | 550 | 267 | 32.7% |
| Mississippi River - Lake Pepin | 07040001 | 2977 | 1840 | 1137 | 38.2% |
| Cannon River | 07040002 | 4768 | 2730 | 2038 | 42.7% |
| Mississippi River - Winona | 07040003 | 3502 | 2124 | 1378 | 39.3% |

| HUC8 Name | HUC8 Number | Recent avg TN load at HUC8 outlet (MT/yr) | Final goal TN load at HUC8 outlet (MT/yr) | TN Load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total HUC8 loads) |
|---|---|---|---|---|---|
| Zumbro River | 07040004 | 8019 | 4553 | 3466 | 43.2% |
| Mississippi River - La Crescent | 07040006 | 469 | 303 | 166 | 35.4% |
| Root River | 07040008 | 8988 | 5167 | 3821 | 42.5% |
| Mississippi River - Reno | 07060001 | 941 | 530 | 410 | 43.6% |
| Upper Iowa River | 07060002 | 2010 | 1094 | 917 | 45.6% |
| Upper Big Sioux River | 010170202 | 47 | 29 | 18 | 37.5% |
| Lower Big Sioux River | 010170203 | 888 | 512 | 376 | 42.3% |
| Rock River | 010170204 | 2937 | 1608 | 1328 | 45.2% |
| Little Sioux River | 010230003 | 1423 | 777 | 646 | 45.4% |
| Upper Wapsipinicon River | 07080102 | 92 | 48 | 45 | 48.5% |
| Cedar River | 07080201 | 5375 | 3078 | 2297 | 42.7% |
| Shell Rock River | 07080202 | 1235 | 689 | 546 | 44.2% |
| Winnebago River | 07080203 | 186 | 105 | 81 | 43.6% |
| Des Moines R. - Headwaters | 07100001 | 4536 | 2289 | 2247 | 49.5% |
| Lower Des Moines River | 07100002 | 685 | 344 | 341 | 49.8% |
| East Fork Des Moines River | 07100003 | 830 | 417 | 413 | 49.8% |

**Table 4. Mississippi River Basin HUC8 watershed TP load goal recommendations and the associated load reduction targets to meet the final 2040 NRS goals.**

| HUC8 Name | HUC8 Number | Recent avg TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Mississippi River - Headwaters | 07010101 | 31.4 | 28.5 | 2.9 | 9.3% |
| Leech Lake River | 07010102 | 6.6 | 6.2 | 0.4 | 6.2% |
| Mississippi River - Grand Rapids | 07010103 | 47.1 | 43.3 | 3.7 | 7.9% |
| Mississippi River - Brainerd | 07010104 | 68.9 | 56.1 | 12.8 | 18.6% |
| Pine River | 07010105 | 7.7 | 7.2 | 0.5 | 6.6% |
| Crow Wing River | 07010106 | 52.0 | 41.6 | 10.4 | 20.0% |
| Redeye River | 07010107 | 70.0 | 53.8 | 16.2 | 23.1% |
| Long Prairie River | 07010108 | 91.7 | 68.2 | 23.5 | 25.6% |
| Mississippi River - Sartell | 07010201 | 65.3 | 47.4 | 17.9 | 27.4% |
| Sauk River | 07010202 | 71.2 | 52.2 | 19.0 | 26.6% |
| Mississippi River - St. Cloud | 07010203 | 126.8 | 91.1 | 35.7 | 28.1% |

| HUC8 Name | HUC8 Number | Recent avg TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| North Fork Crow River | 07010204 | 73.7 | 53.2 | 20.5 | 27.8% |
| South Fork Crow River | 07010205 | 144.0 | 103.8 | 40.1 | 27.9% |
| Mississippi River - Twin Cities | 07010206 | 291.5 | 209.0 | 82.5 | 28.3% |
| Rum River | 07010207 | 67.8 | 55.9 | 11.9 | 17.5% |
| Minnesota River - Headwaters | 07020001 | 60.5 | 44.7 | 15.9 | 26.2% |
| Pomme de Terre River | 07020002 | 52.0 | 38.3 | 13.7 | 26.4% |
| Lac Qui Parle River | 07020003 | 58.1 | 42.3 | 15.9 | 27.3% |
| Minn. R. - Yellow Medicine River | 07020004 | 165.4 | 115.3 | 50.1 | 30.3% |
| Chippewa River | 07020005 | 165.7 | 117.9 | 47.8 | 28.8% |
| Redwood River | 07020006 | 93.6 | 66.6 | 27.0 | 28.8% |
| Minnesota River - Mankato | 07020007 | 166.8 | 119.9 | 46.9 | 28.1% |
| Cottonwood River | 07020008 | 142.8 | 101.7 | 41.1 | 28.8% |
| Blue Earth River | 07020009 | 176.7 | 125.9 | 50.8 | 28.7% |
| Watonwan River | 07020010 | 93.9 | 66.8 | 27.1 | 28.8% |
| Le Sueur River | 07020011 | 207.7 | 148.2 | 59.6 | 28.7% |
| Lower Minnesota River | 07020012 | 159.3 | 114.0 | 45.4 | 28.5% |
| Upper St. Croix River | 07030001 | 17.1 | 15.4 | 1.7 | 9.8% |
| Kettle River | 07030003 | 61.8 | 53.9 | 7.9 | 12.8% |
| Snake River | 07030004 | 76.3 | 64.1 | 12.2 | 16.0% |
| Lower St. Croix River | 07030005 | 38.0 | 28.8 | 9.2 | 24.1% |
| Mississippi River - Lake Pepin | 07040001 | 114.2 | 84.6 | 29.6 | 25.9% |
| Cannon River | 07040002 | 277.4 | 200.7 | 76.8 | 27.7% |
| Mississippi River - Winona | 07040003 | 122.7 | 90.6 | 32.0 | 26.1% |
| Zumbro River | 07040004 | 372.0 | 269.3 | 102.7 | 27.6% |
| Mississippi River - La Crescent | 07040006 | 17.2 | 13.2 | 3.9 | 23.0% |
| Root River | 07040008 | 424.0 | 315.7 | 108.3 | 25.5% |
| Mississippi River - Reno | 07060001 | 82.1 | 60.9 | 21.2 | 25.8% |
| Upper Iowa River | 07060002 | 89.9 | 64.0 | 25.9 | 28.8% |
| Upper Big Sioux River | 010170202 | 1.8 | 1.4 | 0.5 | 25.9% |
| Lower Big Sioux River | 010170203 | 39.0 | 28.2 | 10.8 | 27.7% |
| Rock River | 010170204 | 73.9 | 53.4 | 20.5 | 27.7% |
| Little Sioux River | 010230003 | 55.7 | 40.3 | 15.4 | 27.7% |
| Upper Wapsipinicon River | 07080102 | 3.0 | 2.2 | 0.8 | 28.0% |
| Cedar River | 07080201 | 86.6 | 62.6 | 24.0 | 27.7% |
| Shell Rock River | 07080202 | 46.2 | 33.4 | 12.8 | 27.6% |
| Winnebago River | 07080203 | 3.2 | 2.3 | 0.9 | 28.5% |
| Des Moines River - Headwaters | 07100001 | 260.1 | 180.1 | 80.0 | 30.8% |

| HUC8 Name | HUC8 Number | Recent avg TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Lower Des Moines River | 07100002 | 29.1 | 20.1 | 9.0 | 30.9% |
| East Fork Des Moines River | 07100003 | 36.3 | 25.2 | 11.1 | 30.7% |

**Table 5. Red River Basin HUC8 Watershed TN load goals and associated load reductions needed to meet the final Red River goals for Minnesota.**

| HUC8 Name (Red River Basin) | HUC8 Number | Recent TN load at HUC8 outlet (MT/yr) | Final TN load goal at HUC8 outlet (MT/yr) | TN load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Bois de Sioux River | 09020101 | 678 | 353 | 326 | 48.0% |
| Mustinka River | 09020102 | 756 | 403 | 353 | 46.7% |
| Otter Tail River | 09020103 | 862 | 606 | 256 | 19.7% |
| Upper Red River of the North | 09020104 | 893 | 463 | 431 | 48.2% |
| Buffalo River | 09020106 | 582 | 309 | 273 | 46.9% |
| Marsh River | 09020107 | 152 | 81 | 71 | 46.8% |
| Wild Rice River | 09020108 | 567 | 372 | 195 | 34.4% |
| Sandhill River | 09020301 | 260 | 143 | 117 | 45.1% |
| Upper/Lower Red Lake | 09020302 | 222 | 210 | 12 | 5.3% |
| Red Lake River | 09020303 | 768 | 417 | 351 | 45.7% |
| Thief River | 09020304 | 539 | 355 | 184 | 34.2% |
| Clearwater River | 09020305 | 520 | 350 | 169 | 32.6% |
| Grand Marais Creek | 09020306 | 497 | 256 | 241 | 48.4% |
| Snake River (Red) | 09020309 | 662 | 342 | 320 | 48.4% |
| Tamarac River | 09020311 | 550 | 298 | 252 | 45.8% |
| Two Rivers | 09020312 | 516 | 282 | 235 | 45.5% |
| Roseau River | 09020314 | 147 | 100 | 47 | 32.0% |

**Table 6. Red River Basin HUC8 watershed TP load goals and associated load reductions needed to meet Minnesota's part of the final Red River goals.**

| HUC8 Name (Red River Basin) | HUC8 Number | Recent TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Bois de Sioux River | 09020101 | 67.5 | 46.4 | 21.1 | 31.3% |
| Mustinka River | 09020102 | 74.6 | 51.7 | 22.9 | 30.6% |
| Otter Tail River | 09020103 | 63.7 | 50.5 | 13.2 | 20.7% |
| Upper Red River of the North | 09020104 | 212.4 | 144.8 | 67.7 | 31.9% |
| Buffalo River | 09020106 | 84.2 | 58.3 | 25.9 | 30.8% |
| Marsh River | 09020107 | 25.6 | 17.6 | 8.1 | 31.4% |
| Wild Rice River | 09020108 | 77.1 | 56.2 | 20.9 | 27.2% |
| Sandhill River | 09020301 | 21.6 | 15.0 | 6.6 | 30.4% |
| Upper/Lower Red Lake | 09020302 | 10.2 | 9.6 | 0.5 | 5.2% |
| Red Lake River | 09020303 | 82.4 | 58.8 | 23.6 | 28.6% |
| Thief River | 09020304 | 38.8 | 29.2 | 9.6 | 24.8% |
| Clearwater River | 09020305 | 35.8 | 27.2 | 8.6 | 24.0% |
| Grand Marais Creek | 09020306 | 82.2 | 56.6 | 25.6 | 31.1% |
| Snake River (Red) | 09020309 | 84.6 | 57.6 | 27.0 | 31.9% |
| Tamarac River | 09020311 | 72.7 | 50.5 | 22.2 | 30.6% |
| Two Rivers | 09020312 | 47.6 | 32.9 | 14.7 | 30.8% |
| Roseau River | 09020314 | 21.2 | 17.0 | 4.2 | 19.6% |

**Table 7. Lake Superior Basin HUC8 TN recent modeled loads. These loads represent an average recent load to serve as an upper boundary for long-term load averages.**

| HUC8 Name (Red River Basin) | HUC8 Number | Recent TN load at HUC8 outlet (MT/yr) | Final TN load goal at HUC8 outlet (MT/yr) | TN load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Baptism-Brule | 04010101 | 1134 | 1134 | 0 | 0 |
| Beaver-Lester | 04010102 | 503 | 503 | 0 | 0 |
| St. Louis | 04010201 | 2476 | 2476 | 0 | 0 |
| Cloquet River | 04010202 | 402 | 402 | 0 | 0 |
| Nemadji River | 04010301 | 183 | 183 | 0 | 0 |

**Table 8. Lake Superior Basin HUC8 TP recent modeled loads and load reduction needs to meet NRS goals.**

| HUC8 Name (Lake Superior Basin) | HUC8 Number | Recent TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Baptism-Brule | 04010101 | 43.9 | 43.3 | 0.59 | 1.4% |
| Beaver-Lester | 04010102 | 34.1 | 33.5 | 0.59 | 1.7% |
| St. Louis | 04010201 | 101.5 | 95.8 | 5.73 | 5.6% |
| Cloquet River | 04010202 | 16.5 | 16.5 | 0.07 | 0.4% |
| Nemadji River | 04010301 | 63.4 | 61.3 | 2.11 | 3.3% |

**Table 9. Rainy River Basin HUC8 TP recent modeled loads and load reduction needs to meet the preliminary Lake of the Woods TMDL.**

| HUC8 Name (Red River Basin) | HUC8 Number | Recent TP load at HUC8 outlet (MT/yr) | Final TP load goal at HUC8 outlet (MT/yr) | TP load reduction at HUC8 outlet to meet final goal (MT/yr) | Percent Reduction Target (from recent total loads) |
|---|---|---|---|---|---|
| Rainy Headwaters | 09030001 | 22.1 | 21.6 | 0.5 | 2% |
| Vermilion River | 09030002 | 14.4 | 13.1 | 1.3 | 9% |
| Rainy Lake | 09030003 | 19.7 | 19.4 | 0.3 | 1% |
| Rainy River | 09030004 | 39.0 | 36.5 | 2.6 | 7% |
| Little Fork River | 09030005 | 73.8 | 68.1 | 5.7 | 8% |
| Big Fork River | 09030006 | 48.9 | 46.4 | 2.6 | 5% |
| Rapid River | 09030007 | 21.0 | 20.1 | 0.9 | 4% |
| Rainy River | 09030008 | 9.9 | 6.8 | 3.1 | 31% |
| Lake of the Woods | 09030009 | 26.8 | 22.2 | 4.6 | 17% |

# Best management practice scenarios to achieve watershed nutrient load reductions

Understanding the needed nutrient load reduction amounts for downstream waters will help us ultimately estimate the levels of rural and urban best management practice (BMP) adoption needed to achieve those reductions. When natural resource managers periodically reconsider their local watershed goals, priorities, strategies, and plans, the above nutrient reduction planning targets should be considered. For example, consider the following:

- How do watershed nutrient load reductions for downstream needs compare with the sum of local load reduction needs to address priority waters within the watershed?
- How can these load goals for downstream waters be used to set planning goals for HUC8 outlets (milestones and final goals)?
- How do these numbers inform the long-term vision for land-cover changes in the watershed and adoption of other BMPs?

## Considerations when developing BMP scenarios

Minnesota's NRS includes basin-wide BMP adoption scenario examples that will meet milestone goals. The strategy also encourages each HUC8 watershed to evaluate the suite of practices and acreages that will achieve the load reduction planning goals for downstream water. In many areas of the state, the acreage of new practices needed for downstream nutrient reduction needs will exceed the sum of those implemented for local nutrient reduction needs. Consider the following suggestions when developing watershed nutrient reduction BMP scenarios:

**Set milestones** - Break up large daunting goals into milestones or interim targets and focus initially on achieving the first milestone.

**Don't get hung up on developing the 'perfect' scenario** - Strategy scenarios are meant to provide reasonable expectations of new BMP adoption scales to generally move efforts in the right direction. Scenarios of BMP combinations should identify the key practices and the general magnitude of new BMP adoption needed for each practice, considering both point and nonpoint sources. Strategy scenarios will never be exact or perfect, and multiple combinations of practices can achieve similar nutrient reduction goals at the HUC8 watershed scale. Also, long-term strategies will need to be adapted over time to reflect new research and monitoring, climate trends, land-use trends, social norms, and more.

**Consider BMP acceptance in your area** - For the short-term, choose practices based partly on the likelihood of practice acceptance in your region. For the long-term, also consider BMPs that are less popular now, but that may become more acceptable after technology, research, and education are advanced.

**Do not conflict with regulatory requirements** - The NRS and its voluntary goals do not supersede existing regulatory requirements.

**Emphasize multiple benefits –** When selecting BMP scenarios related to rural sources, first consider in-field BMPs to build soil health, maintain soil cover, optimize fertilizer use, and reduce drinking water nitrate levels. These practices will result in multiple ecosystem benefits. Then, as needed, continue by adding edge-of-field and in-channel practices, especially those that can achieve priority co-benefits to water, air, wildlife, and/or agriculture.

**Identify strategies for broad adoption** –Often, conservation practices are targeted in small priority areas to efficiently prevent phosphorus and sediment from entering waters. To achieve downstream nutrient reduction goals, local strategies should additionally consider broad adoption of in-field practices (i.e. precision nutrient applications, cover crops and conservation crop rotations).

**Use estimates of nutrient load reductions to waters instead of reductions at the field-edge** – Nutrient reduction amounts from BMPs at the field edge will often be quite different compared to effects measured at watershed outlets. For example, a BMP may reduce phosphorus at the field edge by 1 lb/acre, but the reduction effects measured at the end of the watershed may only be 0.1 lb/acre, or less. The planning targets in Tables 3-9 are equated to nutrient load reductions needed in the river (at the HUC8 watershed outlet). Therefore, when assessing the effects of BMPs to meet these planning targets, use tools that provide estimates at the watershed outlet.

# Tools for estimating BMP scenarios

Certain models and tools can be used to estimate typical nutrient reductions expected from combinations of BMPs. None of the tools represent an exact science, and the results will vary among tools. However, tools can be used to provide a general idea of the magnitude of adoption needed to achieve nutrient watershed reduction goals.

## HSPF-Scenario Application Manager (HSPF-SAM or SAM)

**HSPF Scenario Application Manager** (HSPF-SAM or SAM) can generate predicted nutrient and sediment load changes associated with new BMPs and/or land-use changes. The HSPF-SAM provides a user-interface to the HSPF modeled nutrient and sediment load estimates which have been calculated for most of Minnesota. The SAM uses typical BMP effectiveness values from research results to estimate load reductions from agricultural BMP and wastewater nutrient reduction scenarios. The SAM also includes some limited options for urban stormwater and forestry BMPs. In addition to BMP scenario development, the SAM also has many other uses that can help with watershed planning, (i.e. point source evaluations, priority area determination, pollutant loads in different places/times, etc.). https://www.respec.com/product/scenario-application-manager/

The SAM results of nutrient load reductions vary from one watershed to another, largely because each watershed has different land, soil and hydrologic conditions that affect nutrient transport to waters. The SAM results of BMP effects on water quality in any given watershed are provided in a tableau format at https://public.tableau.com/app/profile/mpca.data.services/viz/WatershedPollutantLoadReductionCalculator/WatershedPollutantLoadReductionCalculator.

An example of the SAM-derived nutrient load reduction estimates per acre of BMP adopted is shown in Table 10 for the Cottonwood River Watershed HUC8 outlet. Note that these are typical or average reductions from the BMPs expected when adopted across the watershed, and that more nutrient reduction can sometimes be achieved by only targeting the lands that are the very highest nutrient-contributing lands.

**Table 10**. **Nitrogen and phosphorus nutrient load reduction estimates at the HUC8 outlet for each acre of BMP adopted in the Cottonwood River Watershed, on average, according to the most recent version of SAM.**

| **BMP type** | ***Avg. total *nitrogen* load reduction at HUC8 outlet per acre treated or affected by BMPs (lb/ac/yr)** | ***Avg. total *phosphorus* load reduction at HUC8 outlet per acre treated or affected by BMPs (lb/ac/yr)** |
|---|---|---|
| Tile Line Bioreactors designed for N removal | 2.6 | 0.000 |
| Restore Tiled Wetlands (Cropland) | 7.6 | 0.15 |
| Controlled Tile Drainage | 5.1 | 0.020 |
| Saturated Buffer | 5.3 | 0.000 |
| Ditch Buffers, 16.5 ft wide (replacing row crops) | 2.1 | 0.14 |
| Riparian Buffers, 50 ft wide (replacing row crops) | 3.1 | 0.21 |
| Riparian Buffers, 100 ft wide (replacing row crops) | 3.5 | 0.24 |
| Riparian Buffers, 50 ft wide (Pasture) | 0.5 | 0.03 |
| Conservation Crop Rotation | 5.6 | 0.08 |
| Conservation Cover Perennials | 12.3 | 0.24 |
| Corn & Soybeans changed to Rotational Grazing | 7.6 | 0.13 |
| Corn & Soybeans with Cover Crop | 3.7 | 0.08 |
| Short Season (early harvest) Crops with Cover Crop | 3.7 | 0.05 |
| Water and Sediment Control Basin (Cropland) | 3.4 | 0.26 |
| Terrace | 1.6 | 0.24 |
| Grassed Waterways | 1.1 | 0.14 |
| Filter Strips, 50 ft wide (Cropland field edge) | 3.2 | 0.21 |
| Contour Buffer Strips | 4.8 | 0.20 |
| Contour Stripcropping | 3.5 | 0.14 |
| Feedlot Manure/Runoff Storage | 19.7 | 0.68 |
| Feedlot Runoff Reduction/Treatment | 16.3 | 0.57 |
| Nutrient Mgmt Precision rates | 3.2 | 0.04 |
| Nutrient Mgmt – improved rates and timing | 1.7 | 0.030 |
| Manure/Fertilizer Incorporation (no surface spreading) | 1.1 | 0.10 |
| Alternative Tile Intakes | 1.1 | 0.19 |
| Drainage Side Inlet Improvements | 1.0 | 0.17 |
| Traditional Pasture to Rotational Grazing | 0.6 | 0.04 |

| BMP type | *Avg. total *nitrogen* load reduction at HUC8 outlet per acre treated or affected by BMPs (lb/ac/yr) | *Avg. total *phosphorus* load reduction at HUC8 outlet per acre treated or affected by BMPs (lb/ac/yr) |
|---|---|---|
| Livestock Access Control/Fencing (to waters) | 0.4 | 0.04 |
| Reduced Tillage (30%+ residue cover) | 0.8 | 0.09 |
| Reduced Tillage (no-till) | 2.0 | 0.19 |

*Load reductions per acre of BMP are higher in subwatersheds closer to the field source, as compared to the HUC8 outlet reductions represented in this table. The BMPs will have a greater effect at the nearest water to the fields. This is especially true in watersheds with lakes.

Scenarios showing results of BMP adoption can be approximated by multiplying potential new BMP adoption acreages by the lb/acre/year reduction estimates in Table 10. If we use the example of the Cottonwood Watershed in the Mississippi River Basin, it has HUC8 outlet nutrient reduction targets of 41.1 MT TP and 2070 MT TN (Tables 3 and 4), which equate to approximately 91,000 and 4,566,000 lb, respectively. If an interim goal is chosen to be 25% of these reduction amounts, then a combination of BMPs should be chosen to reduce roughly 23,000 lb of TP and 1,100,000 lb of TN at the watershed outlet.

A BMP scenario can be developed by adding preferred BMPs and associated acreages until the goals are predicted to be achieved (Table 11). The needed acres of BMPs to achieve these interim targets depends on which practices are emphasized, and that is a local decision to be made in the watershed. The tableau web-site nutrient load reduction calculator linked above will do the math of calculating nutrient load reductions expected by selected new acres of BMPs.

**Table 11. Load reduction scenario to achieve one-fourth of the long-term nutrient reduction target in the Cottonwood Watershed (for downstream waters), as calculated using SAM-based nutrient reductions found at the nutrient load reduction calculator website.**

| BMP | Potential new acres affected | TN reduced | TP reduced |
|---|---|---|---|
| Restored Tiled Wetlands | 10,000 | 7.6 lb per acre<br>76,000 lb total | 0.15 lb per acre<br>1500 lb total |
| Nutrient management rates and timing | 80,000 | 1.7 lb per acre<br>224,000 lb | 0.03 lb per acre<br>2400 lb |
| Grassed Waterways | 10,000 | 1.1 lb per acre<br>11,000 lb | 0.14 lb per acre<br>1400 lb |
| Saturated buffers | 10,000 | 5.3 lb per acre<br>53,000 lb | |
| Cover Crops on corn/soybeans | 80,000 | 3.7 lb per acre<br>296,000 lb | 0.08 lb per acre<br>6400 lb |
| Fertilizer/manure incorporation | 10,000 | 1.1 lb per acre<br>11,000 lb | 0.10 lb per acre<br>1000 lb |
| Conservation Crop rotation | 10,000 | 5.6 lb per acre<br>56,000 lb | 0.08 lb per acre<br>800 lb |
| Controlled tile drainage | 10,000 | 5.1 lb per acre<br>51,000 lb | 0.02 lb per acre<br>200 lb |
| Reduced tillage (30+% residue cover) | 10,000 | 0.8 lb per acre<br>8,000 lb | 0.090 lb per acre<br>900 lb |
| Reduced tillage (no-till) | 10,000 | 2.0 lb per acre<br>20,000 lb | 0.19 lb per acre<br>1900 lb |
| Conservation Cover Perennials | 26,000 | 12.3 lb per acre<br>319,800 lb | 0.24 lb per acre<br>6240 lb |
| **Total reductions at HUC8 outlet** | | **1,125,000 lb TN** | **22,740 lb TP** |

While using the SAM-based load reduction values from the web-site nutrient reduction calculator is quicker and easier for developing BMP scenarios as compared to using the actual SAM tool, using the actual SAM tool has advantages, a couple of which are outlined below:

- In any watershed, not all lands are going to be suitable for a given BMP because of soil and landscape conditions or because the BMPs are already present. Tools like HSPF-SAM indicate a maximum amount of land that can be put into a certain BMP; but this information is not included the SAM BMP results tables such as presented in Table 10 and the web-site nutrient load reduction calculator.
- The nutrient reduction calculatro outputs will overestimate nutrient reductions where multiple BMPs are used on the same lands in a "treatment train." For example, if conservation tillage is used in the same field that will receive a Water and Sediment Control Basin (WASCOB), the WASCOB itself will reduce fewer pounds of phosphorus compared to a situation where only the WASCOB was used with no new practices upslope from the WASCOB. Conservation tillage, in

effect, provides a pre-treatment for the WASCOB, such that the WASCOB has fewer pollutants to reduce. HSPF-SAM and other tools account for this diminishing effect when multiple BMPs are used on the same land, but the more simplified approach by using the web-site nutrient load reduction calculator tables alone do not account for diminishing reductions in a treatment train.

## NP-BMP

The Nitrogen & Phosphorus Best Management Practices tool (NP-BMP) is a spreadsheet tool developed by the University of Minnesota for HUC8 or HUC10 watershed scales throughout Minnesota cropland. The user enters agricultural BMP scenario adoption acreages, and the tool compares the effectiveness and cost of BMPs to reduce nutrient loads entering surface waters from cropland. A benefit of using NP-BMP is its ability to quickly and easily estimate watershed agricultural nutrient reductions resulting from various combinations of BMPs. It has a strong economic component to evaluate net annual costs of BMP adoption for landowners. Limitations include its coarser scale of accuracy compared to other tools and exclusion of urban and forestland BMPs.

- The spreadsheet was updated in 2021, and can be downloaded from: https://wlazarus.cfans.umn.edu/activities-projects-and-interests/water-and-air-quality

Below is a screenshot example result of a NP-BMP scenario in the Cottonwood watershed using roughly similar levels of BMP adoption as previously shown for the HSPF-SAM nutrient reduction values, also in the Cottonwood watershed. NP-BMP tool predicts 1,304,000 lb nitrogen load reduction and 18,000 lb phosphorus reduction (figure 5). These reductions are reasonably comparable to the 1,125,000 lb nitrogen and 22,740 lb phosphorus reductions estimated with the HSPF-SAM output tables. Different tools will provide different results since the BMP assumptions are different and the ways that load reductions are calculated are also different. Using two or more tools can provide a range of likely levels of BMP adoption needed to achieve the goals or milestone targets.

**Figure 5. BMP scenario in the Cottonwood watershed using the NP-BMP tool.**

Watershed: Cottonwood River — 0.663 million acres in watershed or state

HUC10 Subwatershed: All

| | % existing | % suitable | % adoption | % treated | % treated, combined | acres treated (000), combined |
|---|---|---|---|---|---|---|
| Variable rate N split-applied on corn that is currently all applied in fall or spring | NA | 37.57% | 8% | 3.01% | 2.92% | 19.34 |
| U of MN rate with inhibitor/stabilizer on fall applied corn | 3.34% | 15.99% | 0% | 0.00% | 0.00% | 0.00 |
| U of MN N rate on corn without changing timing, form, or methods | NA | 50.65% | 20% | 10.13% | 9.15% | 60.71 |
| U of MN soil test-based P2O5 rate on six major crops | NA | 94.58% | 0% | 0.00% | 0.00% | 0.00 |
| Apply P as banded spring preplant/starter on fall-applied corn & wheat | 19.66% | 13.36% | 0% | 0.00% | 0.00% | 0.00 |
| Use reduced tillage on corn, soy & small gr >2% slopes | 34.41% | 31.18% | 10% | 3.12% | 3.12% | 21.42 |
| Treatment wetlands on tiled land | NA | 12.25% | 12% | 1.52% | 1.52% | 10.10 |
| Tile line bioreactors | NA | 12.90% | 0% | 0.00% | 0.00% | 0.00 |
| Controlled drainage | NA | 12.90% | 12% | 1.60% | 1.60% | 10.64 |
| Saturated buffers | NA | 12.90% | 12% | 1.60% | 1.60% | 10.64 |
| Alternative tile intakes | 5.83% | 17.49% | 0% | 0.00% | 0.00% | 0.00 |
| Corn grain & soybean acres w/cereal rye cover crop | 2.65% | 92.55% | 13% | 12.38% | 12.00% | 79.62 |
| Short season crops planted to a rye cover crop | 2.65% | 0.08% | 0% | 0.00% | 0.00% | 0.00 |
| Switchgrass on marginal corn & soy land >2% slope | NA | 4.09% | 50.0% | 1.40% | 1.40% | 9.26 |
| Kernza on marginal corn & soy land >2% slope | NA | 4.09% | 50.0% | 1.40% | 1.40% | 9.26 |
| Inject or incorp manure | NA | 4.74% | 30% | 1.42% | 1.42% | 9.43 |

Weather scenario: Average weather - all of preplant N is available

Load default data | Load zeros | Recalculate

| | | |
|---|---|---|
| Cropland N load reduction with these adoption rates: | 12.1% | 1,304 (000 lb/year) |
| Cropland P load reduction with these adoption rates: | 6.5% | 18 (000 lb/year) |

## Prioritize, Target, and Measure Application (PTMApp)

The Prioritize, Target, and Measure Application (PTMApp) tool uses water-quality related products derived from high resolution topographic data collected using Light Detection and Ranging (LiDAR) technology, soils data, and land-cover data. The PTMApp is designed to inform the prioritization of resource concerns and target specific fields for implementation of nonpoint source BMPs and conservation practices. The PTMApp will also estimate the effectiveness of BMPs by cost and expected pollutant load reduction benefits at the edge-of-field and resource of concern within the watershed. The PTMApp is beneficial when working to refine BMP placement and when estimating BMP benefits to surface runoff waters at the farm and sub-watershed scale. PTMApp is particularly useful for evaluating ways to reduce phosphorus and sediment to protect local water resources of concern.

For the purposes of estimating BMP effects of nutrient reductions at the HUC8 watershed outlet, PTMApp currently has limitations. The tool estimates load reductions at catchment or field scale outlets, defined sub-watershed outlets, but not directly at the HUC8 outlet of a major watershed (unless a priority resource point is defined at that outlet location). Additionally, the tool currently does not account for BMPs that affect nitrate leaching and transport in tile drainage or groundwater pathways, which are typically dominant nitrogen transport pathways. Future modifications may be made to improve the nitrogen reduction predictive ability and to show expected nutrient reductions further downstream, such as at the HUC10 or HUC8 watershed outlets.

- For more information on PTMApp, go to the Minnesota Board of Water and Soil Resources website at https://bwsr.state.mn.us/ptmapp.

## Agricultural Conservation Planning Framework (ACPF)

The Agricultural Conservation Planning Framework (ACPF) develops conservation planning scenarios that are matched to both landowner preferences and landscape-based risks. The basic backbone of ACPF is topography analysis used to identify critical source areas which contribute disproportionate amounts of nutrients, sediment, or runoff water to a water body. After landscape-level targeting occurs, results from this tool can be used to narrow down BMP siting from a landscape scale to a site-specific location. ACPF also tailors management practices to the selected site. At the time of this writing, work was progressing on adding a nutrient load reduction estimation component along with an economics estimator. While ACPF is most-often used at the HUC12 and sub-watershed scales, it has potential to also be scaled up to larger scale watersheds. As it currently stands, ACPF is not able to estimate a suite of practices and associated acreages that will achieve a needed load reduction at the HUC8 outlet.

**ACPF Websites:**

- ACPF Main Website: https://acpf4watersheds.org/
- USDA: https://data.nal.usda.gov/dataset/agricultural-conservation-planning-framework-acpftoolbox
- Iowa State University: https://www.extension.iastate.edu/waterquality/files/page/files/ACPFBigCr-WatershedAcademy.pdf

## Other tools and models

For purposes of showing what it takes to attain the nutrient load reduction needs for downstream waters, the best tools to use are those that estimate reductions at the watershed outlet (as opposed to the field edge) and those that predict the reduction not just in surface runoff loads, but also loads from subsurface drainage systems and groundwater. Models and tools, other than those mentioned above, can also be used to estimate the effects of BMPs at the HUC8 outlet. For example, SWAT and HSPF both have been used for this purpose. The Environmental Protection Agency developed a spreadsheet tool called “Pollutant Load Estimation Tool” (PLET) which can be downloaded at https://www.epa.gov/nps/plet. Tools for estimating the load reduction effects of urban stormwater practices include the “Minimal Impact Design Standards (MIDS) best management practice (BMP) calculator,” which can be found at https://stormwater.pca.state.mn.us/index.php/MIDS_calculator.

# In summary

While many major watersheds have nutrient-impacted waters locally, often the nutrient reduction needs are greater downstream than the sum of the needs at the local level. Watershed Strategies and subsequent long-term planning work should be developed to not only address the goal of protecting and restoring water resources within the watershed, but to also collectively achieve pollutant load reductions needed for downstream waters (in-state and out-of-state goals for the Mississippi River, Lake Pepin, Gulf of Mexico, Lake Winnipeg, Lake of the Woods, etc.).

Estimates of watershed nutrient load reduction planning targets for meeting downstream water needs were developed for each HUC8 watershed in Minnesota. These voluntary planning goals were set equitably, such that each HUC8 within a major river basin would reduce a similar fraction of its anthropogenic (reducible) nutrient loads. In aggregate, achieving the watershed reductions would enable Minnesota to meet NRS goals, while also addressing many local nutrient goals in lakes and streams within the HUC8 watersheds. These targets should be considered when watersheds re-evaluate their needs, goals, strategies, priorities and plans. In many cases, broad application of in-field BMPs will be needed to achieve the long-term goals for downstream waters.

A few different tools are available to estimate BMP acreages to achieve these nutrient reductions. HSPF-SAM can be used to develop nutrient reduction scenarios for point and nonpoint sources. This is made even simpler when using the tableau representation of HSPF-SAM results called “Nutrient Load Reduction Calculator.” The NP-BMP tool allows HUC8 watershed and major river basin BMP scenario development for cropland. These tools can be used to develop scenarios for showing the general magnitude of change that will achieve nutrient reduction goals.

# References

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