

# Incorporating Lake Protection Strategies into WRAPS Reports



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# Contents

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Contents.....	i
List of figures .....	i
List of tables .....	i
Acronyms .....	ii
<b>Introduction .....</b>	<b>1</b>
Why lake protection is good for your community, its economy, and Minnesota’s lake heritage .....	1
WRAPS are a first step in determining which lakes are in greatest need of protection .....	4
<b>Part 1: Selecting lakes for protection activities .....</b>	<b>6</b>
Step 1. Summarize current water quality data .....	6
Step 2. Estimate initial pollution load reduction targets and goals .....	6
Step 3. Prioritize unimpaired lakes using a risk assessment approach .....	9
Step 4. Identify protection targets, priorities and best practices .....	11
Step 5. Recommend WRAPS protection strategies for highest priority lakes .....	18
<b>Part 2. Background information and selected resources .....</b>	<b>20</b>
Important consideration when you develop your lake protection plans.....	20
<b>References.....</b>	<b>33</b>
<b>Appendix 1 .....</b>	<b>34</b>
A. Considerations when selecting lakes for protection activities (Not in priority order) .....	34
B. Best practices for lake protection.....	36

## List of figures

---

Figure 1. Minnesota water management framework.....	4
Figure 2. Example: Preliminary TP targets for lakes in the Pine River Watershed. ....	8
Figure 3. Setting a target TP concentration for Pine Mountain Lake .....	9
Figure 4. Identifying unimpaired waters at risk .....	10
Figure 5. Identifying priority lakes .....	10
Figure 6. Lakes of phosphorus sensitivity significance in the Pine River Watershed .....	11
Figure 7. Map showing priority lakes in the Leech Lake Watershed .....	16
Figure 8. General lake protection framework.....	18
Figure 9. Implementation options for watershed projects.....	19

## List of tables

---

Table 1. Example: Preliminary TP targets for lakes in the Pine River Watershed.....	7
Table 2. Prioritizing lakes by category in the Pine River Watershed .....	10
Table 3. Watersheds with forest component. ....	24

# Acronyms

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BMP – Best Management Practices

BWSR – Board of Water and Soil Resources

DNR – Minnesota Department of Natural Resources

EAO – Environmental Assessment and Outcomes

EPA – U.S. Environmental Protection Agency

EQuIS – Environmental Quality Information System

HSPF – Hydrological Simulation Program – Fortran

HUC – Hydrologic Unit Code

IWM- Intensive Watershed Monitoring

MDA – Minnesota Department of Agriculture

MDH – Minnesota Department of Health

MPCA – Minnesota Pollution Control Agency

MS4 – Municipal Separate Storm Sewer System

NPSFP – Nonpoint Source Funding Plan

NRCS – Natural Resources Conservation Service

PTPT – Pre-TMDL Phosphorus Trading

SWAT – Soil and Water Assessment Tool

SWCD – Soil and Water Conservation District

TP – Total Phosphorus

WRAPS – Watershed Restoration and Protection Strategy

# Introduction

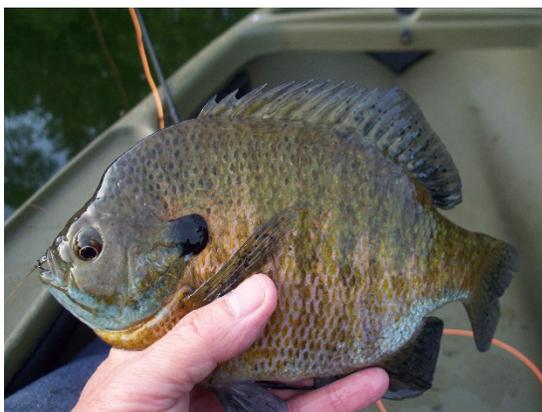
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## Why lake protection is good for your community, its economy, and Minnesota's lake heritage

Critical to any lake ecosystem is the health of the land and habitats that surround it. Stewardship requires an understanding that everything that we do on the land and in the water ultimately affects a lake. Put another way, the quality of our lakes is a direct reflection of the human and natural processes that occur within each lakeshed. Protecting lakes from degradation requires thoughtful consideration of how best to balance the needs of our communities with the needs of our lakes – and a recognition that lakes are more vulnerable to the impacts from human development than we may imagine.



Advocating for the protection of high quality lakes can be a challenging task since there may not be an existing or imminent threat to galvanize public action around. This is especially true in those areas of the state that do not face significant threats from non-point sources of pollution or the impairments resulting from them. However, as population in Minnesota expands, as pressures on land and water increase, as a changing climate threatens to alter the ecosystems of the lakes we know and love, a new level of attention and vigilance will be required in order to ensure that Minnesota's high quality lakes are protected for current and future generations.



No matter what part of Minnesota one is from, lake protection is a management strategy that makes sense. Preventing water quality degradation in lakes can save millions of public dollars otherwise spent on the uphill battle of restoring waters once they are polluted. Protecting high quality lakes is a resource-smart approach when grounded in a sound scientific analysis and robust public involvement. Protection efforts only succeed if they are part of a watershed-wide, collaborative effort that makes use of the talents and commitment of watershed residents and government agency staff alike.

A strong argument for lake and watershed protection is that clean water delivers multiple benefits to our communities, including:

- Reduced capital costs for drinking water treatment

- Increased tourism
- Aesthetic beauty
- Improved capacity to mitigate the impacts of climate change on surface waters
- Improved human health and well-being
- Protection of high quality fisheries and wildlife habitat (conserving biodiversity)
- Higher property values and associated local tax revenues
- Protection of food sources for community members
- Broad economic opportunities for residents and businesses within a lake community

## The economic value of clean water

Economists have asserted that our waters should be managed as an economic resource. In the past, we have often failed to recognize the economic value of water, leading to wasteful and environmentally harmful uses of these resources (Global Water Partnership, 2017). However, if we are thoughtful and realistic about the complexity of protecting lake water quality and commit the necessary resources to do lake protection work now, the economic, social and ecological benefits provided by clean lakes can be sustained over many generations.

Clean lakes and drinking water sources, good fishing and other recreational activities, quietude and aesthetic beauty are key attractions for the many people that own lake homes and cabins in Minnesota. Residents and tourists alike place significant value on the ability to enjoy the benefits that high quality lakes provide. For example, there is strong evidence that the quality of lakes and streams has a significant effect on how much we are willing to pay to own land adjacent to these resources and how far we are willing to travel to enjoy them.

A Wisconsin study found that there is a clear economic rationale for the improvement of water clarity (Kemp, et. al, 2016). In Minnesota, another study found, not surprisingly, that good water quality was positively correlated with the value of homes in the study area. In addition, the researchers concluded that managing the quality of lakes is important to maintaining the natural and economic assets of a region where high quality lakes exist (Krysel, et. al, 2003).

Broadly speaking, clean lakes are a significant economic advantage for communities in Minnesota. Many local governments depend on property taxes from lake homes and cabins and from the significant amount of revenue that comes from tourism related to the enjoyment of lakes. These revenues allow local governments to provide residents with a wide variety of important community services. Accordingly, these benefits should provide a clear incentive for all of us to protect our high quality lakes from current and future degradation.

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**“Protection”**, as used in WRAPS, is a term applies to water bodies that currently meet water quality standards and are not identified as impaired. Any strategies, actions, or conservation practices that address an unimpaired water body or its watershed are considered protection.

**“Restoration”**, as used in WRAPS, is a term applied to water bodies that do not meet water quality standards and are identified as impaired. Strategies, conservation practices, or other actions that address an impaired water or its watershed are considered restoration.

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## The need for a new approach to lake protection

To maintain the economic advantage that clean water provides, we will need to do more than the status quo. This guidance calls for a proactive, collaborative approach. Many state and local leaders understand that government alone cannot protect our lakes and that citizens and stakeholders must be part of the solution. We intuitively understand this to be true; however, we often do not commit the resources needed to make that happen. Creating fair and effective public process and organizing citizens to the task of water quality protection takes time and a sustained commitment in order to see real benefits in lake water quality over time.



A more collaborative public participation approach is needed in order to ensure effective and sustainable watershed management in Minnesota. This means that government agencies and planners will increasingly need to look outward to Minnesota's communities for the solutions. Watershed projects that can establish and maintain collaborative partnerships among government entities, citizens and stakeholders will likely be more resilient, productive, and most able to produce meaningful water quality outcomes over time. Working together to protect Minnesota's lakes is the best protection we have against the many stressors that threaten our valued and treasured lake resources. Before that can happen, however, some important groundwork must be laid so that citizens, stakeholders, and government officials have the information they need to effectively collaborate on lake protection.

## WRAPS are a first step in determining which lakes are in greatest need of protection

The state of Minnesota has adopted a “Watershed Approach” that requires the Minnesota Pollution Control Agency (MPCA) to monitor and assess the quality of thousands of lakes, rivers and streams across the state’s 80 major watersheds. Over a 10-year recurring cycle, each major watershed is monitored and assessed once and a Watershed Restoration and Protection Strategy (WRAPS) Report is developed for each watershed during that cycle. A WRAPS report can be used by local government organizations and watershed residents to inform development of county water plans or lake management plans, as appropriate. The WRAPS report lays the groundwork by providing monitoring data, data analysis, risk assessment and protection and restoration strategy development as outlined in the Minnesota Water Management Framework (Figure 1).

As of 2016, monitoring and assessment efforts show that approximately 40% of Minnesota lakes were not meeting water quality standards or fulfilling their designated beneficial uses. These lakes are considered “impaired”. However, the majority of our state’s lakes are in good or excellent condition. In the past, agency efforts have predominantly focused on the restoration of rivers, lakes and streams. This document, however, draws special attention to the need for lake protection by focusing on lakes that are not yet impaired, are vulnerable to impairment, or have water quality that is substantially better than the state’s water quality standards.

Rather than wait until our high quality lakes have deteriorated and are unable to meet water quality standards, we make the case that creating lake protection strategies provides a unique opportunity to address multiple threats and stressors at one

time and in a way that is proactive, collaborative, efficient, and sustainable. Water planning efforts typically identify opportunities to address both restoration and protection needs within specific land use settings. Having a well-established set of protection priorities for each watershed can help resource professionals accomplish multiple objectives with different combinations of best management practices (BMPs) and conservation practices.

While the Watershed Approach process studies the health of an entire Hydrologic Unit Code (HUC)-8 watershed and suggests general, high-level restoration and protection strategies for meeting water quality standards in all water bodies in the watershed, it is not possible to conduct detailed lake modeling and analysis for all of the state’s water bodies at a subwatershed level. Therefore, making

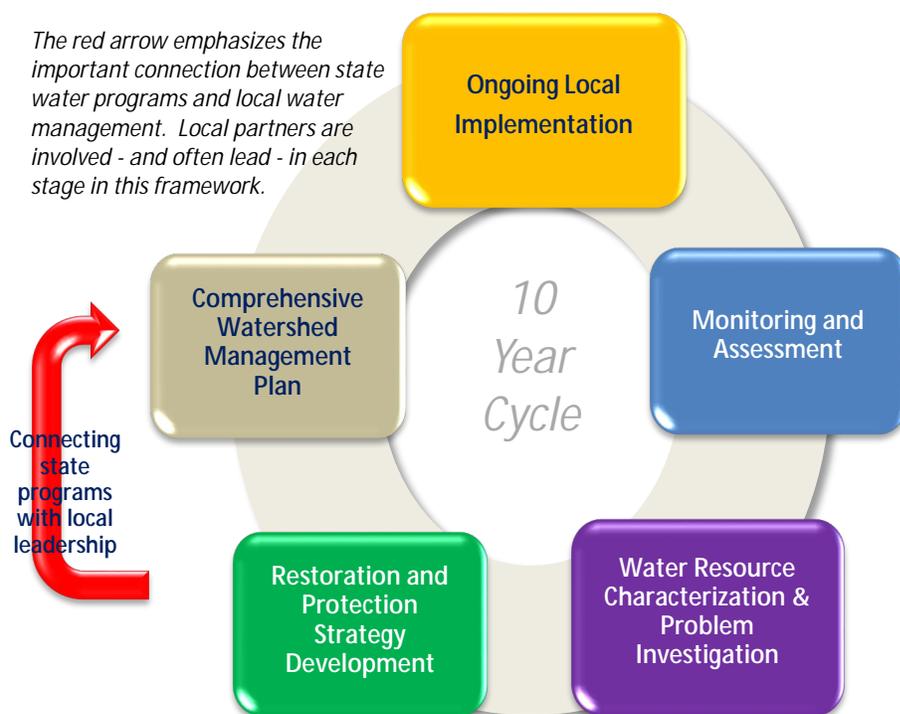


Figure 1. Minnesota water management framework

decisions about which lakes are the highest priority for protection strategies can be difficult. This document provides a framework that can help local government organizations and the public identify water bodies where focused effort is most likely to result in water quality protection.

## What this document includes

This guidance document is not a comprehensive guide to the protection of lake ecosystems. A wide variety of relevant publications and resources have been produced by the U.S. Environmental Protection Agency (EPA) and other public and private organizations to fulfill that need. Rather, this guidance is intended to provide a general, step-by-step framework that can be used by a Project Team to identify lakes that need special attention due to their vulnerability to existing and new sources of pollution, as well as those that have exceptional water quality and require a perpetual, vigilant approach to protection.

In some cases, lakes protection may require more dramatic actions or interventions that will stop or counteract the stressors that are causing degradation. In other cases, where water quality is outstanding, lake water quality can be maintained by simply protecting and sustaining existing land uses (or moving cautiously with new development) in the surrounding watershed. Each watershed is unique, so the framework provided herein is flexible so that local circumstances, values, experiences and interests can be incorporated in a way that makes the most sense for each particular local context.



The guidance has two parts.

**Part 1** of this framework describes a five-step process for identifying lakes that are vulnerable to water quality degradation within a HUC-8 watershed, and a process for prioritizing those lakes for immediate action. The guidance was developed to provide a uniform starting point in which state and local partners can begin to set lake phosphorus concentration goals and prioritize lakes for protection efforts in the HUC-8 watersheds.

**Steps 1-3** are based on an evaluation process developed by MPCA and Minnesota Department of Natural Resources (DNR) that provides an initial attempt at prioritizing lakes within a WRAPS project. The process uses available water quality and watershed data to estimate initial water quality goals, and a ranking of risk for impairment based on those data and goals. Water quality data is compiled and evaluated each year as HUC-8 WRAPS projects get under way. The results are given to the WRAPS Project Teams for use in Steps 4 and 5 as they seek to establish protection priorities.

**Steps 4 and 5** bring the initial prioritization and goal setting process into the Project Team and stakeholder involvement phase.

During these steps, local information, priorities, values and interests are incorporated into the prioritization and targeting process and into the development of lake protection strategies. These two steps are new, so feedback from Project Teams will be needed to refine and enhance this guidance going forward.

**Part 2** of the guidance includes selected reference materials and an overview of key considerations related to lake protection. Part 2 synthesizes information from many sources and is intended to stimulate the thinking of Project Team members and to encourage an integrated, holistic approach to lake protection and management. Internet links are provided to help locate additional information on key topics of interest.

## Part 1: Selecting lakes for protection activities

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### Step 1. Summarize current water quality data

MPCA staff annually updates water quality data for lakes in each HUC-8 watershed based on available information in the Environmental Quality Information System (EQulS) water quality database. Water quality data in EQulS has been collected and entered by MPCA, other agencies, counties, watershed districts, non-profit organizations, individuals, and others. The data generally consists of total phosphorus (TP) concentrations, chlorophyll a concentrations, and/or Secchi transparency depths.

The timing and format for compiling and analyzing the water quality data for some lakes in Minnesota's major (HUC-8) watersheds will vary depending on the status of each watershed in the MPCA's Intensive Watershed Monitoring (IWM) and WRAPS cycle. Lakes may have current data from the first IWM cycle or other source or monitoring may be currently underway. Other lakes may need to be monitored to provide up-to-date water quality data. Local partners in watersheds entering Cycle 2 of IWM will have the opportunity to assist in the selection of lakes that will be monitored during this cycle.

The MPCA begins the data assessment process by looking at the HUC-8 major watershed scale and then by querying the most recent 10 years of TP, corrected chlorophyll-a, and Secchi transparency for lakes. Assessments are completed for those lakes that have an adequate data record to determine whether they are impaired or not, following MPCA assessment methodologies. The assessment process is completed by analyzing available information including watershed characteristics, lake morphometry, and remote sensing, along with the water quality data. It also includes a significant professional judgement component in order to "weigh the evidence" for determining impairment or beneficial use support. Lakes that meet the lake eutrophication criteria in water quality standards are identified as supporting aquatic recreation and aquatic life use goals and require total maximum daily loads (TMDLs) to be completed on them during the Watershed Approach process.

MPCA Environmental Analysis & Outcomes (EAO) Division staff provide the data and results of the assessment process to the WRAPS project manager in a tabular format (Excel) such as that depicted in Table 1. The table provides an initial survey of the number of impaired and non-impaired lakes in the watershed. Arranging the lakes in order of mean TP concentrations provides a comparison of where the lakes are in relation to the lake TP criteria for the watershed.

### Step 2. Estimate initial pollution load reduction targets and goals

The goal of Step 2 is to provide an actionable target for lake protection, just as TMDLs set pollution reduction goals for impaired lakes. As noted above, this step incorporates an evaluation process developed by MPCA and DNR that provides an initial prioritization of lakes along with initial TP concentration targets and pollutant load reduction goals to guide local protection efforts. The targets are intended as preliminary and can be modified based on the unique conditions and circumstances of individual lakes.

In contrast to the most recent 10-year window of data used in the assessment process, this process uses all available water quality and watershed data to estimate initial water quality goals and a ranking of risk for impairment based on those data and goals. The preliminary TP concentration targets are computed as 25<sup>th</sup> percentile of the long-term summer mean TP concentration, estimated using the standard deviation of the annual data.

A target load and load goal are also estimated. The target load level is an estimate of the load needed to achieve the TP concentration target for the lake. A log-log regression model based on in-lake TP concentration, lake volume, and hydraulic inflow rate was used to estimate the target load. This load target provides a numeric mark to shoot for over the long-term. The load goal is the estimated total phosphorus load (in pounds/year) to meet a 5% load reduction goal for the lake. This goal provides the recommended reduction in the amount of pollution entering a lake that watershed partners can reasonably strive to achieve, which should help guide local stewardship practices in the context of a 10-year cycle WRAPS.

The target and goal estimation process is completed for lakes in each major watershed each year. The results are compiled in spreadsheets (Excel files) (Table 1) and can also be presented in map and line graph formats as shown in the Figures 2 and 3.

**Table 1. Example: Preliminary TP targets for lakes in the Pine River Watershed**

Water body Name	DNR ID	Depth	Max. Depth (ft)	Lake Size (acres)	Watershed Size (acres)	Proportion Disturbed Land Use	Mean TP (ug/L)	Secchi Trend	Current Predicted TP Load (lb/year)	Target mean TP (ug/L)	Load Target (lb/year)	Load Goal (lb/year)	Load Reduction Goal (lb/year)
Pig	18035400	Deep	56	213	465	0.06	15	Decreasing	68	9	44	44	3
Bertha	18035500	Deep	64	353	1,880	0.14	15	Decreasing	225	14	210	214	11
Whitefish	18031000	Deep	138	7,969	248,558	0.12	16	Decreasing	22,433	15	21,135	21,318	1,122
Big Trout	18031500	Deep	128	1,363	8,150	0.07	11	None	773	9	673	734	39

Lakes of Phosphorus Sensitivity Significance - Percent load reduction to achieve target TP  
Pine River Watershed

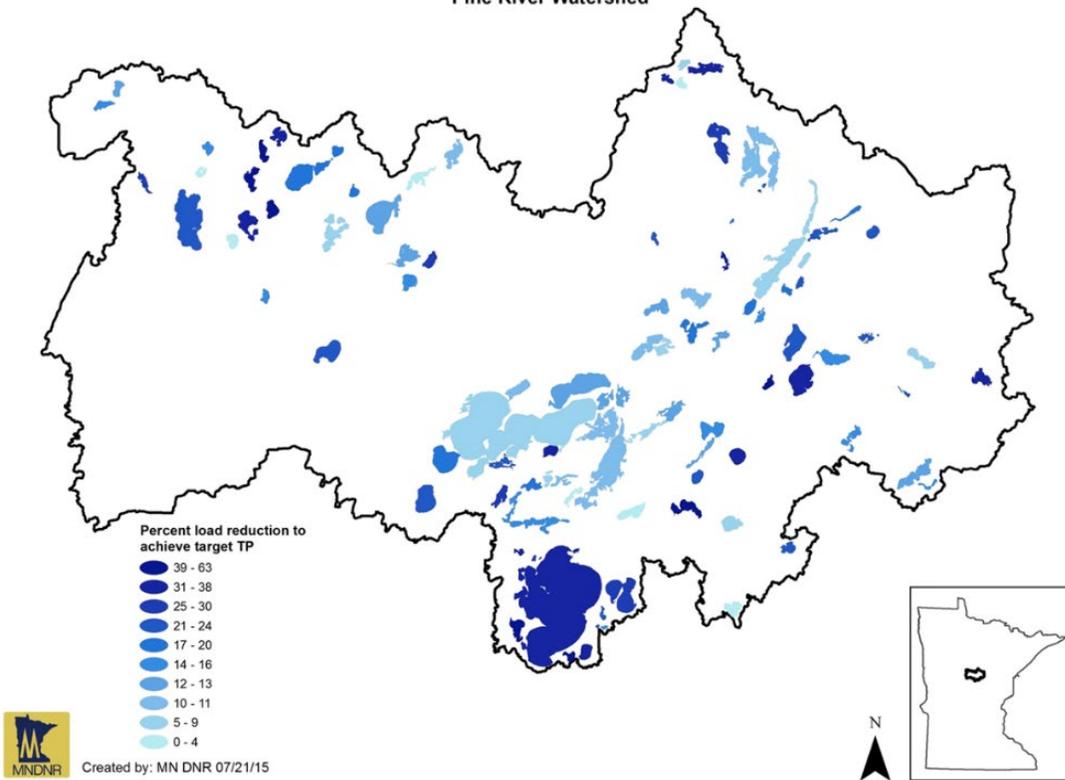


Figure 2. Example: Preliminary TP targets for lakes in the Pine River Watershed.

It is important to note that the targets and load reduction goals established in this step are considered preliminary and can be modified in subsequent steps of this process. The analysis done in Step 2 is applied uniformly to all lakes statewide and does not include regional or lake-specific considerations that may be important in setting protection goals. Local values and considerations should be incorporated into the process as described in Steps 4 and 5.

The estimates provided in this step are subject to considerable variability (estimates have wide confidence intervals) due to data limitations and the nature of the loading model. The variability is present due to the large number of lakes, wide diversity of lake types, and differences in the amount of data available in the statewide analysis. For this reason, it is important to review the load reduction goals to make sure that they are reasonable and in line with other available information on a particular lake's status and trends. However, the preliminary targets can help guide the efforts of the Core Team, communities, and organizations in the watershed in prioritizing and focusing water quality protection efforts through the WRAPS process.

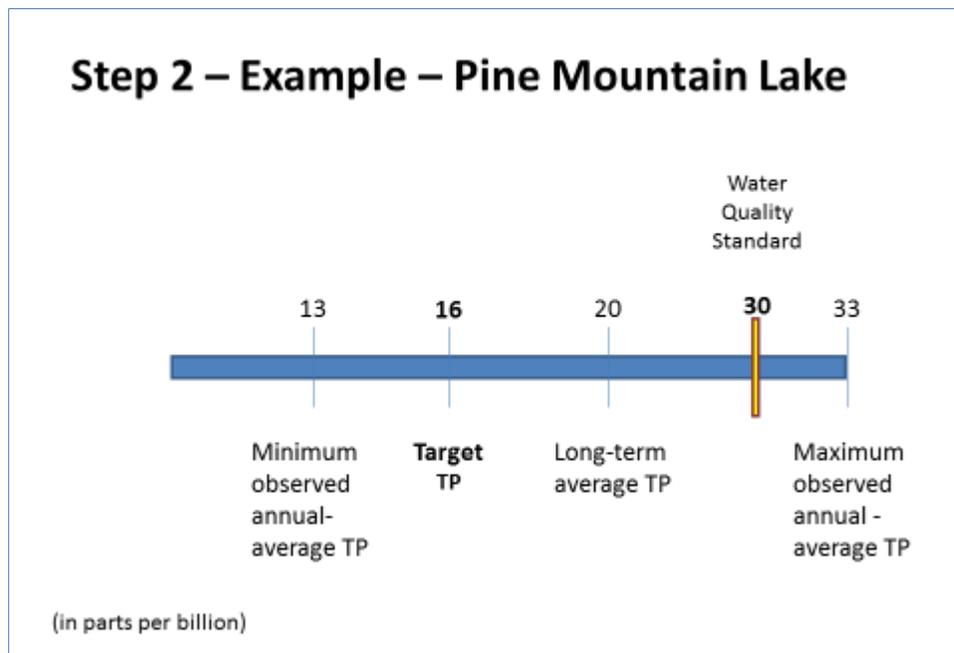


Figure 3. Setting a target TP concentration for Pine Mountain Lake

### Step 3. Prioritize unimpaired lakes using a risk assessment approach

A simple risk assessment analysis using available water quality and land cover and land use data is updated annually by MPCA and DNR to provide an initial ranking of each lake’s relative risk of water quality degradation. The initial ranking is intended to assist the WRAPS Project Team and stakeholders in prioritizing their lakes for protection. The risk assessment approach considers: (Figure 5 and Table 2)

- An estimate of each lake’s sensitivity to increased phosphorus loading
- An adjustment for how close the lake is to the TP criteria for the lake eutrophication standards
- Watershed area derived from the DNR lake catchment layer
- Lake size
- An evaluation of the amount (percent) of human land use (row crop agriculture and urban/developed areas) in the lake’s watershed based on the 2011 National Land Cover Dataset

The assessment of risk is paired with available trend information to help determine the priority order of the lakes. In general, the process identifies as highest priority, those lakes that are large, oligotrophic, vulnerable to phosphorus loading and near their estimated loading thresholds. In addition, lakes with a declining trend are elevated as higher priority.

The results of this analysis are listed in tabular format for all HUC-8 watersheds by the MPCA’s EAO staff (Table 2 below). The results can also be displayed graphically to show possible watershed-scale patterns of risk as shown in Figures 5 and 6. The number of lakes evaluated to determine their degradation risk from additional phosphorus loading are updated annually as new assessment results are added to EQUIS.

### Step 3: Identifying unimpaired waters at risk

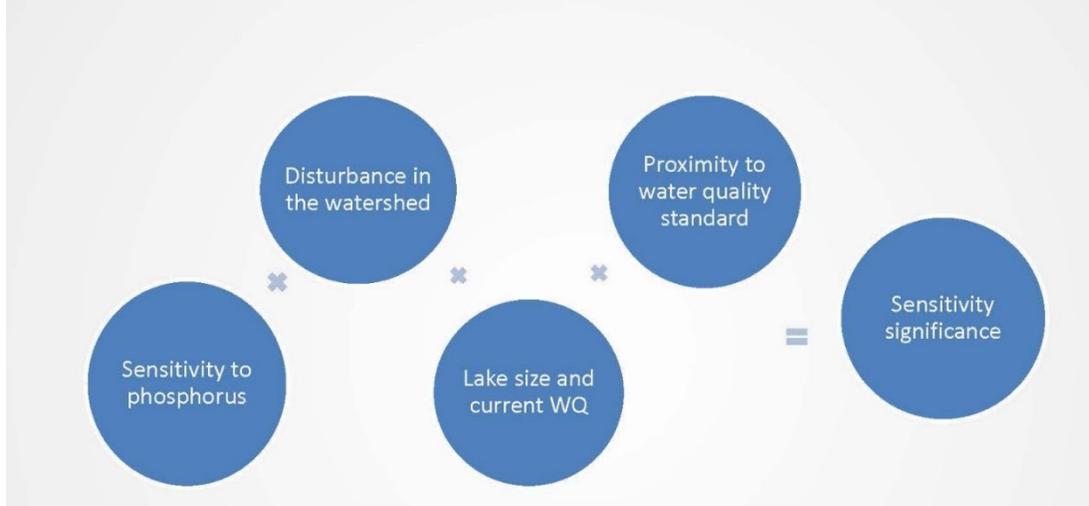


Figure 4. Identifying unimpaired waters at risk

### Step 3: Identifying priority lakes

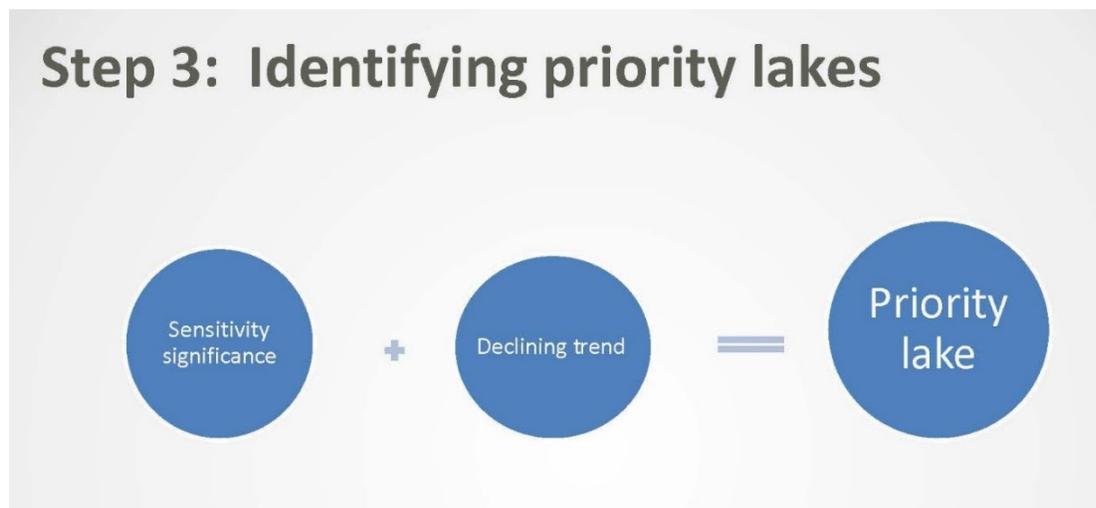


Figure 5. Identifying priority lakes

Table 2. Prioritizing lakes by category in the Pine River Watershed

Lake Name	DNR ID	Sensitivity (Secchi Disk inches lost / 100 lbs of added TP)	Priority Class	Priority Category
Big Trout	18031500	12	Highest	A
Pig	18035400	58	Highest	A
Bertha	18035500	26	Highest	A
Whitefish	18031000	0	Highest	A
Leavitt	11003700	8	Higher	B
Pine Mountain	11041100	2	High	C

Lakes of Phosphorus Sensitivity Significance - Statewide Priority Class  
Pine River Watershed

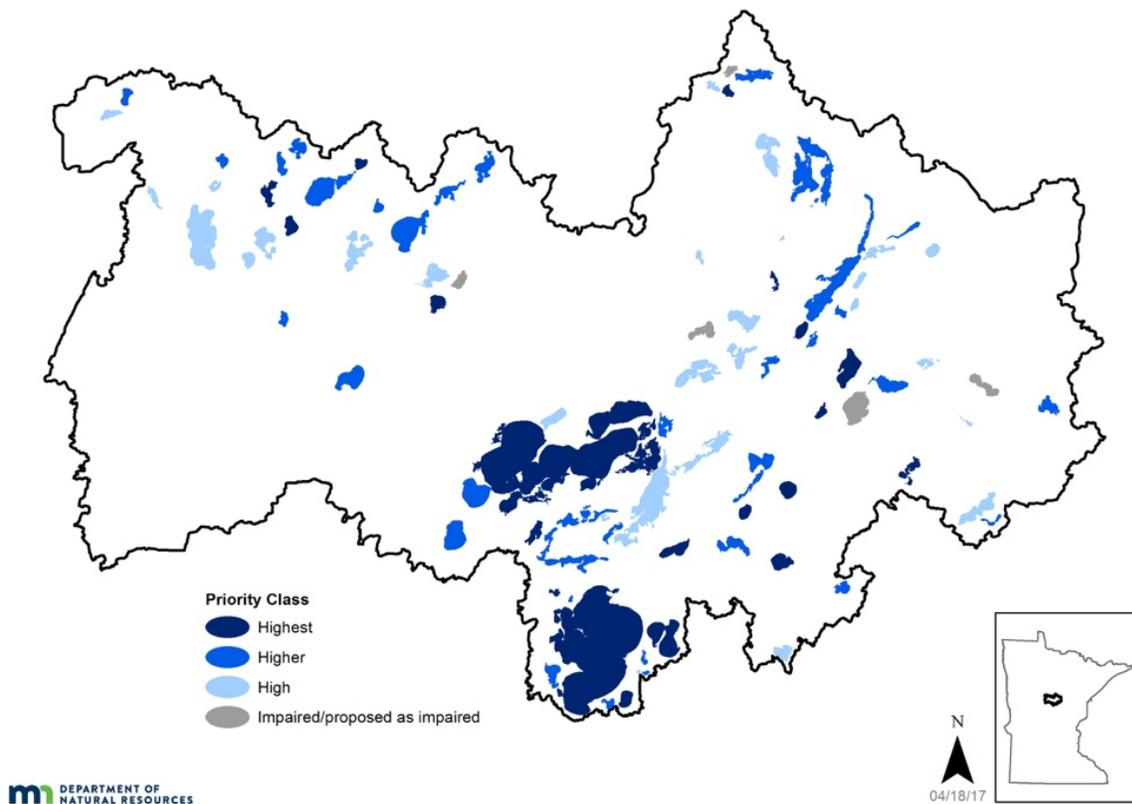


Figure 6. Lakes of phosphorus sensitivity significance in the Pine River Watershed

Step 3 results are based on a statewide analysis, using water quality data, trend information and the other factors described above. The risk priorities derived in Step 3 are typically evaluated and refined based on input from local partners and communities. However, the initial priority ranking can be useful to the Project Team, communities, and organizations in the watershed in prioritizing and focusing water quality protection efforts during the WRAPS process. Project Teams will want to review the generated priority rankings along with the data and any assumptions made in the analysis during the Watershed Approach process.

## Step 4. Identify protection targets, priorities and best practices

While Steps 1 through 3 are performed by MPCA and DNR staff and the results provided to the WRAPS Project Team, Steps 4 and 5 are accomplished entirely by the Project Team. The WRAPS Project Team (sometimes referred to as the Core Team) is comprised of a small group of natural resource professionals (MPCA, DNR, BWSR, SWCD, Watershed Districts etc.) plus other state or federal partners, non-profits, tribes and/or other stakeholders that are interested in participating. Its membership is determined at the beginning of the WRAPS project and can be broadened in order to build ownership in the Team's agreements and plans. For example, a local DNR fisheries staff person or lake association leader might be included as a member on the team.

Once the team is organized, the members are called upon to evaluate the lake prioritization data provided by MPCA and DNR (from Steps 1-3). Supplemental information from local partners and stakeholders can be brought into the discussion at this stage to complement the risk analysis data and broaden the understanding of current conditions and opportunities.

It is widely understood that local values are a key component of any dialogue and deliberation about lake protection priorities. Recreational, ecological, aesthetic, and economic values are important considerations for most local government officials when determining how best to protect high-quality waters. Consequently, it is important that Steps 4 and 5 are regionally- and locally-driven steps. Local staff and water planning professionals bring the historical context of any lake protection work already underway within the watershed.



By following the general guidelines below, the Project Team should be able to gather the necessary information needed to complete the “Protection” portion of the WRAPS report. As you work through these steps, document the process and decisions made along the way so that others can follow your analysis and you can later substantiate decisions made by the Team.

This guidance is not intended to be a “cookbook” that must be followed in a linear manner. Rather, it provides a series of general steps and guidelines that your Project Team can consider as it wrestles with challenging questions and choices related to lake protection. Also, keep in mind that, based on the level of interest or capacity of local partners to participate in Steps 4 and 5 protection planning, some aspects of this work may be delayed or taken up in subsequent water planning or 1W1P activities.

The WRAPS and water planning processes are closely related and interdependent. The primary goal of the guidance is the development of protection strategies in the WRAPS development process; however, the strategy work may interrelate and cross over with local water planning and land use planning activities. As such, a secondary goal of the guidance is to aid in developing a seamless transition between these processes.

## Step 4. Actions

The following action steps are useful when developing lake protection strategies, but they are also likely to be a part of lake restoration strategy development work. As such, the actions for each may coincide.

**A. Have a pre-planning meeting with your Project Team early in the Watershed Approach process to discuss the issue of protection. Consider including these items on an agenda:**

- Discuss the findings summarized in any previously completed watershed reports.
- Discuss the need for lake protection within a watershed-planning context.
- Discuss priority state, regional, and local issues and describe how your watershed fits into these.
- Discuss your process for developing lake protection strategies and what team members can expect.
- Develop guiding principles and develop a long-term vision for lake protection in your watershed.

- Make a list of key stakeholders and determine their potential roles and responsibilities in the strategy development process.
- Determine a process for documenting the team's work and ensuring a transparent process.
- Determine the kinds of information that would be most helpful to your planning efforts.
- Set a calendar for future meetings and a deadline for creating the draft lake protection strategy.

## **B. Collect relevant information**

As you begin, gather information from readily available sources. There is typically a wide variety of information available that can be useful to your team. Your team will need to determine the data sets most useful to your particular area and context and how much data can be realistically gathered given time and resource constraints:

- Current demographics and future projections (population, economic growth, housing demand, etc.)
- Local planning and zoning documents
- Local economic studies or reports on importance of lakes to the local economy
- Source Water Protection Plans and Source Water Assessment Areas
- MDH well vulnerability data, nitrate and arsenic data for drinking water wells (available 12/17)
- Culvert studies
- Fish habitat plans
- Terrestrial habitat plans
- DNR prairie plans
- Aquatic invasive species inventories
- Waterfowl management plans
- Aquatic Invasive Species Prevention and Management plans
- Minnesota Forest Resources Council Landscape plans, Forest Management plans and Forestry Analysis 10-year Projections
- Lake Association/Coalition of Lake Association plans
- Local Water Plans/One Watershed One Plan documents
- Natural Resources Conservation Service (NRCS) Rapid Watershed Assessments
- The Statewide Nutrient Reduction Strategy
- DNR Watershed Health Assessment Framework
- University graduate student research
- Precipitation data

## **C. Develop maps for the Project Team to use in discussions and deliberations well as with external stakeholders**

GIS maps provide key, visual insights for lake protection planning and prioritization activities.

Consider including the following data layers:

- Land use data
- Cropland data
- Feedlot inventories
- DNR County Geologic Atlas maps
- DNR Surficial Geology maps

- Soils, erosion potential, slope
- Impaired stream reaches and lakes
- Wetlands
- Lakes of biological significance
- Drainage systems
- Undeveloped lands available for protection (public lands—state, federal, local)
- Sensitive habitats, ecologically unique areas
- Existing activities in the watershed by agencies, non-profits, etc.
- Disturbed land cover or impervious surface maps from human uses
- Riparian zone disturbance resulting from human uses
- Statewide geomorphology data layer
- Minnesota Department of Health (MDH) shape files for Drinking Water Supply Management Area for local assessment of a public water supply well
- Minnesota Well Index (formerly known as the County Well Index.
- Special features (state or federal parks, monuments)
- Wastewater treatment facilities and regulated stormwater discharges
- Minnesota Water Table Aquifer Vulnerability data layer (available for download through the Minnesota Geospatial Commons website – <https://gisdata.mn.gov/dataset/water-aquifer-vulnerability>)



**D. Take another look at MPCA’s assessment data and determine the need for additional evaluation tools/information**

- Review the assessment information compiled and prioritized by MPCA staff. In some cases, available data will encompass dozens or hundreds of lakes, so the analysis must necessarily be broad-brush. The amount of effort needed to develop strategies will depend on the number of lakes in your watershed.
- Determine whether you need additional tools to refine your selection process for lakes and watersheds that need immediate attention.
- Seek out any input (professional judgment) of stakeholders (e.g. agency resources professionals working in the watershed or experienced private sector contractors working in the watershed).
- Make a list of the questions you need answered and then select the appropriate tool and/or professional assistance that will help you get the information you need.

Note: You may want to use more than one watershed assessment tool in order to get a broader perspective of the impacts that may be occurring and to help you pinpoint areas where special protection efforts may be needed. In addition, using more than one tool provides information that can be useful when looking for project funding from organizations interested in supporting different protection-related activities (e.g., terrestrial vs. water quality).

Specific tools and information that may be of use include:

- HSPF, SWAT, SAM or other watershed modeling tools
- Zonation– most useful at the local planning scale, however, there is a limited amount of technical assistance available due to staffing constraints.
- Environmental Benefits Index - BWSR
- DNR’s Watershed Health Assessment Framework (<http://www.dnr.state.mn.us/whaf/index.html>)
- DNR’s Lake Habitat Conditions (thresholds established for land disturbance (for example, 75% of land in the watershed must be in protected status in order to maintain/protect water quality)
- Information on specific point sources and nonpoint sources causing stresses to lake ecosystems and those anticipated to cause impacts in the future (ex. climate change)
- DNR Land Use Analysis Tool (currently under development)
- The Nature Conservancy’s mapping tool (Mapping Tool)

**E. Begin discussing appropriate protective actions for lakes. In many cases, this will require selecting a small number of priority minor watersheds or specific lakes for strategy discussions**

There are several ways in which the Project Team and stakeholders can select priority lakes for protection. In the Appendix, you will find a table that includes a broad list of technical and social protection-related criteria that may be of use as you try to narrow down the lakes you will give priority attention to. Select prioritization criteria first, followed by the selection of priority watersheds or specific lakes. In some cases, the Project Team may wish to select priority lakes first. If this is the case, the prioritization criteria could be used to provide additional justification for why certain lakes were prioritized.

As lakes are prioritized, it is important to document your process and the criteria used when you came to an agreement as a team. The process will likely be iterative, sometimes requiring several meetings and extensive dialogue in order to reach a final decision.

Figure 7 shows an example from the Leech Lake WRAPS report that shows the lakes that were selected as priority lakes. The lakes highlighted in yellow are those selected from the entire watershed.

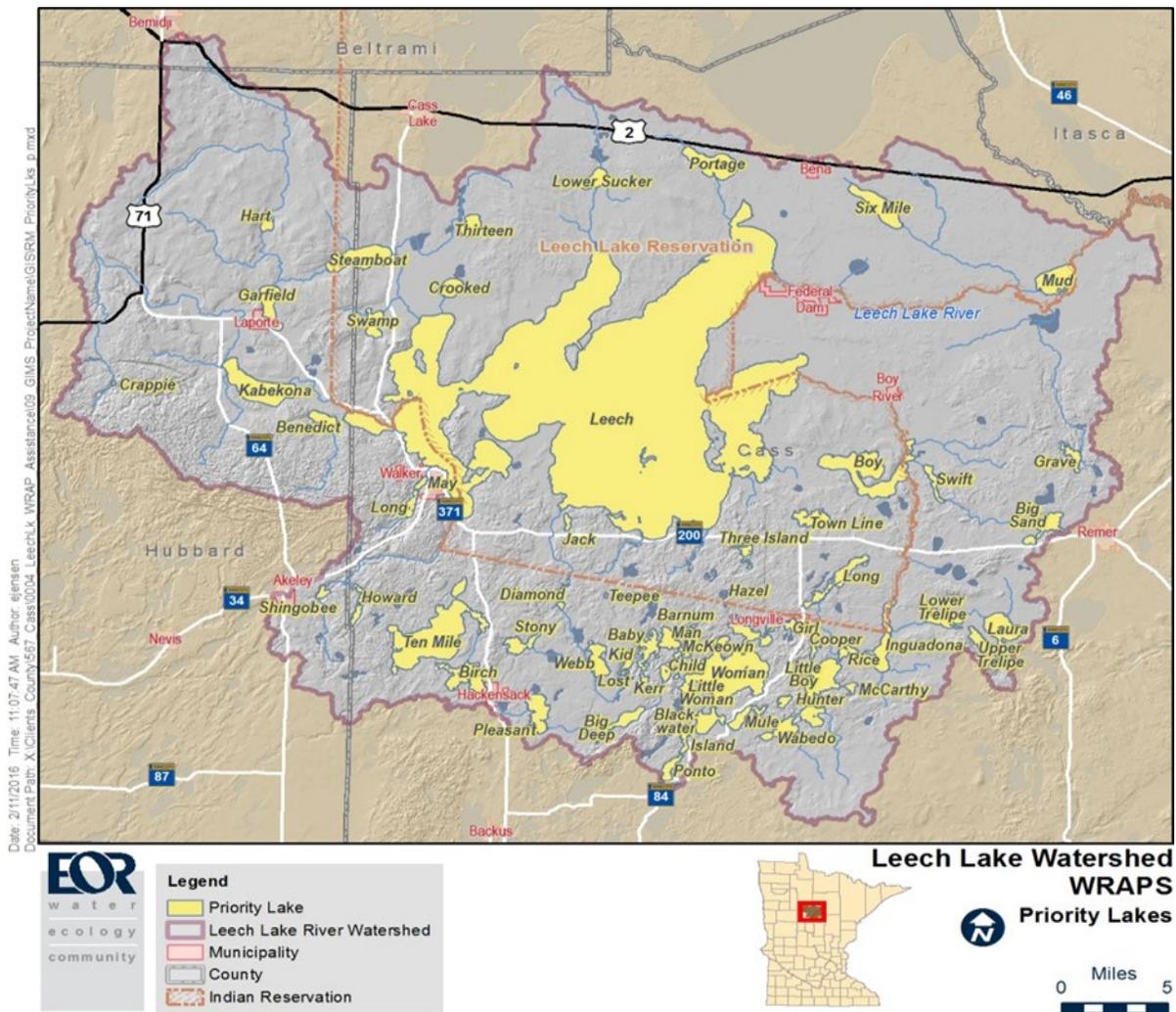


Figure 7. Map showing priority lakes in the Leech Lake Watershed

## F. Revisit the data one last time

In concluding this process, make sure that you have gathered and considered all of the most important data and information available. At this time, the Project Team may also want to consider the scale at which lake protection is needed and achievable. What is the appropriate level of effort needed to protect priority lakes at the major watershed (HUC-8) scale? Would a smaller watershed (i.e., HUC-12 or smaller watershed) be easier to manage? It is often advantageous to work at a minor watershed scale where your group can address a more manageable area and give it closer attention and focus.

## G. Align lake prioritization decisions with the Nonpoint Priority Funding Plan

Leaders from the State natural resource agencies came together and agreed on a set of high-level State priorities around which to align their programs, activities, and funding in an effort to reduce or prevent nonpoint source pollution. Those priorities are as follows:

- Restore those impaired waters that are closest to meeting State water quality standards
- Protect those high-quality unimpaired waters at greatest risk of becoming impaired
- Restore and protect water resources for public use and public health, including drinking water.

The first version of the Nonpoint Source Funding Plan (NPSFP) established criteria as a guide for evaluating program or project activities that are under consideration for receiving Clean Water Fund monies.

Consider the following criteria during your prioritization process to ensure that minor watersheds and specific lake protection projects are in alignment with the NPSFP. The criteria include the following:

- **Produce measurable effects** – Produced at a watershed scale.
- **Produce multiple benefits** – Watershed projects have a secondary water quality or other environmental benefits.
- **Ensure longevity** — Practices will be maintained for specified period-of-time.
- **Build capacity** — Local water management authorities and partners are able to execute proposed activities.
- **Leverage funding** — Able to leverage other resources from other sources.
- **Are cost-effective** — Achieve the greatest pollution reduction per dollar spent.
- **Meet landowner financial needs** — Provide financial assistance to low-income landowners.

#### H. Gather stakeholder feedback on lakes selected as priorities

- Before the Project Team finalizes the lake prioritization process, it may want to broaden its analysis to include input from key stakeholders and partners in the watershed. This could involve designing a public process that will allow watershed residents to dialogue and deliberate in a productive setting (open house, community conversation, etc.).
- Present the Team’s thinking and assumptions regarding your initial selection of priority lakes. Allow for small and large group discussions about the work you have done. Once you have feedback, regroup and make changes to your list as needed.
- Recognize that this is not a linear process and that it will require an iterative approach.

#### I. Set water quality goals and protection targets by parameter of concern for each priority lake.

The Clean Water Legacy Act requires that a WRAPS report:

- Set water quality goals and protection targets by parameter of concern where there is enough data available.

In many lakes, the parameter of concern is phosphorus. The P target is set below the long-term mean, providing a reasonable goal for reducing loadings to the lake. The target is similar to TMDL restoration goals except that this target prevents clean waters from degrading over time.

[Note: In some cases where there are many lakes in the watershed, the Project Team may not have the time or data to do a careful analysis of each lake. Each team will have to create its own approach to this task given their specific circumstances and constraints.]

- Review previous TMDLs and any information associated with other water quality studies.
- Identify potential or existing sources of pollution or human activities threatening each lake.
- Select a handful of priority minor watersheds where you plan to spend the most time implementing protection strategies. Be mindful of funding and time constraints when selecting the number of watersheds you plan to address.

Figure 8 depicts the overall lake protection framework and how lake protection fits within the whole process.

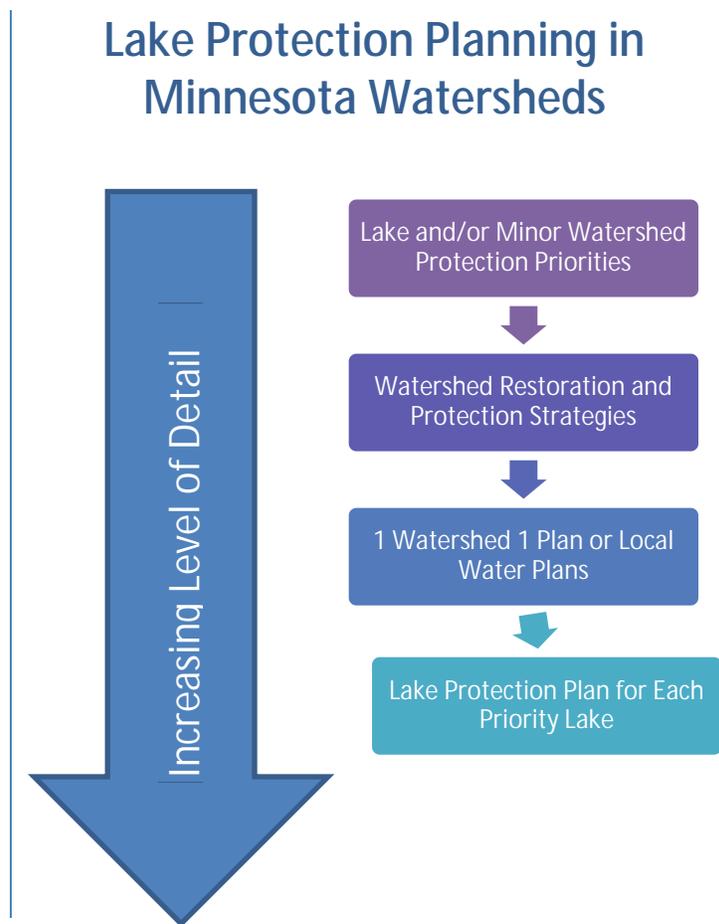


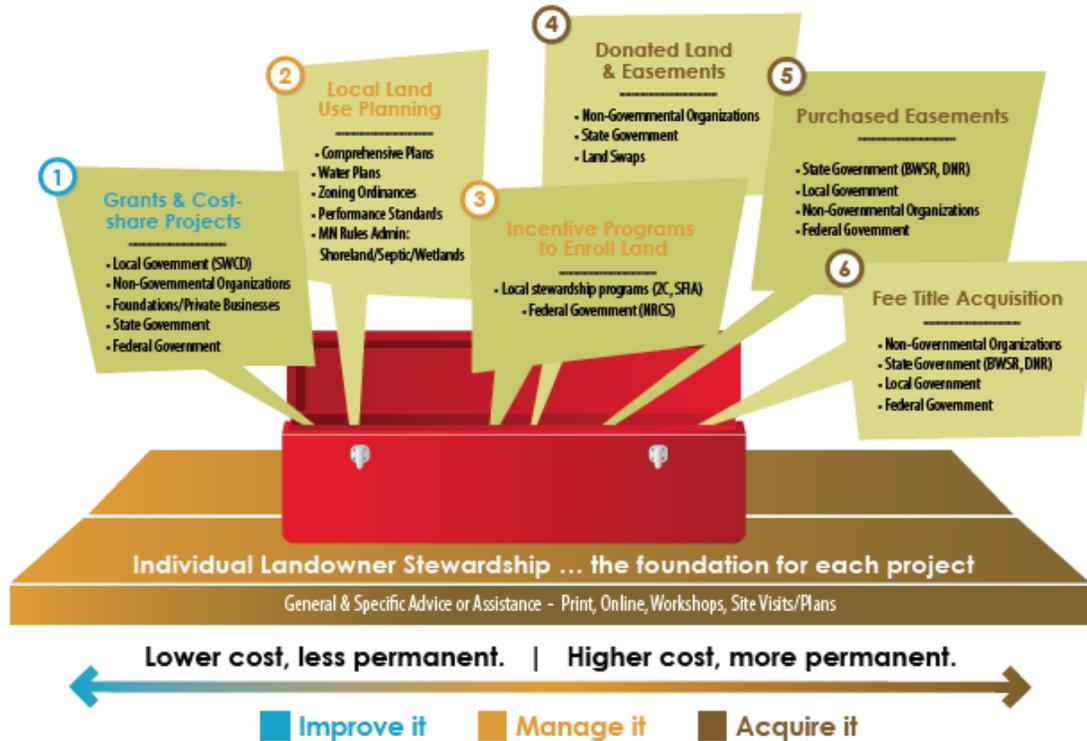
Figure 8. General lake protection framework

### Step 5. Recommend WRAPS protection strategies for highest priority lakes

Step 5 ensures that the water quality risk and prioritization process leads to the identification of high-level protection strategies that are the most appropriate based on the best available science, local knowledge, demographic data and economic factors. The graphic below depicts some protection strategies based on typical costs associated with them. The range of strategies offer either long-term permanent protection or short-term management options. Typically, prevention will be the least costly option in the long run, though these may be more expensive strategies to implement up front.

# Implementation Tool Box

Options for watershed protection



Courtesy of BWSR

Figure 9. Implementation options for watershed projects

**A. Convene your Project Team to discuss how you will approach the selection of protection strategies. Consider including these items on an agenda. Discuss:**

- The kinds of strategies that are likely to be supported locally.
- The best approach to selecting the strategies.
- Who should have a say in the selection of these strategies.

**B. Discuss and select protection strategies for each priority minor watershed and lake**

- Review Table 2 in the Appendix and go over the list of potential lake protection strategies that could be utilized.
- Identify the top 3-5 general strategies that are likely to deliver the most impactful outcomes for lakes in your priority minor watersheds. For example, septic system management, forest protection and land use controls could be high impact solutions in many minor watersheds.
- Select more specific protection tools/Best Management Practices (BMPs) appropriate to the challenges identified for each priority lake.
- Consider groundwater and source water protection as key lake protection strategies.
- Document your decisions for the WRAPS document.
- Develop tables for the WRAPS document which shows lakes assessed, priority lakes, sources of pollution identified as stressors for each priority lake, and protection strategies identified for each lake. In some cases, completing this step might be dependent on the amount of data

available. Without complete data, your team may have to rely on best professional judgment, local data, common complaints from lake residents, etc. when selecting strategies.

### C. Incorporate lake protection strategies into the WRAPS Report

- Gather public input on the Draft Protection Strategy through the WRAPS public comment period.
- Incorporate changes into WRAPS document and finalize.

### D. Present lake protection planning outcomes to others

- Present your team's planning outcomes to local decision-makers, stakeholders and the public, as needed.
- After your WRAPS report is complete, reassess your strategies and progress on implementing strategies on a biennial basis with your Project Team. Make necessary adjustments to planning documents and work plans.

### E. Be sure to document your approach in writing so that you can easily explain/justify your choices in the event of public inquiries.

- Develop basic outreach materials on lake protection.
- Be able to describe in writing and publicly speak to why some lakes are of the highest value, why others require vigilance to maintain water quality, why you selected certain minor watersheds and lakes for immediate attention and activity, and why certain lake protection strategies have been selected. The WRAPS approach does not provide enough time to get into great depth regarding the selection of lake priorities and strategies.

#### Tip

Careful record keeping during the WRAPS development process will be very important. Write down the process you used. Summarize the outcomes and decisions you came to as a team after each meeting. Leave a paper trail for your successor so that they can understand the process you followed and decisions made.

Describe the process your Project Team used in a fact sheet. Also, consider preparing an engaging storyline you can follow when you explain the process and outcomes in public settings or with local decision makers.

## Part 2. Background information and selected resources

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### Important consideration when you develop your lake protection plans

#### A. Approaching protection from a broad, integrated perspective

Protecting lake water quality is a multi-dimensional effort requiring protection of complex natural systems and administration of many inter-related programs (federal, state, local, non-profit) within watersheds. If well-integrated and managed as a whole, these efforts have the potential to address the complex nature of protecting vulnerable and pristine resources.

Lake protection is a difficult task on its own, and perhaps more challenging to do in a way that provides opportunities for interested watershed residents (business leaders, non-profits, schools, congregations, etc.) to take the lead in achieving lake and watershed management goals. Local water managers will

have the challenge of strategically integrating public participation into the process of identifying priority lakes and protection tools, applying agency programs and using available expertise when needed. We encourage managers to think broadly as they weave together the human dimensions of lake protection with the important habitat and water quality management tools available to them. The process can be a daunting and messy task, but it should also be considered iterative and adaptive.

## **B. Protecting vulnerable lakes in the face of potential climate change impacts**

Protecting our high quality lakes as the assets they are takes on a greater significance when one considers the potential impacts of global climate change on Minnesota's environment. Global climate change is changing the character and quality of precipitation in Minnesota. There are projected changes in rainfall, evaporation, and groundwater recharge rates that will affect all freshwater users. Some of these projected impacts include (Kling, et. al, 2005):

- Lake levels are expected to decline in both inland lakes and the Great Lakes as more moisture evaporates due to warmer air temperatures and less ice cover.
- Reduced summer water levels in some lakes and streams are expected to diminish the recharge of groundwater, cause small streams to dry up, reduce the area of wetlands, reduce water quality in some lakes and in turn, produce less wildlife habitat, or diminish the quality of the habitat that exists
- In many lakes, the duration of summer stratification will increase, adding the risk of oxygen depletion, and formation of deep-water dead zones for fish and other organisms, although "winterkill" in shallow lakes will likely decrease.

In 2010, The Legislative-Citizen Commission on Minnesota Resources (LCCMR) commissioned a study that assessed the impact of climate change on Minnesota's water resources. In this sobering report, investigators outlined the numerous ways in which Minnesota's lakes and streams could be impacted. Global climate change appears to have already begun to manifest changes in water quality across the state.

Several key findings from the LCCMR report are:

1. *There is evidence that for lakes with significant time trend data available for the summer months, more than 90% have already shown surface water warming as compared to cooling.*
2. *The salt content of surface waters has increased over time in more than a third of the lakes with >5 years of data, 50% of those with >8 years, and 90% with >18 years of data. This is consistent with increased summer surface warming but also with potential increased exposure to winter de-icing salts and/or increased stormwater runoff from either urban or agricultural areas.*

The study's conclusions underscore the complexity of determining how a given lake will respond to proposed climate impacts. However, it will be important to consider these impacts given the importance of the resources at stake. The report's authors argue that the value of water resources and the ecological services they provide are so significant as to make it economically efficient to incur substantial costs to avoid those losses in the future.

Although the long-term impacts of climate change on specific lakes cannot be known at this time, it seems likely that healthy lakes will become more vulnerable to the many stressors and pollutants

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*Sustainable water protection will require an integration of traditional engineering solutions with nature-based solutions. Nature-based solutions are the services that well-functioning natural systems can contribute toward solving challenges like climate change and human health issues related to environmental degradation (Abell, et. al, 2017)*

already threatening them. Threats include changes in surface water levels/streamflow, increased sedimentation, degraded water quality, aquatic invasive species, degraded drinking water sources, and damages to aquatic life habitat (Welle, 2010).

[http://www.lccmr.leg.mn/projects/2007/finals/2007\\_05k\\_appx\\_a.pdf](http://www.lccmr.leg.mn/projects/2007/finals/2007_05k_appx_a.pdf).

### **C. Watershed protection as a means to achieve multiple benefits for the community**

In many watersheds across Minnesota, making an effort to protect existing land uses, such as forested lands, within major or minor watersheds can be enough to ensure high water quality water in lakes and streams. In other watersheds, highly altered landscapes and certain land uses will have to be modified in order to move toward a higher level of water quality protection. This will require Project Teams and stakeholders to wrestle with how best to balance societal needs with the need to protect critical lake resources.

As Project Teams move forward, integration of multiple stakeholder interests, programs, funding streams, and public values will be necessary to produce multiple benefits to a lake community. This effort is no small or easy task. The following section provides a short description of state programs that may in some way be related to your lake protection goals. We encourage teams to look these over and consider whether they have relevance to your particular lake protection or management needs.

These issues may or may not be relevant to all teams; however, if teams would like to learn more about a specific topic, there is a link to more information.

#### **Forest management and protection**

Our desire to protect the most vulnerable lakes often must begin by investing in forest conservation. Rather than rely on expensive and complex BMPs or new water filtration infrastructure, protection of upstream forests can be a resource-smart way to maintain good water quality in lakes. The DNR, the Minnesota Forest Resources Council (MFRC), and the MDH promote upstream forest conservation as a cost-effective means of ensuring clean water in our lakes and clean drinking water to thousands of people.

Forests can be taken for granted for the benefits they provide us. Forested land in the U.S. provides two-thirds of the nation's water to us. Water, in the form of precipitation (rain and snow), is filtered through forest vegetation and soils, feeding groundwater, streams and rivers. Forests filter nutrients and pollution while regulating the timing and amount of water that flows downstream. Communities, businesses, and individuals enjoy great economic benefits from these "forest ecosystem services". Consider that:

- By naturally filtering rainfall and snowmelt, forests provide clean water downstream and reduce drinking water treatment costs.
- By protecting soils from erosion, forests keep sediment and nutrients from reaching lakes and streams (Yonavjak and Gartner, 2011).

Forests can be threatened by a variety of potential stressors, including climate change. Development pressures of all kinds (e.g. harvesting, residential and recreational development) can put lake water quality and downstream users at risk.

Protecting forests from development or poorly managed harvesting practices is a critical step in ensuring that high quality lakes remain healthy (Yonavjak and Garnter, 2011). It is important to use appropriate BMPs to mitigate or alleviate those impacts; however, the most and sometimes most straightforward strategy is to maintain healthy forests to ensure high water quality waters exist into perpetuity.

The Board of Water and Soil Resources (BWSR) and several northern counties (Cass and Crow Wing) have developed an approach that has helped them prioritize not only minor watersheds that need immediate attention, but these counties have also looked carefully within those watersheds at specific parcels of land where forest protection is especially critical to protecting adjacent and downstream lakes. A fundamental goal of their overall lake protection strategy is to maintain existing forest cover in the watershed so that it does not fall below 75% of total land area.

Crow Wing County, as one example, intends to use prioritized minor watersheds and the most vulnerable and important parcels of land within those watersheds to focus their limited resources on. A key insight from their work has been their growing awareness of the major differences in minor watersheds. This makes a one-size fits all approach ineffectual in addressing water quality stressors. What has proven valuable has been learning how to ask the right questions that will get at the specific issues and needs at the minor watershed scale or smaller.

A plan has been developed to work collaboratively with landowners to keep forests and riparian areas healthy. Specific landowners in Crow Wing County will be selected and contacted requesting their potential participation in private forests protection activities. Preserving sensitive riparian lands will also be a special focus for protection efforts. It is hoped that these protection practices will provide significant returns for water quality and a meaningful return for landowners and watershed residents on the investments made.

#### **“Forestry” in WRAPS guidance**

*(This document is currently included in the “Incorporating Lake Protection Strategies into WRAPS Reports” guidance under the heading, Incorporating forest protection in WRAPS documents, beginning on page 22. A discussion on whether to present it as a standalone document has not occurred to date.)*

Forests are a major land cover in several watersheds in Minnesota (Table 3). The presence of forests also represents a significant factor in attaining water quality goals even though there can be localized water quality problems associated with forest land management. It is important to incorporate forest information into WRAPS reports, but even more important to involve forest managers and landowners in the development of WRAPS.

The DNR WRAPS contact<sup>1</sup> for each watershed should be included in the WRAPS process to assist in connecting and involving the key individuals, organizations, and agencies in the WRAPS process. It is specifically important to contact federal and local forestland managers in the watersheds. These people and entities are key to adequately including and integrating forest information into WRAPS reports. Forest management is largely oriented by the ownership of the land. County, state, and federal forest lands are generally fully managed to maintain forest cover and uses with some exceptions. Private industry forest landowners also actively manage their forest land; however, changes in the timber industry are resulting in industry land being sold increasing the chance for a change in land cover. The least managed forest lands are typically owned by private individuals that often are not aware of the forest resource value of their land nor the importance of that land in protecting water quality. The DNR

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<sup>1</sup> The DNR and other agency contacts for each watershed are listed in the Interagency Watershed Core Teams list on the Interagency WRAPS-Implementation SharePoint site located at <https://mn365.sharepoint.com/sites/DNR/division/ewr/communities/CWFWRAPSIMPLT/SitePages/Home.aspx>. The list is a spreadsheet with several tabs. Users should see the “Agency Contacts – WRAPS” tab for purposes of the Forestry in WRAPS (and Lakes Protection in WRAPS) guidance. The SharePoint site is accessible to most state agency staff working with WRAPS.

Forest Stewardship Program targets improved forest management on individual landowners' land, while the DNR Forest Legacy Program provides monetary assistance in maintaining forest cover through conservation easements.

The DNR and other agency contacts for each watershed are listed in the Interagency Watershed Core Teams list on the Interagency WRAPS-Implementation SharePoint site located at <https://mn365.sharepoint.com/sites/DNR/division/ewr/communities/CWFWRAPSIMPLT/SitePages/Home.aspx>. The list is a spreadsheet with several tabs. Users should see the "Agency Contacts – WRAPS" tab for purposes of the Forestry in WRAPS (and Lakes Protection in WRAPS) guidance. The SharePoint site is accessible to most state agency staff working with WRAPS.

A review of the available plans and documents related to forest and water resource planning found that MFRC documents provide much of the information desired for a WRAPS project. As such, a first "stop" in gathering information and formulating forest management strategies for WRAPS projects should be the regional forest landscape and/or watershed plans developed by the MFRC regional landscape program committees. Forest landscape plans pertinent to WRAPS projects with a significant forest component are listed in Table 4 along with WRAPS status as of March 2017.

**Table 3. Watersheds with forest component.**

<b>Watershed</b>	<b>"Forest" Component*</b>	<b>WRAPS Status**</b>	<b>MFRC Regional Landscape Plan***</b>
Big Fork River	High	Q2 2017	Northern, North Central
Buffalo River	Small	Approved	North Central
Chippewa River	Small	Complete	West Central
Clearwater River	Moderate	Q3 2018	North Central
Cloquet River	High	Q4 2019	Northeast
Crow Wing River	High	Approved	North Central, West Central
Kettle River	High	Q2 2020	East Central, Northeast
Lake of the Woods	Moderate	Q4 2017	Northern
Lake Superior – North	High	Q2 2018	Northeast
Lake Superior – South	High	Q1 2018	Northeast
Leech Lake River	High	Complete	North Central
Little Fork River	High	Q2 2017	Northeast, Northern
Long Prairie River	Some	Complete	West Central
Mississippi River – St. Cloud	Some	Approved	West Central, East Central
Mississippi River – Sartell	Some	Q2 2020	West Central, East Central
Mississippi River – Brainerd	High	Q3 2020	West Central, North Central
Mississippi River – Grand Rapids	High	Q2 2019	North Central
Mississippi River – Headwaters	High	Q2 2018	North Central
Nemadji River	High	Complete	Northeast
Otter Tail River	Some	Q3 2020	West Central
Pine River	High	Q1 2017	North Central

Watershed	"Forest" Component*	WRAPS Status**	MFRC Regional Landscape Plan***
Pomme de Terre River	Small	Approved	West Central
Lower Rainy River	High	Q4 2021	Northern
Rainy River – Rainy Lake	High	Q4 2021	Northeast, Northern
Rainy River – Headwaters	High	Q4 2020	Northeast
Rapid River	High	Q4 2021	Northern
Upper/Lower Red Lake	High	Q2 2020	Northern, North Central
Red Lake River	Some	Q3 2017	Northern (small portion)
Redeye River	Moderate	Approved	West Central
Roseau	Moderate	Q2 2019	Northern (small portion)
Rum River	Moderate	Q2 2017	East Central
Lower St. Croix River	Some	Approved	East Central
Upper St. Croix River	High	Q2 2020	East Central
St. Louis River	High	Q3 2017	Northeast
Sauk River	Small	Approved	West Central
Snake River	Moderate	Complete	East Central
Thief River	High	Q2 2017	Northern (small portion)
Vermilion River	High	Q4 2020	Northeast
Wild Rice River	Some	Q4 2018	North Central

\* General magnitude of forest cover in the watershed based on % forest plus % wetland, if big portion of the wetland thought to be woody wetland. Land cover data obtained mostly from NRCS Rapid Watershed Assessment reports, categories selected subjectively: Small, < 10%; Some, 10-35%; Moderate, 35-50%; and High, > 50%.

\*\* WRAPS status – Indicates 'Approved', 'Completed' (public noticed), or estimated calendar quarter for public notice. Quarter is subject to updates.

\*\*\* Rough visual estimate of primary MFRC landscape region. MFRC regions based on county boundaries. (Footnotes are not included in the lake protection document.)

The MFRC was established by state statute (Minn. Stat. ch. 89A) to “develop recommendations to the governor and to federal, state, county, and local governments with respect to forest resource policies and practices that result in the sustainable management, use, and protection of the state's forest resources.” A key aspect of the MFRC mission is to encourage cooperation and collaboration among the wide array of public and private organizations and individuals affected by forest resources. The MFRC regional landscape plans provide a wealth of effort and information that should be incorporated into the WRAPS development process and WRAPS reports. The MFRC also has some watershed-specific forest resources plans that should be incorporated, if available. MFRC regional landscape plans and other information can be accessed at the MFRC website (<http://mn.gov/frc/reports.html>). In addition to the regional plans, the MFRC developed site-level forest management guidelines for use in timber harvesting and other forest management activities.

In addition to the landscape-level plans, the MFRC completed a watershed landscape stewardship plan for the Kettle River watershed. County land management departments have also developed forest management plans for county-owned forestland. The following list of plans is from the MFRC website:

- Carlton County Tax Forfeited Land Management Plan
- Lake County Management Plan
- St. Louis County Business Plan

The Minnesota Board of Water and Soil Resources (BWSR) forestry assistance program and soil and water conservation districts' forestry and tree programs should also be incorporated in the WRAPS development process. Note: Additional information on how to target landowners for forest protection and management conversations will be added.

The Watershed Approach process may also benefit from contact and coordination with the Minnesota Forest Resources Partnership (MFRP) and Minnesota Forestry Association (MFA). The MFA works to promote stewardship of woodlands on behalf of family forest owners.

Links to the organization websites are:

- MFRP – <http://www.mnforestpartnership.com>
- MFA – <http://www.minnesotaforestry.org>

### **Groundwater and source water protection**

About 1.5 million people in Minnesota receive their drinking water from a surface water source (lake or river). The susceptibility of a surface water source to contamination is considered high because there is no practical means of protecting all potential contaminant releases into surface waters. Source water protection is critical to ensuring safe drinking waters supplies and to minimizing the expense of water treatment. A growing body of evidence suggests that contamination in lakes and streams can affect groundwater used for drinking water through groundwater-surface water interactions

**Source water protection** represents a critical focus and a major change in thought about protection of drinking water supplies. It is part of a multiple barrier approach used to provide safe drinking water – which includes wellhead protection, source water assessments, and protection of surface water intakes.

Currently, neither state agencies nor local units of government are required to address the management of potential sources of contamination to drinking water sources in their planning efforts. Many of the existing watershed management programs are based on the Clean Water Act. This is due, in part, to federal and state rules that focus more on producing fishable and swimmable waters than safe drinking water. Consequently, “fishable” and “swimmable” goals are most often the focus. This approach leaves gaps in our planning for source water protection.

However, it is the goal of state agencies (MPCA, MDH, DNR, BWSR, MDA etc.) to integrate state endorsed/approved source water protection plans into WRAPS and support their implementation through the many regulatory and non-regulatory programs these agencies administer. The MDH is in the process of developing Groundwater Restoration and Protection Strategies that will eventually be helpful in informing lake protection strategies. Coordinate with the MDH to discuss potential strategies that could protect source water within your watershed(s).

The MDH has produced source water assessments to provide a basic understanding of resources being used by public water systems across Minnesota. To find and view source water assessments, click on the link below: <http://www.health.state.mn.us/divs/eh/water/swp/>

### **Fish habitat management and protection**

The DNR's Fish Habitat Plan is a guide that lays out the agency's goals for fish habitat protection, enhancement, and restoration efforts in managed fish waters across the state.

This document provides information that can be helpful in creating a site-specific plan for managing habitat in priority lakes. Many of the proposed strategies for managing healthy fish populations are directly compatible with those for protecting lake water quality. The DNR is interested in partnering with local government organizations to promote specific tools at the watershed, riparian, and aquatic levels. [http://files.dnr.state.mn.us/fish\\_wildlife/fisheries/habitat/2013\\_fishhabitatplan.pdf](http://files.dnr.state.mn.us/fish_wildlife/fisheries/habitat/2013_fishhabitatplan.pdf)

## Shoreline management

Demand for shoreline property is high and shorelands are rapidly being developed across the state. Increasing demand for building sites along lake shores has led to high land costs in many communities. Without local land use controls, land with water frontage tends to be divided into smaller and smaller parcels. Cottages, homes, and resorts soon begin to form a continuous band of development. Roads, and other infrastructure built to support development around lakes, can result in the destruction of natural vegetation, reduction in groundwater recharge areas and impacts to scenic beauty. This kind of development is often followed by a second and third tier of construction until the entire watershed is dramatically changed (Cappiella, and T. Schueler. 2001).

Water and near shore areas are critical to the health and well-being of fish, wildlife, and native plants. All lakes need to have healthy buffer/filter strips along the shoreline to reduce and slow runoff and to increase infiltration of water. In addition, fish and wildlife are highly dependent on vegetated shorelines for healthy spawning areas, as well as habitat for feeding, resting, and mating life stages.

The consequences of uncontrolled and unplanned development can be significant to land and water resources. Overbuilt and poorly designed shoreland areas contribute a number of pollutants, potentially degrading the value of the entire water body. The result may be an increased risk of flooding and non-point source pollution. Nutrients like nitrogen and phosphorous, other pollutants, and improperly designed sewage treatment systems can contaminate wells and surface waters (Cappiella, K., and T. Schueler, 2001)

Local land use controls can be used to limit the amount and kind of development in sensitive shoreland areas. DNR's Shoreland Program provides the backbone of statewide standards that local governmental units can adopt into their own land use controls to provide for the orderly development and protection of shorelands (both rivers and lakes). This involves planning and zoning assistance to local governmental units by DNR Area Hydrologists and Shoreland Management staff.

[http://www.dnr.state.mn.us/waters/watermgmt\\_section/shoreland/index.html](http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html).

## Lakes of biological significance

The DNR maintains a list of high quality lakes that may be useful for local resource managers as they focus protection efforts. These lakes have been studied in detail to determine the presence of unique plants and animals in each of the following communities: aquatic plants, fish, birds, and amphibians. Lakes need to meet criteria for only one of the community types (aquatic plants, fish, birds, amphibians) to be identified as a lake of biological significance. Lakes can be assigned one of three biological significance classes (**outstanding, high or moderate**). Many lakes in Minnesota have not yet been sampled for plants and animals, so the list of lakes will be periodically revised as additional biological data become available. More information can be found at:

<https://gisdata.mn.gov/dataset/env-lakes-of-biological-signific>

This website includes data layers and other information intended to support planning, natural resource management, research and other resource protection-related activities

## Shallow lakes protection

Minnesota's shallow lakes (50 acres in size or greater and maximum depth of 15 feet or less) provide essential waterfowl and wildlife habitat. Certain important shallow lakes have been actively managed for wildlife benefits for decades. Despite this, the overall condition of this kind of lake resource has declined.

Recently, shallow lakes have had renewed attention partly due to the decline in quality of waterfowl hunting and because of a growing concern over poor water quality in many of these lakes. The DNR released a "Long Range Duck Recovery Plan" (Duck Plan) in 2006. This plan provided a strategic 50-year vision to restore, *protect*, and manage our landscapes so they could support abundant populations of ducks and the spring and fall migration of other waterfowl while providing sufficient opportunities to support waterfowl hunters and waterfowl watchers.

The Duck Plan suggests that at least 1,800 shallow lakes (almost half of the total resource) will have to be protected and managed if the State is going to achieve the targets set for recovery of duck populations. Favored habitats are those that have thick stands of emergent vegetation including cattail, bulrush or sedge and areas of open water.

In order for the state to have quality waterfowl habitat, active management and further protection of shallow lakes are necessary. Active management is needed to achieve water quality protection *and* wildlife and waterfowl habitat goals. The WRAPS protection strategy can include special consideration for shallow lakes and protect those that may also provide wildlife and waterfowl habitat benefits. Such plans would likely require greater resources and more partners than are currently involved in water quality management efforts alone. For more information:

[http://files.dnr.state.mn.us/fish\\_wildlife/wildlife/shallowlakes/shallowlakes.pdf](http://files.dnr.state.mn.us/fish_wildlife/wildlife/shallowlakes/shallowlakes.pdf)

## Wild rice habitat protection

Minnesota is at the center of the world's natural wild rice production. Protected, undeveloped shoreland is important to preserving sensitive wild rice lakes for current and future generations of native people, wildlife and outdoor enthusiasts.

Wild rice is important both socially and culturally in Minnesota. Wild rice also provides important ecological benefits. Wild rice thrives in shallow lakes, rivers, and shallow bays of deeper lakes and provides some of the most important habitat for wetland-dependent wildlife species in Minnesota. Wild rice habitat is especially important to Minnesota's migrating and breeding waterfowl and provides Minnesotans with unique recreation opportunities: hunting waterfowl and harvesting the rice itself for food. Wild rice also protects water quality by keeping soil and nutrients in place and acting as a buffer to slow shoreline erosion in wetlands and lakes.

In some regions of the State, wild rice production continues to have a high local value and it may become a key criterion for selecting priority lakes for action.

<http://www.bwsr.state.mn.us/news/webnews/june2015/2.pdf>

## Agricultural management

There are many opportunities to institute protection activities in an agricultural landscape. Projects of greatest benefit, from a water quality protection standpoint, are those that minimize the amount of nutrients and sediments that move from the land to watercourses and ultimately to lakes in the watershed. Nutrient management programs are an important consideration in areas where row crop agricultural is an important land use.

Targeting lands adjacent to tributaries, ditches, or lakeshore may make the most sense where water flows are directly connected to the lake. Many programs are also available to foster the use of agricultural BMPs, including riparian buffer strips, highly erodible land management, and land retirement programs such as

the Conservation Reserve Program or Reinvest in Minnesota. BMPs which provide the most significant water quality improvement or the greatest degree of protection should have the highest priority. For example, priority should be given to projects on lakes where nutrient loading from shoreland areas is (or could be) a major contributor to the lake's nutrient budget.

Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a voluntary opportunity for farmers and agricultural landowners to demonstrate their use of BMPs that protect out water. Producers working toward certification are given priority for receiving technical and financial assistance, and once certified, are granted regulatory certainty for a period of 10 years. The Minnesota Department of Agriculture (MDA) operates the program in collaboration with the MPCA, BWSR, DNR, NRCS, counties and soil and water conservation districts (SWCDs). Through these partnerships, the MAWQCP is aligned with water quality projects across multiple agencies. This program is best administered at the local level. <https://www.pca.state.mn.us/sites/default/files/wq-cwp8-15.pdf>.

### **Septic system management**

Septic systems (also called subsurface sewage treatment systems or SSTS) provide wastewater treatment for many lakefront homes, rural residences, and rural developments. Lakeshore septic systems are potential sources of subsurface nutrient and pathogen seepage to a lake given they are in close proximity to the lake. Indeed, many researchers have identified failing or poorly functioning waterfront septic systems as an important and controllable source of phosphorus and nitrogen in a wide range of lake systems (Cappiella, K., and T. Schueler, 2001).

Fixing failing septic systems is one of the more straightforward and achievable protection strategies. Improving septic systems provides lake homeowners with a tangible action they can take that can bring meaningful changes to lake water quality. Consider whether your existing septic system ordinances are adequate. State law mandates make direct discharges of sewage illegal. See MPCA's SSTS website for more information: <https://www.pca.state.mn.us/water/subsurface-sewage-treatment-systems>. Healthy shoreline buffers also have an important role to play in protecting lakes by providing distance between septic drain fields and lake shorelines. Buffers can provide needed soil treatment in confined areas. Be thoughtful about placement of buffers for greatest impact.

Watershed-wide septic system regulations may also be a key element that can prevent migration of phosphorus to surface and groundwater, especially in watersheds that have potentially high septic system density or unsuitable soils.

### **Urban runoff**

In many areas of Minnesota, wetlands, lakes and streams are increasingly vulnerable to the impacts from urban runoff. Moreover, there is increasing concern about the quality of Minnesota's groundwater, which supplies drinking water for 75% of the state's population.

While the amount of pollution coming from any one residential property can be small and may seem insignificant on its own, the combined effect of many small amounts can be serious. Current urban development practices have been shown to significantly impact lakes and rivers when impervious surfaces within a watershed cover as little as 10% of the watershed (Schueler, T., 1994).

For more information about managing urban runoff:

<https://www.pca.state.mn.us/water/stormwater-best-management-practices-manual>

### **Chloride management**

Chloride occurs naturally in lakes and streams and is essential for aquatic life to carry out a range of biological functions. However, high concentrations of chloride harms aquatic life by disrupting cellular processes. If elevated concentrations of chloride persist in the water, aquatic life such as fish,

invertebrates, and even some plant species become stressed and/or die. Increased chloride concentrations due to salt applied to paved surfaces in winter can also have indirect effects on biota. Additives and contaminants such as phosphorus, cyanide containing compounds, copper, and zinc may cause additional stress or accumulate to a potentially toxic level.

Once chloride is in water, the only known technology for its removal is reverse osmosis through large and expensive filtration plants, which is not economically feasible in most cases. This means that chloride will continue to accumulate in the environment over time. Consequently, preventing chloride from reaching lakes may be a smart management strategy while we determine long-term impacts.

Prioritization of efforts to reduce chloride can be based on current water quality conditions. Many waters are considered to be at high risk, but do not exceed the standard at this time. For the protection of surface and groundwater, implementation of chloride management plans is encouraged statewide.

For the Twin Cities Metropolitan Area Chloride Management Plan:  
<https://www.pca.state.mn.us/sites/default/files/wq-iw11-06ff.pdf>

For a general factsheet on the impacts of chloride on water and what can be about it:  
<https://www.pca.state.mn.us/sites/default/files/wq-iw11-06gg.pdf>

### **The Minnesota Nutrient Reduction Strategy**

Nutrient impacts are widespread. This strategy guides water managers in reducing excess nutrients (nitrogen and phosphorus) in waters so that in-state and downstream water quality goals are met.  
<https://www.pca.state.mn.us/water/nutrient-reduction-strategy>

## **D. Protecting lakes from point sources of pollution**

Point sources of pollution are associated with the water used for domestic, commercial and industrial purposes. The EPA defines a point source as “any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack.” Factories, large-scale stormwater conveyance systems and sewage treatment plants are the most common point sources of water pollution.

Treated wastewater and large-scale stormwater systems can represent significant sources of phosphorus loadings to lakes. Wastewater treatment facilities can also contribute contaminants of emerging concern (such as pharmaceuticals, personal care products) to high quality lakes. While there is limited data available on the impact of these chemicals, efforts could be made locally to collect unused pharmaceuticals and other toxic chemicals as an important preventive effort.

### **Wastewater treatment facilities**

Wastewater treatment is required under the Clean Water Act to remove waste from municipal facilities that treat sewage from cities, residential developments, schools, etc. and from industrial wastewater resulting from industrial processes. Discharges from wastewater treatment facilities usually contain nutrients. Phosphorus discharged from wastewater facilities is often the major concern when it comes to lake protection efforts. Determine if your watershed has a wastewater treatment facility present and if its phosphorus loading is significant.

If there is a permitted wastewater treatment facility (WWTF) discharging significant phosphorus loads to the lake, work with MPCA staff to reduce phosphorus loadings to the lake. Through the water quality permitting process, the MPCA makes sure that new or expanding wastewater treatment facilities do not degrade high quality lakes through its application of anti-degradation rules. If a TMDL is currently under

development, proposals for a new or expanded wastewater discharge containing phosphorus must preserve existing water quality.

In an effort to protect pristine lakes or those lakes that are near the standard for phosphorus, discourage the discharge of treated wastewater to them. Whenever possible, route discharges to nearby streams or rivers. This is especially important due to the sensitivity of lakes to phosphorus inputs. Lakes that have no outlet can be sinks for pollutants, including phosphorus. This can cause the perpetual recycling of nutrients that can become a serious challenge to lake protection efforts.

#### ***Pre-TMDL Phosphorus Trading by WWTFs***

There may be cases where WWTFs (new or existing) discharging to or upstream of high quality lakes may have problems meeting proposed phosphorus effluent limitations. In these cases, phosphorus trading with another phosphorus source can make sense.

To be protective of the environment, fulfill the requirements of the Clean Water Act, and meet the needs of communities, the MPCA developed Pre-TMDL Phosphorus Trading (PTPT). PTPT allows new and expanding wastewater treatment facilities to receive a discharge permit prior to completion of an applicable phosphorus-related TMDL. Through PTPT, a new or expanding facility may increase its phosphorus discharge by purchasing phosphorus reduction from another source. The MPCA documents the transfer of nutrient load, or trade, through the National Pollutant Discharge Elimination System (NPDES) permitting process. Only facilities with effluent phosphorus limits in their existing NPDES permit may sell. Permittees willing to accept a phosphorus limit can choose to be sellers.

New and expanding WWTFs with phosphorus effluent concentrations less than the eutrophication standards (water quality standards) for lakes and reservoirs listed in Minn. R. 7050.0222 will not need to participate in PTPT.

New and expanding facilities that are not able to reduce phosphorus in the discharge to below the phosphorus lakes and reservoirs standard will be allowed to participate in PTPT and can trade phosphorus loading to assure no net increase in the allowable mass of phosphorus discharged upstream of the nutrient impaired water.

If trading partners believe they have a viable option that is protective of downstream waters but differs from those scenarios listed above, the MPCA will review proposals on a case-by-case basis. The MPCA will also consider trades that involve pollutant load reductions made by non-point sources (agricultural operations, stormwater discharges, and other non-point sources), but these situations are not addressed by this PTPT proposal and would require additional review.

For more information on phosphorus trading:

<https://www.pca.state.mn.us/water/pre-tmdl-phosphorus-trading>

#### **Municipal Separate Storm Sewer Systems and stormwater management**

Municipal Separate Storm Sewer Systems (MS4s) are publicly owned or operated infrastructure used solely for stormwater. Examples of stormwater infrastructure include curbs, ditches, culverts, storm sewer pipes, stormwater ponds, and other stormwater treatment facilities. MS4s are not part of or connected to a sanitary sewer or wastewater treatment system.

MS4 general permits are mandated by federal regulations under the Clean Water Act and administered by the MPCA. The MS4 permitting program gives owners or operators of MS4s approval to discharge stormwater to lakes, rivers, streams, and wetlands in Minnesota, but with certain restrictions.

Urban stormwater usually contains excess nutrients, including phosphorus and nitrogen, from leaf litter, lawn clippings, other yard waste, and fertilizers – as well as spilled vehicle fuel and oil, anti/deicing

compounds, bacteria from pets and other sources, metals, and general litter. Polluted stormwater contributes to swimming-beach closures, fish-eating advisories, excess algae growth and poor water clarity in lakes. In addition, urbanized areas have large amounts of impervious surface such as streets, driveways, rooftops, parking lots, and sidewalks. Stormwater runoff from impervious surfaces travels faster and in larger quantities, which results in damage to rivers, streams and wetlands; destruction of aquatic habitats; and elevated pollutant levels reaching surface waters. Impervious surfaces also inhibit infiltration and subsequent groundwater recharge.

Common owners or operators of MS4s include cities, townships, and public institutions. The MS4 General Permit focuses on reducing the pollution that enters these public systems. By state rule, applicability is based on urbanized area as defined by the latest decennial census, population density, and proximity to special receiving waters (e.g., trout streams, Outstanding Resource Value Waters, and impaired waters). The number of regulated MS4s in Minnesota is growing as urban areas expand. As of November 2016, 260 MS4s were regulated for their stormwater discharges under a MS4 permit.

Communities that are not part of the regulatory system designed for larger urban areas can still have stormwater-related pollution problems in local receiving waters. Pollution reduction practices are beneficial in these systems, even though not under regulatory compulsion, as for larger systems.

For more information on MS4 management:

<https://www.pca.state.mn.us/water/municipal-stormwater-ms4>

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# Appendix 1

## A. Considerations when selecting lakes for protection activities (Not in priority order)

Potential Criteria for Selecting Priority Lakes	Source of Criteria
1. MPCA/DNR lakes with highest sensitivity to additional P loading	MPCA
2. Presence of healthy Tulibee population	DNR
3. It is a trout lake	DNR
4. Lake's ability to support swimmable uses	MPCA/MDH
5. It is a wild rice lake	DNR
6. Depth is less than 20 feet (therefore more sensitive to pollutants)* SH	MPCA/DNR
7. Lake size (greater than 100 acres)* SH	DNR
8. Undisturbed riparian areas are under pressure from development	DNR
9. Lake is within Tribal Lands	DNR
10. Lake has public access	
11. HSPF modeling runs are available	MPCA
12. Zonation modeling/maps are completed	DNR
13. Lake has been surveyed by DNR fisheries	DNR
14. Identified as a high value and sensitive water resource	DNR
15. Watershed includes areas of biodiversity and significance	DNR
16. Land use planning has revealed a probability for future land use changes, pressures and risks to the lake	DNR
17. Shoreland and watershed disturbance data is available	DNR
18. Watershed size (small is higher priority)	MPCA/DNR
19. High percent of land in protected status (land in public ownership, permanent easements, lakes, rivers, wetlands, etc.)	DNR, BWSR, TNC
20. Level of stakeholder/citizen interest and capacity is high	MPCA/DNR/BWSR
21. Active lake association present	
22. Recreation and tourism data is available	
23. Minor watershed includes a Drinking Water Supply Management Area	MDH
24. Lake serves as public water supply for drinking water in the watershed	MDH
25. Identified as a priority water in local water plans	BWSR
26. Watershed is part of Parks and Open Space Long Range Plans	DNR
27. Lake has a significant economic contribution to the local government	
28. Aligned with State priorities	NP Priority Plan
29. Cost effective practices are available/can be used	NP Priority Plan
30. Efforts could produce multiple benefits	MDH, Nonpoint Priority Plan
31. Results are measurable	NP Priority Plan
32. Sustainable source of drinking water	MDNR
33. Addresses potential threat to human health concerns in the watershed	MDH

Potential Criteria for Selecting Priority Lakes	Source of Criteria
34. General public has access to lake	DNR
35. Local priorities (TBD) derived through engagement activities	LGUs
36. Impervious surfaces in the subwatershed now at < 10%	DNR
37. Large percentage of watershed is owned by the state or is tax-forfeited land	
38. 75% of the land in the subwatershed is in protected status	BWSR/DNR
39. Residents have previously been willing to implement protection BMPs	N/A
40. Lake provides significant economic benefit through tourism dollars	N/A
41. Cultural values are high	N/A
42. Spiritual values high	N/A
43. Lakes have critical importance to the Forest Service	USFS

## B. Best practices for lake protection

(Note: These best practices are compiled from various government sources. There are many other sources of best practices available from non-profit organizations, universities, etc.)

Protection Best Practices	Agency with Rules, Authority Oversight	Internet Link to More Information
<b>Land Conservation</b>		
Perennial buffers	BWSR	<a href="http://www.dnr.state.mn.us/buffers/index.html">http://www.dnr.state.mn.us/buffers/index.html</a>
Improved soil health	NRCS	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/">https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/</a>
Residue management	NRCS	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/energy/conservation/?cid=nrcs143_023637">https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/energy/conservation/?cid=nrcs143_023637</a>
Conservation Tillage	MDA/NRCS	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/constillage.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/constillage.aspx</a>
Conservation drainage	BWSR/AG/USDA	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/consdrainage.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/consdrainage.aspx</a>
Nutrient management	BWSR/MDA/USDA	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/nutrientmgmt.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/nutrientmgmt.aspx</a>
Forage and biomass planting	NRCS	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/cp/tsp/?cid=nrcs142p2_023536">https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/cp/tsp/?cid=nrcs142p2_023536</a>
Cropland Grazing Exchange	MDA	<a href="https://www.mda.state.mn.us/cge">https://www.mda.state.mn.us/cge</a>
Vegetation management in shorelines	DNR	<a href="http://dnr.state.mn.us/lakescaping/index.html">http://dnr.state.mn.us/lakescaping/index.html</a>
Conservation easements	BWSR/USDA	<a href="http://www.bwsr.state.mn.us/easements/">http://www.bwsr.state.mn.us/easements/</a>
<b>Wild Rice Easements</b>	<b>County SWCDs</b>	
Conservation Reserve Program	USDA Farm Service Agency	<a href="https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-enhancement/index">https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-enhancement/index</a>
Fee title acquisition	DNR	<a href="http://www.dnr.state.mn.us/lands_minerals/acquisitions.html">http://www.dnr.state.mn.us/lands_minerals/acquisitions.html</a>
Bank stabilization	BWSR/DNR?	<a href="http://files.dnr.state.mn.us/publications/waters/understanding_our_streams_and_rivers_resource_sheet_2.pdf">http://files.dnr.state.mn.us/publications/waters/understanding_our_streams_and_rivers_resource_sheet_2.pdf</a>
Wetland protection and restoration	BWSR/Local Governments	<a href="http://www.bwsr.state.mn.us/wetlands/">http://www.bwsr.state.mn.us/wetlands/</a>
Shoreland protection	DNR	<a href="http://shorelandmanagement.org/depth/bmp.pdf">http://shorelandmanagement.org/depth/bmp.pdf</a>
Shoreland buffer strips	DNR	<a href="http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html">http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html</a>
Shoreland development rules	DNR	<a href="http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html">http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html</a>
Dam and culvert assessment	DNR/local government	<a href="http://www.dnr.state.mn.us/whaf/about/scores/connectivity/aquatic_conn.html">http://www.dnr.state.mn.us/whaf/about/scores/connectivity/aquatic_conn.html</a>

Protection Best Practices	Agency with Rules, Authority Oversight	Internet Link to More Information
Aquatic invasive plant management	DNR	<a href="http://www.dnr.state.mn.us/invasives/eco/aquatic_plants.html">http://www.dnr.state.mn.us/invasives/eco/aquatic_plants.html</a>
Buffer Law	BWSR/DNR	<a href="http://www.bwsr.state.mn.us/buffers/">http://www.bwsr.state.mn.us/buffers/</a>
Shoreline BMPs for public water access sites	DNR	<a href="http://www.dnr.state.mn.us/water_access/bmp/index.html">http://www.dnr.state.mn.us/water_access/bmp/index.html</a>
Chloride/road salt management	MPCA/local government	<a href="https://www.pca.state.mn.us/water/road-salt-and-water-quality">https://www.pca.state.mn.us/water/road-salt-and-water-quality</a>
Infiltration basins	Local government	<a href="http://stormwater.pca.state.mn.us/index.php/Infiltration_basin">http://stormwater.pca.state.mn.us/index.php/Infiltration_basin</a>
Pervious pavements	Local government	<a href="http://stormwater.pca.state.mn.us/index.php/Permeable_pavement">http://stormwater.pca.state.mn.us/index.php/Permeable_pavement</a>
Grazing lands conservation	NRCS	<a href="https://www.mda.state.mn.us/~media/Files/protecting/conservation/glcabrochure.ashx">https://www.mda.state.mn.us/~media/Files/protecting/conservation/glcabrochure.ashx</a>
Lawn and turf management	MN Extension	<a href="http://www.extension.umn.edu/garden/turfgrass/">http://www.extension.umn.edu/garden/turfgrass/</a>
Rain barrels/rain gardens	Local governments	<a href="http://stormwater.pca.state.mn.us/index.php/Stormwater_re-use_and_rainwater_harvesting">http://stormwater.pca.state.mn.us/index.php/Stormwater_re-use_and_rainwater_harvesting</a>
Perennial cover crops	MDA/Midwest Cover Crop Council	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/covercrops.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/covercrops.aspx</a>
<b>Local land use</b>	<b>Local governments</b>	
Establish Aquatic Preserves	None to date	<a href="http://www.dep.state.fl.us/coastal/programs/aquatic.htm">http://www.dep.state.fl.us/coastal/programs/aquatic.htm</a>
SSTS setbacks		<a href="https://www.pca.state.mn.us/sites/default/files/wq-wwists4-47.pdf">https://www.pca.state.mn.us/sites/default/files/wq-wwists4-47.pdf</a>
Restrict % of impervious surfaces		<a href="http://www.dnr.state.mn.us/water_access/bmp/stormwater_mids.html">http://www.dnr.state.mn.us/water_access/bmp/stormwater_mids.html</a>
Set minimum lot sizes		<a href="https://www.pca.state.mn.us/water/improving-water-quality">https://www.pca.state.mn.us/water/improving-water-quality</a>
Road maintenance		<a href="http://www.dep.state.fl.us/coastal/programs/aquatic.htm">http://www.dep.state.fl.us/coastal/programs/aquatic.htm</a>
Stormwater Ordinances	MPCA/local governments	<a href="https://www.pca.state.mn.us/sites/default/files/wq-strm2-16a.pdf">https://www.pca.state.mn.us/sites/default/files/wq-strm2-16a.pdf</a>
<b>Hydrology Management</b>		
Culvert Inventory		<a href="http://www.dnr.state.mn.us/whaf/about/scores/connectivity/aquatic_conn.html">http://www.dnr.state.mn.us/whaf/about/scores/connectivity/aquatic_conn.html</a>
<b>Regulatory Strategies</b>		
NPDES Stormwater controls	MPCA/local governments	<a href="https://www.pca.state.mn.us/water/minnesotas-stormwater-manual">https://www.pca.state.mn.us/water/minnesotas-stormwater-manual</a>
No Wake Zones	Local government	<a href="http://www.dnr.state.mn.us/safety/boatwater/nowake/index.html">http://www.dnr.state.mn.us/safety/boatwater/nowake/index.html</a>
Municipal sewage sludge management	MPCA	<a href="https://www.pca.state.mn.us/water/wastewater">https://www.pca.state.mn.us/water/wastewater</a>
SSTS technical assistance	MPCA/Local Governments	<a href="https://www.pca.state.mn.us/water/ssts-staff">https://www.pca.state.mn.us/water/ssts-staff</a>

Protection Best Practices	Agency with Rules, Authority Oversight	Internet Link to More Information
Feedlot/livestock BMPs (open lot inspections, reduce/eliminate late winter/early spring manure applications, manure management plans, livestock exclusion)	MPCA/Delegated Counties	<a href="https://www.pca.state.mn.us/quick-links/feedlot-program">https://www.pca.state.mn.us/quick-links/feedlot-program</a>
MN Buffer Law	BWSR/DNR	<a href="http://www.bwsr.state.mn.us/buffers/">http://www.bwsr.state.mn.us/buffers/</a>
<b>Forest Management</b>		<a href="http://mn.gov/frc/docs/Site-level_monitoring_2014-2015_Monitoring_Report_Final.pdf">http://mn.gov/frc/docs/Site-level_monitoring_2014-2015_Monitoring_Report_Final.pdf</a>
Private Forestry Management Plans	DNR	<a href="http://www.dnr.state.mn.us/foreststewardship/index.html">http://www.dnr.state.mn.us/foreststewardship/index.html</a>
Permanent land conservation (fee title or conservation easements)	DNR/BWSR	<a href="http://www.house.leg.state.mn.us/hrd/pubs/conease.pdf">http://www.house.leg.state.mn.us/hrd/pubs/conease.pdf</a>
Forestry BMPs operational effectiveness assessments	DNR	<a href="http://stateforesters.org/sites/default/files/issues-and-policies-document-attachments/Literature%20Review%20published%20in%20Forest%20Ecology%20and%20Management.pdf">http://stateforesters.org/sites/default/files/issues-and-policies-document-attachments/Literature%20Review%20published%20in%20Forest%20Ecology%20and%20Management.pdf</a>
Sustainable harvesting practices	DNR	<a href="http://mn.gov/frc/documents/council/site-level/MFRC_FMG&amp;Biomass_2007-12-17.pdf">http://mn.gov/frc/documents/council/site-level/MFRC_FMG&amp;Biomass_2007-12-17.pdf</a>
Selective harvesting to protect old growth forests		<a href="http://www.dnr.state.mn.us/forests_types/oldgrowth/index.html">http://www.dnr.state.mn.us/forests_types/oldgrowth/index.html</a>
Reforestation practices	DNR	<a href="http://www.dnr.state.mn.us/woodlands/cost-share.html">http://www.dnr.state.mn.us/woodlands/cost-share.html</a>
Water Diversion and Erosion Control	DNR	<a href="https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices_-_Diversion_barrier_controls_(cofferdams/temporary_dikes)">https://stormwater.pca.state.mn.us/index.php?title=Sediment_control_practices_-_Diversion_barrier_controls_(cofferdams/temporary_dikes)</a>
<b>Mining Regulations</b>		
Erosion BMPS	EPA	<a href="https://www3.epa.gov/npdes/pubs/sector_j_mineralmining.pdf">https://www3.epa.gov/npdes/pubs/sector_j_mineralmining.pdf</a>
Best Practices to Protect Drinking Water from Gravel and Aggregate Mining	MDH	<a href="http://www.health.state.mn.us/divs/eh/water/swp/resources/mining.pdf">http://www.health.state.mn.us/divs/eh/water/swp/resources/mining.pdf</a>
<b>Industrial</b>		
On-site stormwater management	MPCA	<a href="https://www.pca.state.mn.us/sites/default/files/wg-strm3-26.pdf">https://www.pca.state.mn.us/sites/default/files/wg-strm3-26.pdf</a>
<b>Economic</b>		
Property tax credit	Local Governments	
Property tax reduction	" "	

Protection Best Practices	Agency with Rules, Authority Oversight	Internet Link to More Information
<b>Civic</b>		
Build civic capacity to problem-solve collaboratively and address potential sources of pollution	U of M	<a href="http://www.extension.umn.edu/community/civic-engagement/">http://www.extension.umn.edu/community/civic-engagement/</a>
Civic Governance approach to building local capacity	Minnesota Active Citizenship Initiative	<a href="http://activecitizen.org/">http://activecitizen.org/</a>
<b>Groundwater Management</b>	<b>MDH</b>	<a href="http://www.health.state.mn.us/divs/eh/groundwater/background.html">http://www.health.state.mn.us/divs/eh/groundwater/background.html</a>
Irrigation management	MDA/ MN Extension	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/irrigation.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/irrigation.aspx</a>
Capping abandoned wells	MDH	<a href="http://www.health.state.mn.us/divs/eh/wells/sealing/abandwel.html">http://www.health.state.mn.us/divs/eh/wells/sealing/abandwel.html</a>
Private well testing	MDH	<a href="http://www.health.state.mn.us/divs/eh/wells/waterquality/">http://www.health.state.mn.us/divs/eh/wells/waterquality/</a>
Wellhead protection areas - stormwater	MDH/MPCA	<a href="https://stormwater.pca.state.mn.us/index.php/Stormwater_and_wellhead_protection">https://stormwater.pca.state.mn.us/index.php/Stormwater_and_wellhead_protection</a>
Source water protection plans	MDH	<a href="http://www.health.state.mn.us/divs/eh/water/swp/">http://www.health.state.mn.us/divs/eh/water/swp/</a>
Nutrient management	NRCS/MDA	<a href="http://www.mda.state.mn.us/protecting/conservation/practices/nutrientmgmt.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/nutrientmgmt.aspx</a>
Row crop to perennial cover	University of MN/Extension Service	<a href="https://www.forevergreen.umn.edu/crops-systems">https://www.forevergreen.umn.edu/crops-systems</a>
Cover crops	NRCS/MDA	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/?cid=nrcs142p2_023671">https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/?cid=nrcs142p2_023671</a>
Soil health	NRCS	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/main/mn/soils/health/">https://www.nrcs.usda.gov/wps/portal/nrcs/main/mn/soils/health/</a>
Conservation Reserve Program	NRCS/FSA	<a href="http://www.mda.state.mn.us/protecting/conservation/programs/ccrp.aspx">http://www.mda.state.mn.us/protecting/conservation/programs/ccrp.aspx</a>
Feedlot and livestock BMPS	NRCS/MDA	<a href="http://www.mda.state.mn.us/animals/feedlots/feedlot-info.aspx">http://www.mda.state.mn.us/animals/feedlots/feedlot-info.aspx</a>
Forage and biomass plantings	NRCS/MDA	<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/cp/tsp/?cid=nrcs142p2_023536">https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/cp/tsp/?cid=nrcs142p2_023536</a>
Permanent land cover	NRCS/MDA	<a href="http://files.dnr.state.mn.us/assistance/landprot.pdf">http://files.dnr.state.mn.us/assistance/landprot.pdf</a>
Grazing management	NRCS/MDA	<a href="https://www.mda.state.mn.us/news/publications/animals/livestockproduction/grazing.pdf">https://www.mda.state.mn.us/news/publications/animals/livestockproduction/grazing.pdf</a>
Permanent Easements	BWSR	
Mining management	MDH	
<b>Hydrology Management</b>		
Saturated buffer		<a href="http://www.saturatedbufferstrips.com/images/final_report.pdf">http://www.saturatedbufferstrips.com/images/final_report.pdf</a>
Culvert review in subwatershed		<a href="http://cues.cfans.umn.edu/old/extpubs/5726turf/DG5726.html">http://cues.cfans.umn.edu/old/extpubs/5726turf/DG5726.html</a>
Culvert Sizing/Road retention/culvert downsizing		<a href="http://files.dnr.state.mn.us/waters/publications/stream-crossing-guidelines.pdf">http://files.dnr.state.mn.us/waters/publications/stream-crossing-guidelines.pdf</a>

Protection Best Practices	Agency with Rules, Authority Oversight	Internet Link to More Information
Constructed wetland		<a href="http://www.mda.state.mn.us/protecting/conservation/practices/wetlandconst.aspx">http://www.mda.state.mn.us/protecting/conservation/practices/wetlandconst.aspx</a>
Wetland restoration		<a href="http://www.bwsr.state.mn.us/wetlands/">http://www.bwsr.state.mn.us/wetlands/</a>
Improve soil health		<a href="https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/">https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/</a>
Row crop to perennial cover		<a href="http://www.forevergreen.umn.edu/crops-systems">http://www.forevergreen.umn.edu/crops-systems</a>
Cover crops		<a href="http://www.forevergreen.umn.edu/crops-systems">http://www.forevergreen.umn.edu/crops-systems</a>
Two stage ditches		<a href="http://www.bwsr.state.mn.us/drainage/cons_drainage_MAWD_2009.pdf">http://www.bwsr.state.mn.us/drainage/cons_drainage_MAWD_2009.pdf</a>
Controlled subsurface drainage		<a href="http://www.bwsr.state.mn.us/drainage/BTSAC_FINAL_Breifing_Paper_2_4-5-2012.pdf">http://www.bwsr.state.mn.us/drainage/BTSAC_FINAL_Breifing_Paper_2_4-5-2012.pdf</a>
Alternative tile intakes		<a href="http://www.bwsr.state.mn.us/outreach/eLINK/Guidance/Practices.pdf">http://www.bwsr.state.mn.us/outreach/eLINK/Guidance/Practices.pdf</a>
Bioreactors for filtering runoff		<a href="http://www.mda.state.mn.us/protecting/cleanwaterfund/research/woodchipbioreactors.aspx">http://www.mda.state.mn.us/protecting/cleanwaterfund/research/woodchipbioreactors.aspx</a>
Dam removal	DNR	<a href="http://www.dnr.state.mn.us/eco/streamhab/reconnecting_rivers.html">http://www.dnr.state.mn.us/eco/streamhab/reconnecting_rivers.html</a>
<b>In-Lake Management</b>		
Fisheries management		<a href="http://www.dnr.state.mn.us/fisheries/index.html">http://www.dnr.state.mn.us/fisheries/index.html</a>
Aquatic plant management		<a href="http://www.dnr.state.mn.us/fisheries/index.html">http://www.dnr.state.mn.us/fisheries/index.html</a>
<b>Other Categories</b>		
Education and Outreach – what is a watershed, etc.		<a href="https://www.epa.gov/watershedacademy/online-training-watershed-management#community">https://www.epa.gov/watershedacademy/online-training-watershed-management#community</a>