Minnesota's Impaired Waters – A Legislative Report, March 2003

APPENDICES

The following appendices to the impaired waters report can be found on the MPCA's Website at http://www.pca.state.mn.us/water/tmdl.html and click on "publications".

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Appendix A: Excerpt from Legislative Auditor's Report

The following is excerpted *verbatim* from the Legislative Auditor's report "Minnesota Pollution Control Agency Funding", Jan. 2002, pp. 40-44.

Water quality management

Congress passed the federal Clean Water Act in 1972 to "restore and maintain the chemical, physical and biological integrity" of the nation's water resources. The best long-term data on the condition of Minnesota streams comes from measurement of six key pollutants at 80 stream locations over a 40-year period, according to MPCA. These data show reductions at a majority of sites in fecal coliform, ammonia, phosphorus, and biochemical oxygen demand. A majority of sites show no change in total suspended solids, and a majority of sites show increases in nitrogen levels.[2]

The condition of individual lakes, rivers, and streams is important because of federal requirements for "total maximum daily loads," also known as TMDLs. A TMDL establishes the amount of pollution that a water body can receive and still meet water quality standards for its designated uses (such as drinking, fishing, swimming, irrigation, or industrial purposes). Calculation of a TMDL is based on pollutant "loads" from point source and nonpoint source discharges, as well as a margin of safety. Federal law requires states to develop a list of "impaired" water bodies, and states are expected to develop a TMDL for each relevant pollutant in each water body on the list. Although the federal Clean Water Act has had TMDL requirements for decades, little action occurred to enforce these requirements until environmental groups filed lawsuits in recent years against the federal government and various states.

In 1998, MPCA identified impairments on about 140 rivers, streams, or lakes in Minnesota (or portions of these). Agency staff told us that the agency's draft of the latest list of impaired waters would more than double the 1998 number. According to federal regulations, states have 13 years from the initial listing date (starting in 1998) to develop TMDLs for each impaired water body. So far, MPCA has not completed any TMDLs, and federal officials told us that Minnesota's TMDL program is off to a slower start than most other states' programs. Federal data indicate that more than 3,900 TMDLs have been approved in recent years by the U.S. Environmental Protection Agency (EPA).[3] MPCA intended to complete several TMDLs during 2001, but it did not do so. Minnesota is now the only state in EPA Region 5 without an approved TMDL. MPCA had contracts for studies of 23 TMDLs as of October 2001, and MPCA staff told us that they expect Minnesota's first TMDL to be completed in 2002.

MPCA officials told us that TMDL development will require significantly more water quality monitoring than Minnesota presently does. In 1995, the Blue Ribbon Task Force on Water Quality Funding said that Minnesota "has one of the most inadequate ambient monitoring programs in the nation, due to a lack of monitoring stations," noting that only 4 percent of Minnesota's river and stream mileage was monitored.[4] The task force recommended that the Legislature accelerate the purchase of monitoring stations outlined in MPCA's 10-year water quality monitoring plan. Since that report was issued, there have been some improvements in Minnesota's water monitoring network, but the percentage of water bodies monitored has not increased significantly. In 1998, 5 percent of Minnesota's river and stream mileage and 57 percent of its lake acreage were monitored.[5] In response to a survey for a federal study, MPCA reported that Minnesota had less than half the data it needed to assess whether all state waters were meeting water quality standards.[6] According to MPCA, it takes several years of monitoring data to develop a TMDL for a water body—for instance, to look at changes in pollution impacts as water levels vary over the years. A rough estimate by MPCA indicated that it would cost $5 million a year for five years to implement a "relatively complete assessment" of the state's surface waters.[7] MPCA expects to complete a more thorough estimate by June 1, 2002.

EPA's "preliminary estimate" is that improved water quality monitoring to support TMDL development may cost $17 million per year nationally In addition, EPA estimates that it may cost $69 million annually to develop TMDL cleanup plans.[8] However, MPCA's resource needs for TMDL implementation are unclear at this time, partly because federal and state rules have not been completed. First, the status of EPA's TMDL rules is uncertain. EPA published final revisions to its TMDL rules in July 2000. Initially, however, Congress prohibited EPA from implementing the new rules, due to concerns about their costs, rigidity, and scientific basis. In August 2001, EPA announced that it would delay the effective date of the revisions for 18 months, seeking further public input in the meantime. A study mandated by Congress recently recommended that EPA consider many changes in the TMDL program to improve its scientific basis and cost-effectiveness.[9]

Second, MPCA is in the midst of a rule-making process that will result in criteria for designating waters as impaired.[10] MPCA has a draft of these criteria, and it expects to issue rules in October 2002. Third, MPCA officials predict that Minnesota's list of impaired waters (and, thus, its number of TMDLs) will grow to many times its present size as the state increases its level of monitoring. The 1998 list of impaired waters was based on the limited number of water bodies for which adequate monitoring data had already been collected. For instance, the 1998 list included only 11 lakes.[11]

Fourth, MPCA hopes to develop some TMDLs on a watershed basis, rather than developing a separate TMDL for each impaired water body. A regional approach might be a more efficient use of staff time, although it is unclear exactly how many TMDLs could be prepared in this way. MPCA has been working for several years with communities throughout the state to develop watershed plans.[12]

Fifth, MPCA still needs to identify specific strategies for addressing impaired waters. This may be particularly challenging in the case of nonpoint source pollution, for which MPCA and other states have relied mostly on voluntary actions.[13] In 2000, MPCA determined that nonpoint sources were the main cause of impairment for 88 percent of the river miles deemed impaired in their ability to support aquatic life.[14] Recently, an MPCA staff report said that the agency's water programs lacked coherence, limiting MPCA's ability to respond effectively to nonpoint source pollution problems.[15]

Finally, it is unclear exactly how much TMDL work can be done with existing MPCA staff and resources. As of early 2001, MPCA had at least 100 staff working on activities that were in some way connected to nonpoint source pollution activities, as shown in Table 3.1. Most of these staff were funded by the state's General Fund or federal sources. MPCA officials estimated that the number of full-time-equivalent staff working on TMDL issues increased to about 12 during 2001, up from the 6.9 staff shown in the table. Overall, as a recent federal report concluded, "states will need additional tools, resources, and assistance in developing TMDLs for their waters—a task that will significantly tax already limited resources over a sustained period of time."[16] The TMDL program has considerable potential to provide a comprehensive, overarching approach to water pollution control, but many details about its implementation remain unclear. MPCA staff told us that they presently do not have a sound basis for estimating future TMDL resource needs. We think that MPCA should provide the Legislature with more information about its TMDL plans to facilitate future discussions about funding needs and compliance with federal requirements.

Table 3.1 MPCA Staff Activities that Address Nonpoint-Source Water Pollution, January 2001

		Percentage of Staffing Costs Paid by:				
Activity	Total FTEs[a]	General Fund	Federal Sources	Environmental Fund	Other Sources	Total
TMDLs	6.9	36	64	0	0	100
Clean Water Partnership	12.1	58	39	3	0	100
Watershed/Basin Planning	26.1	44	41	15	<1	100
Feedlots	24.8	79	18	<1	3	100
Septic Tanks	7.4	45	26	29	0	100
Minnesota River	3.1	70	30	0	0	100
Lake Assessment	7.3	53	34	12	1	100
Storm water	10.4	28	33	39	<1	100
Wetlands	2.2	45	48	7	0	100
Other Nonpoint Source	16.2	39	57	4	0	100

NOTE: The funding columns represent the percentage of FTEs, not total expenditures or personnel expenditure, funded by the various funds.

[a]For some activities, only a portion of the total FTE are involved with nonpoint source pollution. The FTE data do not reflect changes made during the 2001 legislative session.

SOURCE: Office of the Legislative Auditor analysis of MPCA data.

Recommendation

MPCA should provide the 2003 Legislature with a multi-year TMDL implementation and financing plan, outlining 1) what mix of existing and new resources would be needed to meet federal requirements, 2) specific strategies the agency will use to assess water quality statewide, and 3) the types of strategies the agency will likely pursue to clean up impaired waters.

[Footnotes]

2 MPCA, *Minnesota Environment 2000*, www.pca.state.mn.us/about/pubs/mnereport/part_3.pdf; accessed October 18, 2001. Some streams that have improved may still have pollution levels in excess of standards designed to protect human health, aquatic life, and wildlife. Unfortunately, it is not possible to make reliable comparisons of water quality across states—see U.S. General Accounting Office, *Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data* (Washington, D.C., March 2000), 5.

3 EPA, *National 1998 Section 303(d) List Fact Sheet*, http://oaspub.epa.gov/waters/national_rept.control?p_cycle=1998; accessed December 12, 2001.

4 Report of the Blue Ribbon Task Force on Funding Minnesota's Water Quality Programs: Findings and Recommendations (St. Paul, December 1995), 31-32.

5 This includes water bodies monitored for aquatic life, recreational use, or both. A substantial share of the monitored waters do not meet state standards. For instance, MPCA determined that 65 percent of the lakes and 68 percent of the rivers monitored in 1998 met state water quality standards for recreational uses. The monitored rivers and lakes are not necessarily representative of all rivers and lakes in the state, so the overall quality of Minnesota's surface water cannot be determined from existing data.

6 The survey was conducted by the U.S. General Accounting Office for its report titled *Water Quality: Key EPA and State Decisions Limited by Inconsistent and Incomplete Data*.

7 MPCA, "Revised Preliminary Cost Estimates for a Complete Assessment of Surface Waters of the State" (St. Paul, January 30, 2001). The estimate was based on increasing the number of river biomonitoring sites from 100 presently to 400 and increasing the number of lake monitoring sites from 40 presently to 500.

8 U.S. EPA, *The National Costs of the Total Maximum Daily Load Program (Draft Report)* (Washington, D.C., August 3, 2001). MPCA and other states' environmental agencies have expressed concerns that EPA has underestimated TMDL implementation costs.

9 National Research Council, *Assessing the TMDL Approach to Water Quality Management* (Washington, D.C.: National Academy Press, 2001).

10 States are not required to adopt rules on their impairment criteria, but MPCA decided to do this upon the advice of the Minnesota Attorney General.

11 MCPA staff told us that 100 to 300 new water bodies might be added to the list of impaired waters every four years, but this may be difficult to estimate more precisely until federal and state rules are finalized.

12 There are ten watershed basins in Minnesota, and MPCA hopes to develop and revise plans for the watersheds on a five-year cycle. In the first five years of planning, however, only two watershed plans were completed. MPCA hopes to complete the others by mid-2003.

13 One recent assessment of TMDLs said, "The litmus test of the TMDL program's success will be its ability to promote more effective nonpoint controls at the state level." See James Boyd, *The New Face of the Clean Water Act: A Critical Review of the EPA's Proposed TMDL Rules* (Washington, D.C.: Resources for the Future, March 2000), 20.

14 MPCA, "Causes and Summary of Impairment," Summary of data from MPCA's 305 (b) assessment report to EPA, 2000.

15 MPCA Program Delivery Design Team, *Phase I Final Report* (St. Paul, February 26, 2001).

Appendix B: Fact sheet on Clean Water Partnership and Clean Water Act Sec. 319 programs

MPCA financial assistance programs addressing nonpoint-source water pollution

Introduction

The Minnesota Pollution Control Agency (MPCA) administers three important financial assistance programs for watershed management of nonpoint-source water pollution: Clean Water Partnership (CWP) grant and loan programs, and the Clean Water Act Section 319 program. Combined, these programs have provided about $60 million in grants and loans to local units of government and other resource managers for the protection and restoration of waters in Minnesota over the past 13 years. Typically, the amount of money requested from these programs far exceeds the amount available. In the fiscal year 2002 funding cycle, the MPCA received over $16 million in funding requests, but had less than $9 million to award. The MPCA administers all three programs with the assistance of a project coordination team comprised of staff from state, federal and local resource agencies.

Clean Water Partnership grant program

The CWP grant program was created in 1987 to address pollution associated with runoff from agricultural and urban areas. The program provides local governments with resources to protect and improve lakes, streams and ground water. CWP projects begin with a desire by a local unit of government to improve a water resource that has been polluted by land-use-related activities or to protect unpolluted water from pollution. Local leadership and expertise, combined with technical and financial resources from the state, create an effective program for controlling pollution and restoring water quality. CWP funding for local water-quality projects is awarded in two phases:

1. In the first phase of a project – the resource investigation phase – a diagnostic study and implementation plan are completed to determine the sources of pollution to the water body and to develop a plan for addressing them.

2. The second phase – the project implementation phase – involves putting in place the best management practices (BMPs) identified in the first phase. BMPs may include sedimentation ponds, animal-waste management, education, or other methods designed to reduce nonpoint-source pollution.

Grants are available for up to 50 percent of project costs. The grantee must come up with the money to cover the other 50 percent of project costs. As of the fiscal year 2002 funding cycle, the program had about $2.3 million annually to grant to local units of government. Through 14 application cycles, 83 Phase I diagnostic studies and 48 Phase II implementation projects have been funded.

Clean Water Partnership loan program

The CWP loan program focuses on implementing BMPs that are targeted toward the restoration of specific water resources, such as lakes, streams or groundwater aquifers.

CWP implementation activities include upgrading or replacing individual sewage-treatment systems (ISTSs) and fostering beneficial agricultural practices.

The local unit of government can use the funds to implement BMPs itself or it can re-lend the funds to private parties for other types of BMP activities. Loans have a 2 percent interest rate with an average term of 10 years.

Clean Water Act Section 319 nonpoint-source grants

The Section 319 grant program offers funds for nonpoint-source water pollution control implementation projects. The goal of this grant program is to protect and improve the quality of Minnesota's water resources by implementing nonpoint-source pollution control measures that have been identified in the state Nonpoint Source Management Program Plan. The U.S. Environmental Protection Agency (EPA) provides the grant funds for the program.

During the fiscal year 2002 funding cycle, about $3.4 million was available for funding nonpoint-source projects through this program. Through 13 funding cycles, the MPCA has awarded over 25 million in Section 319 funds for nonpoint-source projects. Congress determines funding levels annually and the EPA allocates funds to states and tribes based on an allocation formula. Projects are required to provide 50 percent of the total project cost as nonfederal matching funds.

Projects eligible to compete for available funds are those that address a nonpoint-source pollution issue and offer a means of moving toward resolution of the problem. Planning and program development or diagnostic studies are not eligible. Projects addressing feedlot or storm-water NPDES permit requirements are also not eligible for Section 319 funds.

Appendix C: Land use and impaired waters

Land-use impacts

There's one simple fact behind nonpoint-source pollution: Everything we do on land has the potential to show up in our waters. Therefore the variety of nonpoint sources of water pollution is as wide as the variety of all the things we do on the land. For example:

- It's easy to see the impacts of improperly treated wastewater dumping into a river from a poorly operated urban sewage treatment plant. But the storm water that has just scoured the streets of the same urban area in early spring may contribute many more pollutants to the river in a day than the treatment plant.
- Suburban shopping malls bring jobs and convenience, but the acres of paved parking surrounding them provide no opportunity for rain to filter slowly through the soil and replenish ground water. Instead, storm water runs off to the nearest lake, creek or wetland, carrying with it debris and chemical pollutants from automobiles.
- Cattle wading in a meandering creek might look at first glance like part of a rural ideal. But a closer look reveals stream-bank erosion caused by trampling hooves and water polluted by sediment and animal wastes.
- New construction starts are signs of a thriving economy. But soil, paint, solvents and construction debris too often wash off cleared building sites into nearby waters.
- Lakeshore cabins, a symbol of the good life in Minnesota, can pollute the very lakes they celebrate if septic systems are not properly installed or maintained, or if too much shoreline vegetation is removed or lawn fertilizer applied.

Understanding and restoring impaired waters means we must also understand how these and many more of our everyday land-use practices play a part in nonpoint-source water pollution.

Table 1 on the next page summarizes how land uses (including point source uses like industrial and municipal wastewater treatment plants) contribute to four common pollutants that cause waters to become impaired -- sediment, nutrients, toxic chemicals and fecal bacteria.

Table 1: Land Uses and Pollutants - How Do They Impair our Waters?

Sediment

Origins

- *Urban Runoff*
- *Construction*
- *Agriculture*
- *Mining*
- *Forestry*

Impacts on water quality and associated uses

- Decreased transmission of light through water.
  - Decreases primary productivity (aquatic plants and phytoplankton) upon which other species feed, causing decrease in food supply.
  - Obscures sources of food, habitat, hiding places, nesting sites; interferes with mating activities that rely on sight and delay's reproductive timing.
- Directly affects respiration of aquatic species (e.g. gill abrasion).
- Decreases viability of aquatic life. Decreases survival rates of fish eggs and therefore size of fish population; affects species composition.
- Increases temperature of surface layer of water—increases stratification and reduces oxygen-mixing with lower layers, therefore decreasing oxygen supply for supporting aquatic life.
- Decreases value for recreational and commercial activities.
  - Reduces aesthetic value.
  - Reduces sport and commercial fish populations.
  - Decreases boating and swimming activities.
  - Interferes with navigation.
- Increases water treatment costs.

Nutrients (nitrogen, phosphorus)

Origins

- *Municipal and industrial wastewater treatment plants*
- *Noncompliant septic systems*
- *Agriculture*
- *Animal feedlots*
- *Urban runoff*
- *Construction*
- *Forestry*

Impacts on water quality and associated uses

- Promotes premature aging of lakes (eutrophication).
  - Algal blooms and decay of organic materials create turbid conditions that eliminate submerged aquatic vegetation and destroy habitat and food for aquatic animals and waterfowl.
  - Blooms of toxic algae can affect health of swimmers and aesthetic qualities of water bodies (odor and murkiness).
  - Blooms of toxic algae can cause illness and death in animals and livestock that drink affected water.
  - Favors survival of less desirable fish species.
  - Interferes with boating and fishing.
  - Reduces quality of drinking water supplies.
  - Reduced dissolved-oxygen levels can suffocate fish.
  - Reduces waterfront property values.

Toxic chemicals

Origins

- *Industry*
- *Agriculture*
- *Urban Runoff*
- *Construction*
- *Forestry*
- *Mining*
- *Household Wastewater*

Impacts on water quality and associated uses

- Sublethal effects lower organism's resistance and increase susceptibility to other environmental stresses.
- Can affect reproduction, respiration, growth and development, reduce food supply, or be fatal to aquatic life.
- Some toxic chemicals are carcinogenic, mutagenic, or teratogenic to aquatic life.
- Some toxic chemicals can bioaccumulate in tissues of fish and other aquatic life.
- Reduces commercial/sport fishing and other recreational values.
- Creates health hazard from human consumption of contaminated fish/water.

Fecal bacteria

Origins

- *Animal feedlots*
- *Urban runoff*
- *Non-compliant septicsystems*
- *City sewer bypasses*
- *Agriculture*
- *Wildlife and pets*

Impacts on water quality and associated uses

- Introduces pathogens (disease-bearing organisms) to surface and ground water.
- Reduces recreational uses.
- Increases treatment costs for drinking water.
- Creates a human health hazard.

Appendix D: Impaired waters case studies

The Heron Lake project aims to restore a once-nationally known waterfowl lake in the Des Moines River basin.

Des Moines River watershed

Note: While this case study is a blend of voluntary CWP projects and a required TMDL, it is a good demonstration of how the impaired waters program will work.

Minnesota's portion of the Des Moines watershed includes parts of Lyon, Cottonwood, Murray, Nobles, Jackson, and Martin counties in southwest Minnesota. The 1,246- square-mile watershed includes the communities of Windom, Jackson, Slayton and Worthington, among others. Agriculture is the dominant land use.

The problems

Residents in this watershed depend on the waters of the Des Moines River. For example, the Red Rock Rural Water well field and the well fields for the cities of Jeffers, Jackson, and Windom all draw water from the Des Moines River aquifer. Recreational activities such as canoeing, hunting and fishing are common along parts of the river; fish species include northern pike, buffalo, carp, channel catfish, crappie, and bullhead. Riverfest, a summer festival in Windom, brings visitors to celebrate the river. State and county parks along the river provide these recreational opportunities as well as camping, sledding and tubing.

However, reaches on the Des Moines River do not meet their designated uses of fishing and swimming. Several reaches are impaired for fecal coliform bacteria, turbidity, dissolved oxygen, and ammonia. Ammonia, in addition to affecting fish, can be converted to nitrate if it mixes with oxygenated ground water, which is a human-health concern because the drinking-water well fields are near the river. Although the community water supplies are within the nitrate-nitrogen standard, concentrations are elevated, according to the Minnesota Department of Health.

Pollutants affecting these reaches come from both point and nonpoint sources. Feedlots and septic systems in the watershed are out of compliance. Several wastewater treatment plants on the river do not have phosphorus limits, which affects dissolved oxygen and turbidity. Erosion also contributes to the problems.

Developing solutions

Residents in the Des Moines River watershed were concerned about these water-quality issues and received funding for a Phase I Clean Water Partnership in 2001. The results of this project will also be used by a future TMDL study planned for the watershed. Several organizations are involved in the project including cities, counties, sporting groups and non-profits, in addition to state government. Objectives for the project involve calculating nutrient, sediment and bacteria loads; determining the connection between surface water and drinking water; identifying sources of pollution contributing to the impaired reaches; educating the public; and involving the public in the monitoring and implementation process, among others. Citizens have been interested in the project. From May to September 2001, 15 volunteers monitored 23 sites on 10 streams and rivers in the watershed as part of a citizens stream-monitoring project.

In the near future, the MPCA along with the local partners will move several initiatives ahead in this watershed including 1) the Des Moines River Basin Information Document, 2) the Des Moines River Basin Plan, 3) Clean Water Partnership Phase II implementation, and 4) achieving water-quality standards in the impaired reaches. It will be cost-effective for the MPCA and local government to work the four processes together and complete them simultaneously. Since the Des Moines River is also a contributor to local community water supplies, wellhead protection activities also will be involved. Many strategies for wellhead protection will be similar to those needed to restore impaired waters, such as keeping soil and nutrients on the land and bringing septic systems and feedlots into compliance.

Example restoration strategy for the Des Moines River watershed

1) Clean Water Partnership data are used to prepare for setting goals and strategies in the basin plan.
2) Basin Plan – goals and strategies for meeting water-quality standards for impaired reaches are developed .
3) Clean Water Partnership applies for implementation funding to clean up the impaired reaches.
4) Basin Plan completed, implementation activities occur as part of Clean Water Partnership, wellhead protection plans developed for communities.

What is needed to fix the problem?

The solutions will include education, voluntary BMP adoption, and regulatory strategies. Upgrading feedlots and septic systems along with agricultural BMPs (ag BMPs) will decrease nutrient, bacteria and turbidity levels. Additionally, assigning phosphorus limits to the wastewater treatment facilities and implementing upland erosion and ag BMPs may help to decrease turbidity. Dissolved oxygen and ammonia problems will be solved by working with wastewater treatment facilities.

(See table of needs, next page.)

Des Moines River Budget over five years			
Item	Number	$/unit	Total
Feedlot upgrades	400 feedlots in need of upgrade (40 percent of registered feedlots)	$25,000	$10,000,000
BMPs – upland erosion and ag nutrients	80,000 acres with BMPs	$100/acre/year	$40,000,000
Septic system upgrades	2,000	$7,500	$15,000,000
Wastewater treatment plant upgrades	Windom, Slayton, Jackson, Lakefield	$175,000	$700,000
Education/outreach		$200,000	$200,000
<u>Total</u>			**$65,900,000/5 years**

Vermillion River Watershed

The Vermillion River, located in Dakota County, is considered by many to be one of the Twin Cities' outstanding resource-value waters. A portion of the river is designated as a trout stream, a rarity in a metropolitan area of this size.

The problems

Unfortunately, the Vermillion River is also listed as being impaired for swimming and aquatic-life uses. TMDL studies are underway to address these problems. This is a priority watershed because urban expansion in cities such as Farmington, Lakeville, Elko and New Market threatens to further degrade this valuable water resource. The rapid growth in this watershed has prompted a proposed major expansion to the Metropolitan Council's Empire wastewater treatment plant serving the area.

The Vermillion River faces a variety of challenges including runoff from suburban development.

Developing solutions

As part of the MPCA's nondegradation review of this proposed project, the contributing cities were required to have expanded programs to control construction erosion and manage storm water from new development in the watershed. Furthermore, Dakota County and the Metropolitan Council are completing a Vermillion River groundwater study to evaluate stream hydraulics and controls that will be necessary to protect the river's biota, including fish populations. However, much remains to be done.

The Department of Natural Resources (DNR) recently re-evaluated the Vermillion's trout-stream status and expanded the portion classified for trout. The DNR is working with the MPCA, Met Council and other state and local governmental units to provide adequate protection and restoration as necessary to protect the river's trout, but it is widely acknowledged that without additional funding and effort, the river's water quality will continue to be impaired and in all likelihood worsen.

Because of intense interest in preserving the Vermillion's unique qualities, many local, regional and state partners are working hard to facilitate responsible development in the rapidly urbanizing area, as well as to provide needed protection and restoration of the river. An effort to improve and expand riparian[1] conditions along the Vermillion would be coordinated and implemented by a variety of state and local partners.

Example restoration strategy for the Vermillion River Watershed

As will undoubtedly be confirmed through the TMDL study, the best way to address impairments in the Vermillion River will be to increase land buffering, foster increased use of BMPs, and improve wastewater treatment. With new funding, the MPCA will be able to assist landowners adjacent to the river as well as the local, regional and state units of government that are working to protect and improve its riparian conditions, which will ultimately lead to a swimmable river and sustainable trout fishery.

What is needed to fix the problem?

Cleaning up the Vermillion would involve actions in a variety of areas:

- Upgrading feedlots
- Providing education, technical and financial assistance to landowners on the importance of providing natural buffer strips and shading in riparian areas;
- Providing plant materials to improve conditions in riparian areas;
- Acquiring land or conservation easements in riparian areas to prohibit further development and convert land use from active agriculture to buffer strips and natural filtering
- Upgrading failing individual sewage treatment systems.

Vermillion River budget over five years			
Item	Number	$/unit	Total
Feedlot upgrades	150	$25,000	$3,750,000
Plant materials		$50,000	$ 50,000
Conservation easements	3,000 acres	$200/acre/year	$ 3,000,000
Septic system upgrades	130	$7,500	$ 975,000
Education/outreach		$150,000	$ 150,000
Total			**$7,925,000/5 years**

[1] Riparian land is that immediately adjacent to a river or stream. These are often the areas where best management practices can have the most immediate impact.

Crow River watershed

Note: While this case study is a blend of voluntary CWP projects and a required TMDL, it is a good demonstration of how the impaired waters program will work.

The Crow River watershed includes prime central Minnesota farmland and areas of rapid urban development on the western edge of the expanding Twin Cities metropolitan area. Part of the Crow River's North Fork is a state-designated Wild and Scenic River, and much of the river is a designated canoe route. The Crow empties into the Mississippi River upstream of the water intakes for the Minneapolis and St. Paul's drinking-water supplies.

The problems

The watershed of the highly polluted Crow River is the most impaired watershed in the Upper Mississippi River Basin. The problems are urban, suburban and agricultural in nature, and include sediment and turbidity, dissolved oxygen, nutrient enrichment, and bioaccumulative toxics. We do not yet have a complete picture of the magnitude of the effort that will be required for the Crow River, although we can approximate it. The two forks of the Crow River have a total of 28 TMDL listings including mercury, biota, dissolved oxygen, turbidity, and ammonia.

The Crow River is a popular recreational resource even though it is highly polluted by nonpoint sources.

Developing solutions

The Crow River Clean Water Partnership Phase I project is currently engaged in defining the nature and scope of the watershed's impairments. The results of this project will be used in the TMDL study to address the impairments listed above. We know that that future restoration and preservation efforts will be sizable and will involve efforts in both point and nonpoint-source arenas. The effort will be similar to that for the Minnesota River in some respects, with the added factor of moderate to extreme growth and development impacts in the rural-urban interface portions of the watershed.

Since the Phase I Clean Water Partnership diagnostic work has not been completed it is difficult to estimate the scale of the problem or the total cost for restoration and delisting. However, rough estimates are:

Crow River budget over five years			
Item	Number	$/unit	Total
Feedlot upgrades	800	$25,000	$20,000,000
Conservation easements	100,000 acres	$100/acre/year	$50,000,000
Septic system upgrades	600	$7,500	$4,500,000
Education/outreach		$150,000	$ 150,000
Total			**$74,650,000/5 years**

<u>Whitewater River watershed</u>

Southeastern Minnesota is home to unique and magnificent water resources, including numerous trout streams, waterfalls, multiple reaches of designated outstanding resource-value waters, and designated canoe routes. The Whitewater River system in southeastern Minnesota includes a lower main-stem portion and three major tributary streams, called the North, South and Middle Branches (or Forks). The watershed contains significant public assets, including two state parks (one of which, Whitewater, is among the state's most popular), a large wildlife management area, and a cold-water fish hatchery. Some of the watershed’s trout streams are considered among the top 10 trout streams in the nation, supporting healthy, reproducing populations of native brook and brown trout. Recreation based on these waters is a mainstay of the local economy. However, water-quality monitoring by the MPCA shows widespread impairment by fecal coliform bacteria of streams throughout the Lower Mississippi River basin of southeastern Minnesota, with the Whitewater River Watershed being the most bacteria-impaired watershed in the region.

The Whitewater River valley offers unique scenic beauty and recreational opportunities. These opportunities are threatened by widespread stream impairments due to fecal coliform bacteria.

<u>The problems</u>

Fecal coliform bacteria are an indicator of the presence of pathogens in surface water. Levels of fecal coliform bacteria in streams throughout southeastern Minnesota are well above the federal water-quality standard, indicating a potential risk of disease from recreational contact with the water. The level of impairment in this system is approximately two to four times the basin-wide geometric mean.

The MPCA conducted a regional TMDL/impaired waters study for the entire region (see next case study). This study verified that fecal-coliform impairment is widespread and identified its chief causes as failing septic systems, unsewered communities, overgrazing along streams and waterways, and livestock manure runoff from feedlots and fields where manure is surface-applied.

Distribution of the draft regional TMDL study during the public notice period in the summer of 2002 generated many news articles and much discussion about the problem. MPCA staff received phone calls and emails from citizens expressing concern about water quality and wondering what kinds of precautions should be taken to avoid illness from contact with water while recreating. Newspaper editorials urged stepped-up efforts to reduce bacteria levels and increased investment in water resource protection.

Developing solutions

Many groups and individuals have taken action for decades to improve water quality in the Whitewater River watershed. Many landowners have acquired better manure-handling equipment and become involved in soil conservation practices. Both these actions help reduce bacterial pollution. The Whitewater Watershed Project, in conjunction with the National Resource Conservation Service, has been promoting, designing, and installing pollution-preventing BMPs. Specific small-scale efforts have focused on nutrient management planning and planned grazing systems. Despite these actions, the Whitewater continues to show greater impairment from fecal coliform bacteria than other area watersheds. Explanations for this may include a preponderance of pastured livestock with access to streams, steep slopes and high runoff potential; widespread use of box manure spreaders and surface-applied manure; and the possibility that cooler water reduces die-off of fecal bacteria.

In order to achieve necessary reductions in fecal coliform bacteria in the Whitewater, technical assistance from both the public and private sectors will be needed. The basic strategy for cleaning up the Whitewater watershed will be to utilize the existing conservation infrastructure and expand it in a targeted manner. County environmental services staff will lead ISTS upgrading efforts. The full implementation of new feedlot rules by the MPCA and local partners will improve feedlot conditions and manure management practices. Managed grazing and exclusion of livestock from sensitive areas will be emphasized. Educational efforts will be increased for the non-farm component of the watershed. Urbanizing areas in the Rochester-Winona corridor will require special attention so that storm waters and other urban/suburban sources are minimized.

Whitewater River fecal coliform TMDL five-year implementation budget outline			
Item	**Number**	**$/unit**	**Total**
Feedlot upgrades	130	$25,000	$3,250,000
Septic system upgrades	1400	$7,500	$10,500,000
Grazing and manure management assistance	2 FTE	$50,000/year	$500,000
Educational programs for non-farm residents	1 FTE	$50,000/year	$250,000
Five-Year Total*			**$14,500,000**

*Cost only addresses fecal coliform bacteria. Additional costs would be incurred to address turbidity impairments, which are also identified on the 2002 impaired waters list.

Lower Mississippi regional TMDL offers a model for increased efficiency

The MPCA's first regional TMDL combines a number of individual TMDLs for fecal coliform bacteria into one regional study. The Lower Mississippi Regional TMDL, released to the public in August 2002 and approved by EPA in November, covers a 7,266-square-mile area of southeastern Minnesota that drains through a network of 11,000 miles of stream to the Mississippi River.

Most MPCA monitoring sites in the region have recorded regular violations of water-quality standards for fecal coliform bacteria in recent years. Reaches of the Root, Cedar, Zumbro, Cannon, Whitewater, Vermillion and Mississippi rivers are listed on the 303(d) impaired waters list because of fecal coliform. Excessive amounts of fecal bacteria in surface water used for recreation may indicate an increased risk of pathogen-induced illness to humans, including gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases.

The Lower Mississippi regional TMDL aims at reducing fecal coliform bacteria so that affected rivers in the basin may be made safe for body contact.

The Lower Miss TMDL traces these problems to thousands of pollutant sources distributed across the landscape, including failing residential septic systems, urban runoff of pet waste, livestock feedlots, manured fields, pastures and wildlife.

Using a basin management process as a framework, the MPCA combined impairments in 20 individual reaches into one regional TMDL, rather than the usual practice of dealing with each impairment through a separate study.

The report calls for a 65 percent reduction in pollutant loads from these sources, and notes several regional efforts already underway are being directed toward this goal. These projects were developed through a regional coordinating group called the Basin Alliance for the Lower Mississippi in Minnesota and implemented mainly through local government, often with the support of state or federal funding. Current projects address feedlots, pasture management, and septic systems.

This model may offer similar efficiencies for future TMDLs in Minnesota where impairments can be grouped by contaminant and region. (To review the EPA-approved final report on the regional TMDL, go to www.pca.state.mn.us/water/tmdl.html and click on “final TMDLs.”)

Appendix E: Background on the impaired waters process

The impaired waters process

1. **<u>Designate uses for waters of the state and set standards or pollutant limitations to protect those uses.</u>**

The CWA requires the states to adopt water-quality standards to protect the nation's waters. These standards define the maximum amounts of specific pollutants which may be present in a water body for a particular designated use. In order to set standards, the states first assign usage classifications to water resources. These classifications reflect the beneficial uses that the citizens of that state want to make of their waters, including aquatic life (fish and other species and their safe consumption), recreation (swimming), and drinking water. Standards are then set to protect these uses based on EPA criteria. In Minnesota, this step has been completed, as all waters of the state have standards set for them and are classified for specific uses.

<u>2. Collect water-quality data and use it to assess whether water bodies meet the water-quality standards established for their designated uses.</u>

The CWA requires the states to monitor and assess their waters and report on their quality. To determine whether a water body meets its designated uses, the MPCA uses monitoring data to assess its level of "use support." The four levels of use support are:

- Fully supporting
- Partially supporting
- Not supporting
- Not attainable.

Waters assessed as "partially" or "not supporting" are considered impaired. "Fully supporting" waters are non-impaired (i.e., not listed). A designation of "not attainable" is applied to waters that are of limited resource value and are not expected to meet fishable and swimmable goals (Minnesota's "class 7" waters). Impairment status identifies which water bodies need restoring, which are in good shape, and which have been restored to the point they no longer need corrective action.

<u>Current use-support status of Minnesota's waters</u>

Since 1996, the MPCA has used a rotating geographic approach to assess Minnesota's waters, focusing on a few of the state's 10 major drainage basins for each two-year assessment period. In order to determine impairments, the MPCA relies on data collected by its own staff, other state agencies, local governments and volunteers. Minnesota's water resources are vast, and only about five percent of stream miles and 12 percent of lakes have been assessed.

For rivers and streams, assessments are based mostly on the water's ability to support aquatic life (fishable) and allow for safe contact with the water (swimmable). Aquatic life use support is based on data for conventional and toxic pollutants[1] and biological community impairment. Assessments for swimmable use are based on fecal coliform bacteria levels. River and stream assessments in Minnesota are done by river segments or "reaches," generally extending from one tributary to another and typically less than 20 miles long. For lakes, assessments are based primarily on nutrient levels (trophic status) and their effect on the lake's ability to support swimming and aesthetics. For example, excess phosphorus tends to cause nuisance algae blooms which makes lakes less attractive for swimming. Therefore lake assessments are based on summer Secchi transparency, total phosphorus, and chlorophyll-a (an indicator of algal growth). Lake assessments are generally completed for an entire lake.

See Appendix G for more detail about the use-support status of Minnesota's lakes and streams.

3. Develop and gain EPA approval for the list of impaired water bodies.

According to current federal regulations, states, territories, and authorized tribes are required to submit their list of impaired waters in every even-numbered year. Proposed federal regulation revisions, anticipated sometime in the next year or two, are expected to change that to every four years.

In March 2000, EPA waived the requirement for the 2000 list, although some states chose to submit such lists on their own initiative. The MPCA drafted a list, but due to public requests for a rule revision to clarify factors used to determine violation of narrative water-quality standards, the list was not submitted that year. Following this rule change, MPCA's 2002 impaired waters list was submitted for EPA approval in October, 2002 and was approved in January, 2003. It lists 1,774 impairments in hundreds of lakes and rivers statewide and is organized by the state's 10 major drainage basins. More than two-thirds of these listings are for mercury impairments.

States, territories, and authorized tribes must consider "all existing and readily available water quality-related information" when developing their lists. The list must identify for each water body the pollutant that is causing the impairment. Monitored and evaluated data may be used. The methodology must be submitted to EPA at the same time as the list is submitted. At EPA's request, the states, territories, or authorized tribes must provide "good cause" for not including and removing a water body from the list.

The complete 2002 impaired waters list for Minnesota may be viewed on the Web at http://www.pca.state.mn.us/water/tmdl.html.

4. Conduct TMDL studies to evaluate why impaired waters are not meeting standards and set pollutant-reduction goals that will eventually restore them to their designated uses.

Federal law requires that impaired waters be investigated through Total Maximum Daily Load studies. According to federal guidance, a TMDL is the sum of the allocated loads

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[1] Conventional pollutants include excessive nutrients in lakes, fecal coliform bacteria, turbidity, excessive temperature or chlorides, low oxygen, ammonia and biological impairments (loss of fish or invertebrate diversity). Toxic pollutants include persistent bioaccumulative toxins such as mercury and PCBs.

of pollutants set at a level necessary to meet the applicable water-quality standards. A TMDL includes waste-load allocations from point sources, load allocations from nonpoint sources, a margin of safety, and natural background conditions. A TMDL must also consider seasonal variations. TMDLs may be done for any of the potential contaminants that may put a particular lake or stream reach on the impaired waters list. A completed TMDL determines pollutant inputs from all sources causing the violations and sets pollutant-reduction goals. The aim is to identify the amount of pollutant reductions needed from specific sources in order to restore water quality so a lake or stream once again meets it designated uses. (See Appendix F for additional definitions related to the TMDL process.)

Stakeholder involvement and public participation are critical in development of TMDL studies. The process includes opportunities for active public involvement at the junctures of data collection, plan development, data analysis, developing pollutant reduction scenarios, and review of the final report. The MPCA's regional staff is the primary facilitator of this intensive public participation effort.

The CWA also says the states should develop schedules for establishing TMDLs expeditiously. Factors to be considered in developing the schedule could include:

- Number of impaired segments
- Length of river miles, lakes, or other water bodies for which TMDLs are needed
- Proximity of listed waters to each other within a watershed
- Number and relative complexity of the TMDLs
- Number and similarities or differences among the source categories
- Availability of monitoring data or models
- Relative significance of the environmental harm or threat.

According to current EPA regulations, TMDL studies required for the 2002 impaired waters list must be completed by 2015.

Although TMDL requirements have long been part of the CWA, the EPA and states have only recently started to implement these requirements, and the driving force behind implementation has been the success of lawsuits. In order to restore water quality (and comply with federal law), the MPCA has planned 200 TMDL projects covering 413 impairments on the current list that are due to conventional pollutants. The number of TMDL projects will grow based on increased water-quality assessments which will add lakes and rivers or stream segments to the impaired waters list. Depending on the outcome of discussions at the federal level, the remaining 1,300 impairments on the 2002 list, which are caused by toxic pollutants like mercury, may be addressed by an alternative to a state-initiated TMDL.

5. Develop implementation plans for impaired waters that have an EPA-approved TMDL study.

Following the approval of a TMDL study by the EPA, an implementation plan is required to describe how the pollutant reduction goals set in the TMDL will be met. The MPCA is responsible for approving this plan. In general, the plan is only applicable to reductions for nonpoint sources because plans for point source reductions are normally addressed in the TMDL itself.

For example, the TMDL will include recommended waste-load allocations for point sources, effluent limits, upgrades to wastewater treatment technology, alternative treatment options or discharge sites, or other means to reduce pollution. These changes will be implemented through issuance or reissuance of required permits. In addition, a compliance schedule for each point-source discharger may be agreed upon through the TMDL process. Finally, the TMDL must also contain an allocation for future growth of pollution loads anticipated from point sources.

Implementation plans for nonpoint-source reductions are also required in order to qualify for state and federal funding. The plans the MPCA approves must describe information about restoration activities, including:

- Reasonable assurances that load allocations will be achieved, using incentive-based, non-regulatory or regulatory approaches. TMDL implementation may involve individual landowners and public or private enterprises engaged in agriculture, forestry, or urban development. The primary implementation mechanism may include the state, territory, or authorized tribe's nonpoint-source management program coupled with state, local, and federal land-management programs and authorities.
- A schedule for implementing nonpoint-source management measures and the interim measurable milestones (e.g., amount of load reductions, or improvement in biological or habitat parameters) for determining whether nonpoint-source management measures or other control actions are being implemented.
- A description of the follow-up monitoring that will be used to evaluate the effectiveness of implementation efforts as well as the criteria for determining whether the implementation plan or TMDL study needs to be revised.
- A public education and participation process.
- Recognition of other watershed management processes and programs, such as local source-water protection and urban storm-water management programs, as well as the state's section 303(e) continuing planning process.

The MPCA will assist local governments in the preparation of implementation plans, but the ultimate success of these plans will depend on locally driven restoration efforts.

6. Implement restoration or other activities to achieve water-quality standards.

Restoring impaired waters will require a wide range of solutions to address point and nonpoint sources of pollution. As mentioned previously, the MPCA may modify point-source permits to reduce wastewater discharges or require needed infrastructure improvements. Nonpoint sources of pollution will require installation/adoption of best management practices (BMPs) for agricultural or urban runoff problems, upgrades of septic systems, or changes to permits for storm water and feedlot sources.

In general, point sources will make improvements under existing regulatory authorities, while nonpoint sources will do so under existing regulatory authority (for feedlots, storm water or ISTS) or under voluntary programs of education and incentive support for other agricultural or urban sources. Unlike the requirements for TMDL studies, there is no time frame specified in the CWA for completion of restoration activities.

7. Evaluate effectiveness of source-reduction activities through monitoring water-quality trends. If monitoring indicates standards are still not met, modify implementation plans and, if necessary, the TMDL to achieve water-quality standards. If standards are met, delist the impairment.

Following implementation of restoration activities, the MPCA must evaluate whether these activities are improving water quality and will restore water bodies to their designated uses. If the restoration effort was successful, the waters are removed from the impaired waters list.

The effectiveness of point-source reduction measures will be evaluated through the MPCA's routine point-source compliance activities. For example, to meet a TMDL's waste-load allocation requirement, the discharge monitoring reports submitted by affected wastewater treatment facilities will be monitored by the MPCA to ensure any new permit conditions are being met.

The MPCA will also evaluate the effectiveness of nonpoint-source solutions and monitor impaired waters to determine whether they are back in compliance with water-quality standards. There is inherent uncertainty in the effectiveness of BMPs, which is why nonpoint-source load allocations require a margin of safety in TMDLs. Many restoration efforts may take a decade or much longer, not only to implement but to produce measurable results.

If initial restoration measures fail (or interim targets are missed), alternative measures will be evaluated to meet water-quality goals. The implementation plan may need to be modified to specify these new measures. In some cases, follow-up monitoring may show that the pollutant load allocations in the TMDL also must be modified. If this happens, than the modified TMDL must meet the same public participation and other requirements as the initial TMDL and be resubmitted to EPA for approval.

Appendix F: Definitions related to the impaired waters process

Total Maximum Daily Load (TMDL): A TMDL is the sum of the allocated loads of pollutants set at a level necessary to meet applicable water-quality standards. A TMDL includes waste-load allocations from point sources, load allocations from nonpoint sources, a margin of safety, and natural background conditions. A TMDL must also consider seasonal variations. (U.S. Environmental Protection Agency, "Guidance for Water Quality-Based Decisions: The TMDL Process," Office of Water, WH-553, Washington D.C., April 1991).

Margin of Safety (MOS): The MOS accounts for uncertainty about the relationship between pollutant loads and the quality of the receiving water body. The MOS is normally "implicit" – incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models). This is particularly true where the pollution is largely from nonpoint sources. If the MOS needs to be larger than the "implicit" levels, additional MOS can be added explicitly as a separate component of the TMDL. (Source: U.S. Environmental Protection Agency's *Protocol for Developing Pathogen TMDLs, First Edition (January 2001)).*

Load Allocation (LA): The portion of a receiving water's loading capacity that is attributed to nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of loadings, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. (40 CFR 130.2 (g)).

Waste Load Allocation (WLA): The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2 (h)).

Loading Capacity (LC): The greatest amount of loading that a water can receive without violating water-quality standards (40 CFR 130.2 (f)).

Phased Approach: Under the phased approach to TMDL development, LAs and WLAs are calculated using the best available data and information recognizing the need for additional monitoring data to accurately characterize sources and loadings. The phased approach is typically employed when nonpoint sources dominate. It provides for the implementation of load-reduction strategies while collecting additional data (Source: U.S. Environmental Protection Agency's *Protocol for Developing Pathogen TMDLs, First Edition (January 2001)).*

Implementation plans: TMDL implementation plans, per se, are not approved by EPA, and are not required in a TMDL study that is submitted to EPA. (Source: "Review Elements of TMDLs", EPA). However, the MPCA requires that TMDL studies contain general implementation *strategies*. Detailed implementation *plans* are required following EPA's approval of a TMDL study.

Reasonable assurance: EPA guidance calls for reasonable assurances to be submitted as part of the TMDL study when TMDLs are developed for waters impaired by both point and nonpoint sources. In a water body impaired solely by nonpoint sources, reasonable assurances that load reductions will be achieved are not required in order for a TMDL to be approvable. However, for such nonpoint source-only waters, states are strongly encouraged to provide reasonable assurances regarding achievement of load allocations in the implementation plans (described above). For these impairments, such reasonable assurances should be included in implementation plans and may be non-regulatory, regulatory, or incentive-based, consistent with applicable laws and programs (U.S. Environmental Protection Agency, "Review Elements of TMDLs", August 1999).

Appendix G: Background on the water-quality assessment process

This section contains more detail on how the MPCA assesses Minnesota's waters for the "fishable" and "swimmable" goals of the CWA. The assessment process followed to determine use-support and impairments varies slightly based on water body type and designated use (see the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters* for an in-depth explanation of the MPCA's assessment methods or go to the website: http://www.pca.state.mn.us/water/tmdl.html#publications).

Use-support methodology

To understand the needs associated with the listing and de-listing of impaired waters it is important to know how the process works. The assessment of Minnesota's rivers, streams and lakes is tied to the 1972 Clean Water Act (CWA) goals for restoring and protecting America's waters to benefit fish and wildlife, while providing for recreation wherever possible. These goals are commonly referred to as the "swimmable and fishable" goals of the CWA.

The goals of the CWA have been translated into numeric and narrative standards for Minnesota's surface waters. Water-quality standards consist of two parts: beneficial uses for a stream or lake and water-quality criteria to protect and support those uses. Beneficial uses are desirable uses that a water body should support, including domestic consumption, aquatic life, recreation (swimming), agriculture and wildlife, industrial consumption, and aesthetics. Water-quality criteria set acceptable levels for various pollutants, including chemical and physical factors and biological conditions, based upon the beneficial use. This allows the MPCA to determine if a water body is supporting its designated uses by comparing the quality of the water body to the water-quality criteria established for each use.

To determine the level of use support of a water body, the MPCA assesses data related to the designated use in question. Use-support assessments are important tools for managing Minnesota's water resources. These assessments are categorized as one of the following levels:

- Fully supporting
- Partially supporting
- Not supporting
- Not attainable.

A water body assessed as "fully supporting" is considered to be non-impaired, while one assessed as "partially supporting" or "not supporting" is considered impaired. In some cases, a "partially supporting" assessment triggers further analysis of the water body before a determination of impairment (or non-impairment) is made. A designation of "not attainable" is applied to waters that are of limited resource value and are not expected to meet fishable and swimmable goals (Minnesota's "class 7" waters).

The concept of impairment is important in that it identifies which water bodies are in need of restoration efforts, which are in good shape, and which have been restored to a point where they are no longer in need of corrective actions. Every two years, section

303(d) of the CWA requires Minnesota to prepare a list of impaired waters in Minnesota. The MPCA submitted the 2002 final draft list of impaired waters for Minnesota to the U.S. Environmental Protection Agency on Oct 15, 2002 for their review and approval.

The difference between a use-support assessment and a determination of impairment reflects two related elements of the CWA. Section 305(b) requires states to develop a biennial report to Congress that identifies the use-support status of all surface waters statewide. A separate section of the Act – Section 303(d) – requires states to identify and list impaired water bodies for which a plan will be developed to remedy the pollution problem(s). While the two sections are related, in some cases the data requirements for use-support assessments differ from the requirements for identifying/listing impaired water bodies and delisting those water bodies once they have improved.

<u>Current use-support status of Minnesota's waters</u>

Since 1996, the MPCA has used a rotating geographic approach to assess water bodies, focusing on a few of the state's 10 major drainage basins for each two-year assessment period. To complete the lake and stream assessment needed to determine if a resource is impaired, the MPCA relies on data collected by its own staff, other state agencies, local units of government, and citizen volunteers. Despite using all these sources of data, the MPCA currently has assessed only about 5% of the state's stream miles and 12% of the state's lakes.

In general, river and stream assessments are based on the water's ability to support aquatic life (fishable) and allow for safe contact with the water (swimmable). The assessments for aquatic life use are based on data for a set of conventional pollutants, toxic pollutants and biological community impairment. The assessments for swimmable use are based on fecal coliform bacteria data. River and stream assessments in Minnesota are determined for river "reaches," which extend from one tributary to another – typically less than 20 miles long.

Lake assessments are based primarily on the trophic, or nutrient enrichment, status of the lake and its relation to the ability of the lake to support primarily swimming and aesthetics. For lakes, the assessments are based on summer Secchi transparency, total phosphorus, and chlorophyll-a (an indicator of algal growth). These data are evaluated in the context of region-specific measures of water quality potential, and user expectations of water quality. Lake assessments are generally completed for an entire lake.

The following paragraphs and figures provide more details about the use-support status of Minnesota's lakes and streams for the "fishable" and "swimmable" goals of the CWA. The assessment process followed to determine use-support and impairments varies slightly based on water body type and designated use (see the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters* for an in-depth explanation of the MPCA's assessment methods).

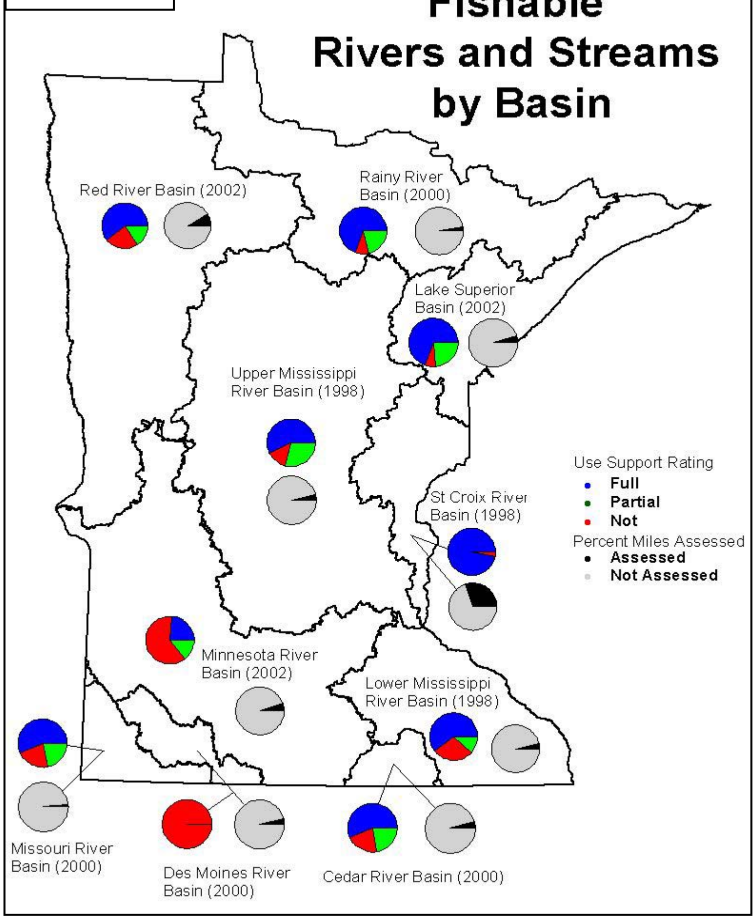
<u>Aquatic life use-support</u>

The aquatic life use-support determination is based on a suite of indicators for streams. Figure 1 shows statewide aquatic life use-support for streams and the percent of stream miles assessed within each basin. The MPCA does not complete aquatic life use-support assessments for lakes. However, note that the MPCA's 303(d) list of impaired waters does include listings for aquatic life impairments due to fish consumption advisories and concentrations of toxic pollutants in the lake itself (see the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters* for an explanation of the process the MPCA follows to identify and list lakes for aquatic life impairments). Fish consumption advisories are issued by the Minnesota Department of Health to warn the public about eating fish from certain lakes or rivers due to the level of toxins (primarily mercury and PCBs) that have been found in their tissues.

For streams, the use-support determination is based on water chemistry parameters (dissolved oxygen, pH and turbidity), toxic pollutants (mercury, PCBs, dioxin and chlorinated pesticides) and land use parameters (such as land use types, in-stream habitat, riparian vegetation, stream channelization or dredging). This information is combined into an indicator of the ability of the evaluated stream reach to support aquatic life:

- Not supporting—at least one conventional or toxics parameter indicates nonsupport
- Partially supporting—the worst parameter indicates partial support
- Fully supporting—all measures show full support

Figure 1



In addition to performing chemical analyses, the MPCA conducts fish community assessments for streams using an Index of Biotic Integrity (IBI). The IBI is one of the most common and widely accepted analytical tools used to measure the integrity of aquatic communities. The IBI relies on multiple attributes of the fish community called, “metrics”, to evaluate a complex biological system. The metrics are integrated to develop an overall IBI “score”, which provides a relative indication of the quality of the biological community. The acceptable condition for aquatic life is determined by comparing the IBI score to a threshold value. The threshold value is determined by identifying IBI scores from streams that are minimally influenced by human disturbance. Because not all streams throughout the state are similar, IBIs must be tailored to specific regions and stream types. Thus, threshold values for determining impairment may also vary by geographic region and type of stream being assessed.

Biology is considered to be the strongest indicator of a stream’s ability to support aquatic life, so IBI evaluations take precedence over other assessments when the MPCA makes a final determination of aquatic life use-support. In the absence of biological measures, support measures are based on physical and chemical parameters.

<u>Swimming use support</u>

The MPCA conducts assessments for swimming use support to see if a water body is of sufficient quality to support primary body contact (swimming). Figure 2 shows statewide swimming use-support for streams and the percent of stream miles assessed within each basin. Figure 3 shows the same information for lakes.

(Note that Figure 3 shows a greater percentage of lakes assessed than the 12% figure reported previously. This is because the percentages in Figure 3 are based on total *acres*

Figure 2

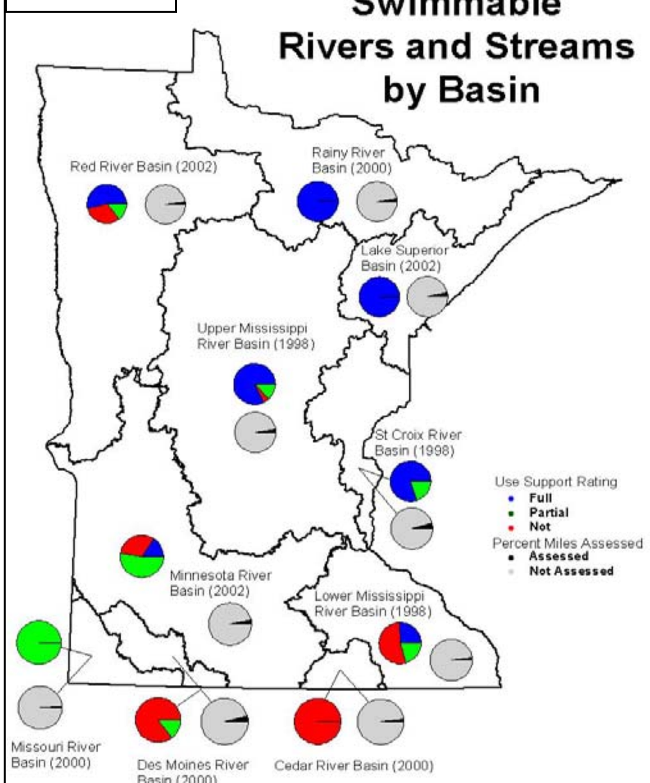
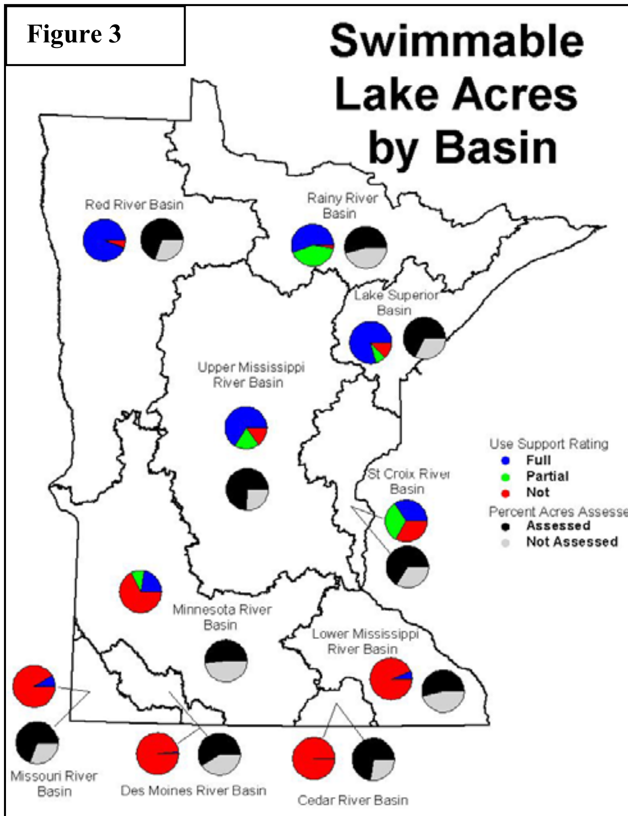


Figure 3



assessed, while the 12% figure is based on the total *numbers* of lakes assessed. Therefore, while the MPCA has only assessed about 12% of all of the lakes in Minnesota, since the lakes that have been assessed are generally larger lakes, the MPCA has assessed more than 50% of all of the lake *acres* in the state.)

Streams

The assessment of swimming use-support for streams is determined by the monitoring of fecal coliform bacteria. In Minnesota, water quality standards for primary body contact apply from April 1 to October 31. At least 10 samples are needed for the data to be evaluated and 10 years of data are used, where available, based on water year. In addition, at least five observations for a month (all years combined) are needed to determine a geometric mean for that month. Use-support categories are then defined as follows:

- Fully supporting—the geometric mean for each month (all years combined) did not exceed 200 organisms/100ml, *and* fewer than 10% of all observations exceeded 2000 organisms/100ml
- Partially supporting—the geometric mean for one or two months (all years combined) exceeded 200 organisms/100ml, *or* 10-25% of all observations exceeded 2000 organisms/100ml
- Not supporting—the geometric mean for three or more months (all years combined) exceeded 200 organisms/100ml, *or* more than 25% of all observations exceeded 2000 organisms/100ml

Lakes

For lakes, the assessment of swimmability is based on an analysis of the trophic (or nutrient enrichment) status of the lake. The parameters used to assess trophic state are total phosphorus (TP) in the upper waters, chlorophyll-a, and Secchi disk transparency. Based mainly on TP criteria identified for lakes by ecoregion and the MPCA's experience in lake assessments, the following categories and working definitions of swimmable use support for lakes are used by the MPCA:

- Full-support – few algal blooms and adequately high transparency exist throughout summer to support swimming;
- Full-support (marginal) – swimmable use is still fully supported, but the lake is near the TP criteria for its ecoregion and small increases in in-lake TP could result in increased algal blooms and perceptible decreases in transparency;
- Partial support (impaired) – algal blooms and low transparency may limit swimming for a significant portion of the summer; and
- Non-support (impaired) – severe and frequent algal blooms and low transparency will limit swimming for most of the summer.

As mentioned previously, see the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters* for a more detailed explanation of the methods the MPCA follows to complete use-support assessments for lakes.

Appendix H: Background on resource needs for assessment, TMDL studies, and restoration activities

This appendix examines current resources and future needs for the MPCA's impaired waters program. It is separated into the following sections:

1. Current resources for assessment, TMDL studies, and restoration activities
2. Assessment needs
3. TMDL study costs and needs
4. Restoration costs and needs
5. Follow-up monitoring costs and needs
6. Long term needs

1. Current resources for assessment, TMDL studies and restoration activities

Funds from the federal CWA Section 319 grant and state funds are dedicated to carry out the assessment activities, TMDL studies, and restoration activities of the impaired waters program (see table and graphs on next page).

<u>CWA Section 319 grant</u>

- On a yearly basis, the MPCA dedicates $3.44 million in CWA Section 319 grants to TMDL studies, restoration activities, and staffing. Of that total, $700,000 is allocated to TMDL development, $1.069 million to restoration projects, and 1.67 million to staffing.
- In terms of staffing, beginning with FY03 319 funds, the MPCA will also direct 16 of its 38 full-time equivalents (FTEs) funded through CWA Sec. 319 funds to work on TMDLs. The combination of these FTEs and pass-through will meet EPA's requirement that 43 percent of Sec. 319 funds be used for TMDLs.

<u>State Funds</u>

- To support TMDL studies, the MPCA also receives a matching annual appropriation of $500,000 from the state Legislature.
- Assessment activities receive an annual appropriation of $1.1 million from the state. Of that total, $425,000 is allocated to monitoring activities, and $670,000 to support 11 FTEs.

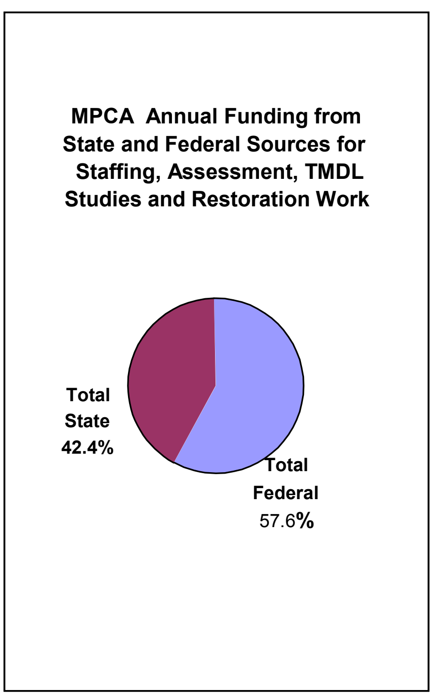
FY 2004 dedicated funding for impaired waters activities

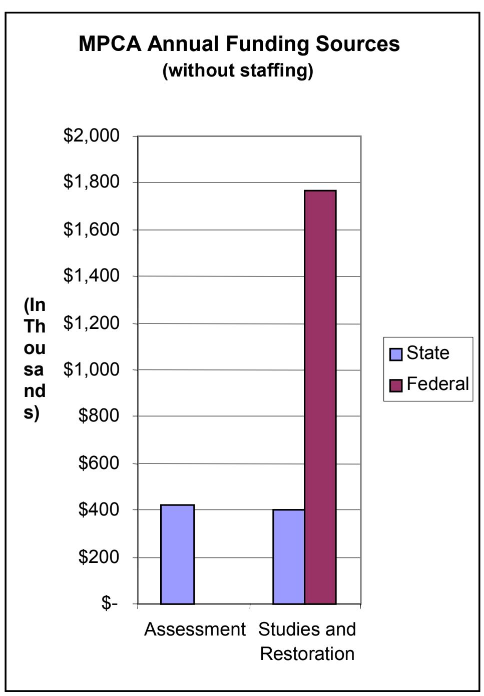
Funding sources	Water quality assessment	TMDL studies	Restoration activities (BMPs)	MPCA staff (FTEs)*
Federal 319 grant	—	$700,000	$1.069 million	$1.67 million** TMDL/Restoration – 16 FTE
State Funds	$425,000	$400,000	—	$1.03 million TMDL/Restoration – 4 FTE Assessment – 11 FTE
Total	**$425,000**	**$1.1 million**	**$1.069 million**	**$2.7 million** 31 FTE TMDL – 20 FTE Assessment – 11 FTE

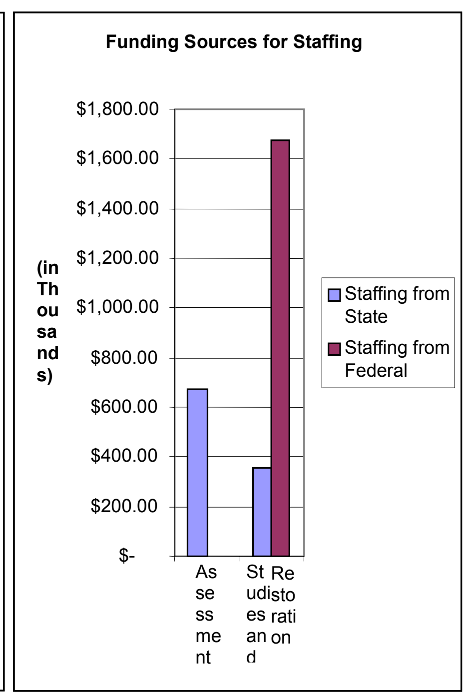
* Includes management and clerical support. The *Guide to MPCA Programs* states "the agency employs 42 FTE to do TMDL studies and restoration work, at a cost of $4.5 million." Those numbers include basin management work as well as TMDLs.

** Includes special expenses associated with a developing program

State/federal funding for assessment, TMDL studies and restoration activities







2. Assessment needs

The MPCA's overall strategy for increasing the number of assessed lakes and streams relies on a combination of MPCA-conducted monitoring, remote sensing technologies, and volunteer monitoring. However, there are options as to the overall level of effort needed to implement this strategy.

The following tables present two alternative monitoring scenarios[1]. Scenario 1 would enable the MPCA to assess 100 percent of remaining lakes (over 100 acres) and streams over 10 years; this scenario would cost $8.2 million per year (and then continue at that funding level to maintain 100% assessment capabilities). Scenario 2, considerably more scaled back, would assess 30 percent of remaining stream miles and 100 percent of lakes (over 500 acres) for a cost of $3.8 million per year over 10 years (and then continue at that funding level to maintain 30% assessment capability). The second scenario reflects the fact river assessments are more complicated and thus more costly than lake assessments.[2]

Scenario 1 (next page), with a total annual cost of $8.2 million (including current resources), is based on the following goals:

- Assessing 100% of streams in 10 years through a combination of MPCA assessments (MPCA visits each stream one out of every 10 years), remote sensing (every five years) and volunteer monitoring (every year), and
- Assessing 100% of lakes over 100 acres. This would be accomplished by the MPCA's monitoring of each lake over 500 acres once in a 10-year period, using remote sensing to help target the agency's assessment efforts for lakes between 100 and 500 acres, and volunteer monitoring of all lakes between 100 and 500 acres.

(see table next page)

[1] Note that these are not the only options for increasing the assessment levels of the state's waters; however, they do illustrate two possible approaches (and related costs) to achieving the goal of increased assessments. It is also important to emphasize that as the resources available for the MPCA's detailed assessments decrease, the importance of relying on remote sensing and citizen monitoring as targeting tools increases.

[2] The MPCA expects that with existing resources and efforts the percentage of river miles assessed in Minnesota will increase from five to 15 percent over the next 10 years, and the percentage of lakes assessed will go from 12 to 15 percent.

Scenario 1: Estimated Costs if 100% of Minnesota's waters are fully assessed

Estimated Costs			
	Monitoring Type	Subtotal (annual)	**Total (annual)**
Streams	Flow and Chem[1]	$1,320,000	$6,233,000
	Integrated Monitoring[2]	$2,720,000	
	Remote sensing[3]	$105,000/every 5 yrs	
	Volunteer Monitoring[4]	$2,172,000	
Lakes	On Lake Assessment[5]	$428,500	$1,499,500
	Remote Sensing[3]	$105,000/every 5 yrs	
	Volunteer Monitoring[6]	$1,050,000	
Data Management		$520,000	$520,000
Total (annual)			**$8,252,500** (+ $180k in 1st year)

Assumptions:

1. MPCA samples 86 flow monitoring sites (with chemistry) and 32 of 80 chemistry sites per year.
2. MPCA samples 680 integrated monitoring sites per year.
3. Remote sensing every 5 years (streams and lakes).
4. Volunteer monitoring of stream transparency (with transparency tubes): 3600 sites monitored each year by 84 groups with some chemistry monitoring done at 10 sites.
5. MPCA monitors 100 lakes each year by 5 teams (20 lakes are a follow-up of remote sensing).
6. Lake transparency (Secchi) volunteers on all lakes over 100 acres each year plus volunteer monitoring with chemistry on 300 lakes per year of the 100-500 acre size.

Scenario 2 (next page), with a total annual cost of $3.8 million (including current resources), is based on the following goals:

- Assessing 30% of stream miles in 10 years through MPCA assessments (MPCA visits 30% of MN streams one out of every 10 years), along with remote sensing (every five years) and volunteer monitoring (every year) to identify and target areas of concern for additional assessment; and
- MPCA assessment of 100% of lakes over 500 acres at least every 10 years, using remote sensing to help target the agency's assessment efforts for lakes between 100 and 500 acres, and relying on remote sensing and volunteer monitoring to identify and target areas of concern for additional assessment.

(see table next page)

Scenario 2: Estimated Costs if 30% of Minnesota's waters are fully assessed

Estimated Costs			
	Monitoring Type	Subtotal (annual)	**Total (annual)**
Streams	Flow and Chem[1]	$1,320,000	$2,793,000
	Integrated Monitoring[2]	$960,000	
	Remote Sensing[3]	$105,000/every 5 yrs	
	Volunteer Monitoring[4]	$492,000	
Lakes	On Lake Assessment[5]	$428,500	$749,500
	Remote sensing[3]	$105,000/every 5 yrs	
	Volunteer Monitoring[6]	$300,000	
Data Management		$260,000	$260,000
Total (annual)			**$3,802,500** (+ $180k in 1st year)

Assumptions:
1. MPCA samples 86 flow monitoring sites (with chemistry) and 32 of 80 chemistry sites per year.
2. MPCA samples 240 integrated monitoring sites per year.
3. Remote sensing every 5 years (streams and lakes).
4. Volunteer monitoring of stream transparency (with transparency tubes) at 3600 sites.
5. MPCA samples 100 lakes each year by 5 teams (20 lakes are a follow up of remote sensing).
6. Lake transparency (Secchi) volunteers on all lakes over 100 acres each year.

Again, the above two scenarios are two potential options for improving the number of assessments of Minnesota's lakes and streams. This would provide data necessary for listing impaired waters and for removing waters from the list as they are restored. This would also provide the monitoring data needed to identify water bodies that are currently meeting their intended uses.

Currently, of the five percent of stream miles that have been assessed, about 40 percent are impaired for aquatic life support. Of the 12 percent of lakes that have been assessed, about 37 percent are impaired. The MPCA anticipates these impairment percentages will remain roughly the same as additional water bodies are assessed and additional parameters are evaluated. Note that this expectation does not consider impairment percentages due to mercury, since mercury impairments are being addressed on a regional basis, rather than by individual water body.

3. TMDL study costs and needs

Minnesota's 2002 impaired waters list includes 413 individual listings of stream or lake impairments due to conventional pollutants.[3] The MPCA has grouped these individual listings into about 200 projects that must be completed by 2015, which is the federally-required date that TMDL studies must be completed for impaired waters listed in 2002. Another 1,300 impairments for toxic pollutants are expected to be addressed by alternate methods (such as a national TMDL for mercury) rather than individual TMDLs.

[3] Conventional pollutants include excessive nutrients in lakes, fecal coliform bacteria, turbidity, excessive temperature or chlorides, low oxygen, ammonia and biological impairments (loss of fish or invertebrate diversity). Toxic pollutants include persistent bioaccumulative toxins such as mercury and PCBs.

- Project complexity: As described in the table in Appendix I, the MPCA assigns two levels of complexity to conventional projects to determine resource requirements. These complexity categories and time estimates were developed based on the MPCA's best professional judgment and 10 years of experience in watershed work. Although there are exceptions, complexity (and therefore time needed to complete a project) increases with the geographic scale, type and number of pollutant sources, and number of impaired waters. As the agency develops more experience in doing TMDLs, these criteria and planning estimates will be refined.

- Project size: The same lakes or stream reach may appear on the impaired waters list several times, depending on the number of pollutants that are causing impairments. For example, a river reach could be listed three times because it does not meet standards for turbidity, dissolved oxygen and ammonia. A TMDL study is required for each of these impairments; however, in order to increase efficiency, many projects have been organized to include several listings within a watershed. The number of impairments per project depends on whether we can feasibly address all listings in a watershed together, or whether it must be done one reach or lake at a time because of the complexity of the pollutants or other reasons.

The MPCA has primary responsibility for the study development phase of a TMDL project. The agency's staff, working with local government and private contractors as needed, will conduct or oversee water quality monitoring, land-use assessments, computer modeling and other data analysis for the technical phases of the project. The MPCA will also lead the stakeholder processes to develop pollution-reduction goals, write the final TMDL study, and conduct ongoing citizen participation activities throughout the entire project. EPA approval of a final TMDL study is required.

Staffing requirements: The MPCA estimates less-complex TMDLs require an average of 0.3 FTEs per year per project (two to four years average). More-complex projects require 1 FTE per year (four to six years average). The agency currently has dedicated funding for 20 FTEs.

At the current level of staff resources, the MPCA can only complete TMDL studies for 50 to 75 impairments by the end of FY 2007. Compare this with the 130 impairments for which the MPCA must complete studies by 2007 in order to stay on pace with the project workload generated by the 2002 impaired waters list. In order to meet the 2015 deadline, a total of 65 FTEs would be needed for impaired waters activities, or 45 FTEs more than current levels. This estimate is an average based on projected needs of 35 FTEs in 2003, 70 FTEs in 2005, and 90 FTEs in 2007. At current costs per FTE, adding 45 FTEs would require an additional $4 million per year (includes salary, fringe and indirect expenses).

Contracting costs and expenses for study development

The MPCA will contract with local government, private consultants and others for technical work related to TMDL studies, and will actively manage these contracts. In addition, each project incurs expenses related to monitoring equipment, data analysis tools, laboratory costs to analyze water samples, and other expenses.

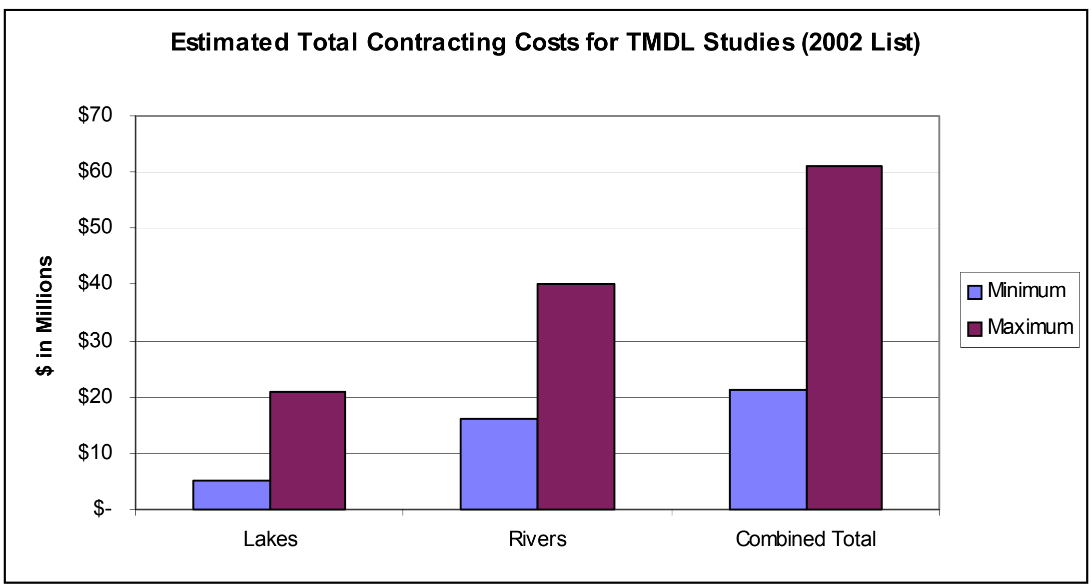
Based on past watershed (CWP and 319) and TMDL projects, costs for study development are estimated at:

- For impairments to small lake watersheds, $50,000 to $100,000. For large lake watersheds, $100,000 to $200,000.
- For impairments to small river watersheds, $50,000 to $300,000. For large river watersheds, $400,000 to $1 million.

Costs are dependent upon differences in geographic size, pollutants, number of point sources, number of tributary streams, number of monitoring stations, and size of source-inventory efforts. River watersheds are more complex to study than lakes, with higher associated study costs.

The graph below illustrates estimated contracting costs. Using the average costs for river and lake studies listed above, approximately $40 million is needed to develop TMDL studies for the 211 projects currently planned for the 2002 impaired waters list. This estimate assumes a range of $20 million to $60 million for the total of all currently planned studies.

If funding from current sources remains constant, a total of $14.3 million ($1.1 million per year over 13 years) would be available to meet this need. Assuming the cost for contracting (and related expenses) for TMDL studies is currently $40 million, then $3.1 million is needed annually, which leaves a shortfall of $2.0 million per year. This funding gap will continue to grow in subsequent years as the impaired waters list grows proportionately with new assessments.



4. Restoration costs and needs

Staffing requirements

Local government will have the primary leadership role in implementing restoration projects, including education efforts, technical support for BMP selection/installation, and contract management. The MPCA will develop detailed implementation and monitoring plans, manage fiscal contracts (block grants), monitor progress in meeting water-quality goals, and prepare the necessary information to remove waters from the impaired waters list after they are restored to their designated uses. This implementation work will require an estimated 0.1 to 0.15 FTEs per project. Based on this assumption, implementation projects planned on the 2002 impaired waters list will require a total of 1 FTE in 2003, 2 FTEs in 2005 and 5 FTEs in 2007. This increase is proportional to the number of restoration projects that will be underway during these years.

Restoration costs for nonpoint sources

A wide array of BMPs may be used to reduce nonpoint-source pollution, and this is where the primary costs of restoration are incurred. (A list of BMPs and the problems they address is included in Appendix J). BMPs for agricultural use include nutrient management, high-residue tillage practices, and soil conservation structures. Urban runoff problems will be addressed with a combination of structural fixes, housekeeping ordinances, and educational efforts.[4]

Estimated costs[5] for BMP implementation are:

- For small lake watersheds, $1 million to $5 million. For large lake watersheds, $8 million to $15 million.
- For small river watersheds, $5 million to $10 million. For large river watersheds, $10 million to $40 million.

Estimate of total restoration costs for the 2002 impaired waters list

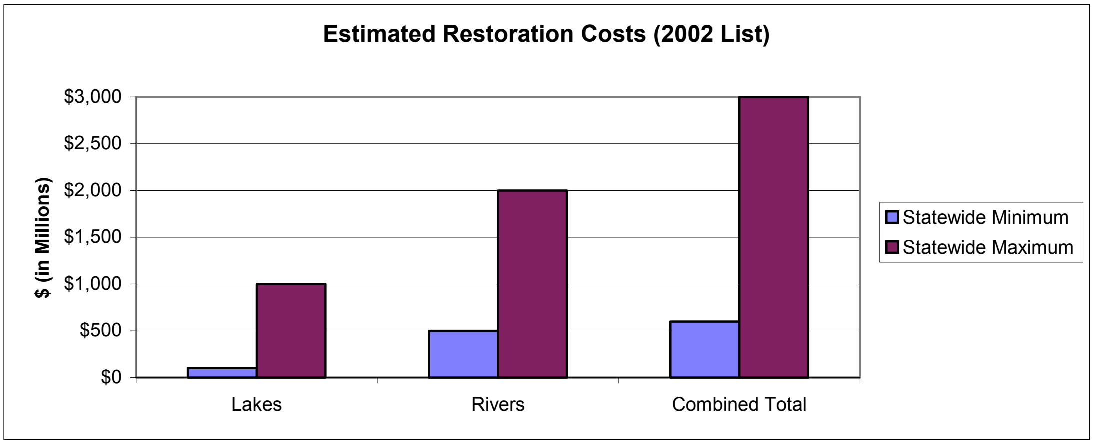
Using these averages, estimated costs for the projects planned on the 2002 impaired waters list are:

- Rivers: With about 50 major watersheds (of 82 statewide) represented on the 2002 list, requiring costs averaging $10 million to $40 million per watershed, approximately $500 million to $2 billion will be required in the next 20 to 30 years for nonpoint-source BMPs. Lakes: With over 100 lakes on the 2002 list, requiring

[4] There is a wide range of costs for BMPs. These range from actual profit for the producer (high residue tillage and nutrient management) to moderate cost corrections ($3,000-$12,000 for septic systems or $100-$150 per acre per year for BMPs like buffers and grassed waterways). Higher cost structural improvements ($100,000 to well over $1 million) are often required for sensitive areas, such as Karst regions, or developed urban areas.

[5] Due to the agency's relative inexperience with restoring impaired waters to CWA requirements, these cost estimates were derived from previous watershed restoration efforts sponsored by the MPCA's Clean Water Partnership and CWA Sec. 319 programs.

costs of $1 million to $10 million per lake, about $100 million to $1 billion would be required for nonpoint-source BMPs.[6]



Less than 10 percent of BMP costs would be covered by funds dedicated to the MPCA for impaired waters (General Fund and CWA Sec. 319 grant), while the major share would come from federal programs. Where restoration requires upgrading wastewater treatment facilities, those costs are not included in the estimates above. Those amounts are difficult to predict, but it is assumed that improvements to wastewater treatment facilities would be subsidized through State Revolving Fund loans and Wastewater Infrastructure Fund grants. The graph below illustrates total estimated costs for restoration of impaired waters.

As with the costs of completing TMDL studies, restoration costs will grow proportionately with the percentage of our waters that are assessed and found impaired.

5. Follow-up monitoring costs and needs

Following implementation of BMPs, the law requires states to evaluate whether water quality is improving and whether the waters will be restored to their designated uses. As with the assessment phase, evaluation will be done through water-quality monitoring. If monitoring indicates standards are still being violated, the MPCA must modify restoration plans or the TMDL waste-load allocations to try to meet water-quality standards. If monitoring shows standards are met and the water restored, then the water body is removed from the impaired waters list (delisted).

Note that the overall effectiveness of restoration projects will be evaluated on a regular basis through the same type of routine monitoring used for assessment purposes. This assessment monitoring will identify the water bodies where designated uses have been restored and the waters can be removed from the list.

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[6] Nonpoint-source impairments in rivers are often due to widespread, chronic problems over watersheds. Restoring individual reaches without addressing watershed problems thus would be ineffective. Therefore these cost estimates are for restoration efforts over entire watersheds rather than individual reaches.

However, along with this assessment monitoring there will also be large costs incurred with each project to evaluate the adoption of BMPs and their effectiveness. However, these costs cannot be estimated until the MPCA gains additional project experience. The MPCA will use the eLink system of the Board of Water and Soil Resources and other tools to track the installation and effectiveness of BMPs as a standard activity in restoration work. If BMPs are not controlling nonpoint sources, adjustments will need to be made in the restoration efforts or in the TMDL itself. For wastewater facilities whose permits have been modified to meet the goals of a restoration plan, MPCA will rely on its current regulatory system to determine compliance.

Appendix I provides a graphical representation of the project life cycle, from studies to restoration, for the 2002 impaired waters list.

6. Long-term needs: Estimate of impaired waters over the next 10 years

How healthy are Minnesota's rivers and lakes? Since the MPCA has assessed only five percent of the state's 92,000 stream miles and 12 percent of its 14,000 lakes, we can only estimate the answer. However, these estimates are critical to help policy makers and the public understand the long-term resource needs of the impaired waters program.

One of the major factors contributing to future impairments will be the impact of growth and development in Minnesota's major cities. According to recent projections, the state anticipates a population increase of nearly 1.5 million people over the next 30 years, many of whom will be living in a growth corridor from Rochester to the Twin Cities to St. Cloud to the Brainerd lakes region. The additional pressure of this growth on lakes and rivers is likely to be significant. More impervious surface from new residential developments and highway expansions will lead to greater urban runoff of pollutants like chlorides (from road salt) and nutrients, and will cause increased erosion, higher water temperatures, and lower oxygen levels.

Because of this anticipated growth and other pressures, including agricultural impacts in non-urban areas, the MPCA assumes the current proportion of impaired waters—37 percent of lakes and 40 percent of rivers—will remain about the same over the next 10 years as more of our waters are assessed.

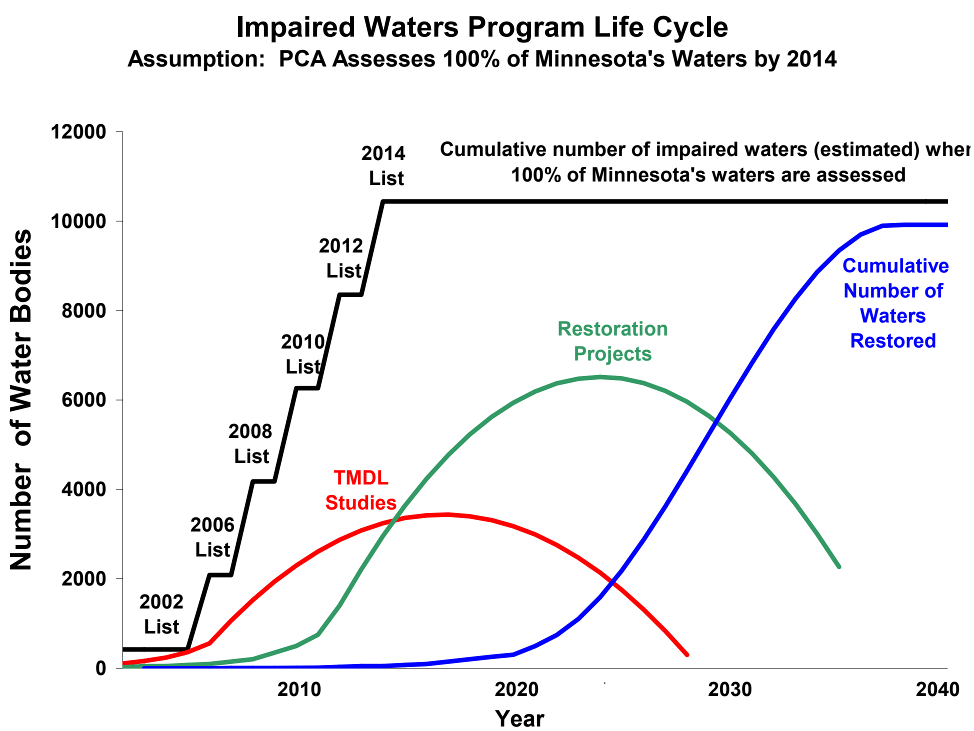
If funding is provided to fully assess 100 percent of our waters by 2014 (scenario 1), the impaired waters list is projected to increase by approximately 25 times over 2002 levels for conventional pollutants. Again, this assumes that 37 percent of lakes and 40 percent of rivers will be found to be impaired, which is the proportion of impairments found in current assessments.

The graph on the next page shows the projected program life cycle for study development, restoration projects, and waters restored for this scenario:

- With 100 percent of our waters assessed, the estimated number of impaired waters for conventional pollutants will grow from 413 on the 2002 list to over 10,400 by 2014. (This assumes all 82 of the state's major watersheds may have impaired waters.)

- This listing curve is shown as growing at four-year intervals from 2002 until 2014. These intervals represent expedited, federally required deadlines for updating the impaired waters list (although final federal rules may alter this schedule slightly).
- Restoration projects are shown following study completion. It is assumed that they will require an average 10 to 20 years to complete.
- The restoration curve (total waters restored) lags behind implementation periods.

Obviously, if this scenario holds true, it will have profound resource implications for the MPCA's impaired waters work. These costs are very difficult to estimate, particularly because it is difficult to estimate the number of lakes that may be impaired. However, if all of the state's 82 major river watersheds are found to be impaired by nonpoint sources, $820 million to $3.3 billion would be required for nonpoint-source restoration efforts alone (assumes a range of $10 million to $40 million per watershed).[7] Moreover, if we include the 37% of lakes over 100 acres (about 4,500 lakes) that can be assumed to be impaired, at about $1 million per lake, another $4.5 billion would be required for restoration.[8]



[7] See footnote 4.
[8] The range of $1 million to $10 million estimated for lake restoration on the 2002 impaired waters list (page H-8) was used because most of these lakes were located in the Twin Cities metropolitan area. Metro-area lakes will be more costly to restore because they will not benefit as much from watershed-scale restoration that will be used for nonpoint-source problems in Greater Minnesota. Therefore, the more conservative estimate of $1 million was used for this statewide projection. In general, lake BMPs include more expensive measures than those used for rivers because lakes do not have the natural pollutant flushing rates that rivers do.

Appendix I: Workload analysis for TMDL projects on the 2002 impaired waters list

The following table outlines how projects were evaluated and organized for the 2002 impaired waters list.

2002 Impaired Waters List: Project Criteria/Workload for TMDL Studies

Project Criteria and Workload for TMDL Studies	**Level 1 Complexity:*** **Conventional projects** **2-4 year avg.** **40% of workload**	**Level 2 Complexity:*** **Conventional projects** **4-6 year avg.** **60% of workload**	**Toxics** **Unclear duration** **Unclear workload requirements**
1. Pollutant	Fecal Coliform, Excess Nutrients, Chloride, Temperature	Biotic Impairment, Low Oxygen, Turbidity, Ammonia	Mercury, PCBs, Pesticides, other toxic pollutants
2. Geographic scale of project area	Minor river watershed, Small Lake Watershed, Individual Stream Reach	Major river watershed, Large lake watershed, Basin	Statewide to single stream reach, depending on the toxic pollutant
3. Number of listings per project	1-3 listings per project	4 or more listings per project	Approximately 1,300 listings for toxics on the 2002 impaired waters list
4. Number of projects Total of ~200 projects are currently planned for 413 conventional pollutants	~100 projects covers ~165 listings	~100 projects covers ~245 listings	Alternative approach to a TMDL is under development at the national level

*A final determination of a project's complexity was equivalent to its highest ranking in each category. For example, if a project includes a minor reach, but it was listed for biotic impairment, then the project was ranked as "a Level 2 project".

Assumptions:

1. "Type of Pollutant" may be the most important of all the criteria in determining project complexity.

- Pollutants assigned to Level 1 complexity category: These projects address pollutants where the MPCA has direct experience (i.e. excess nutrients and fecal coliform) or general understanding (temperature, chloride) to complete the TMDL (although implementation may be a more complex task).

- Pollutants assigned to Level 2 complexity category:

    a) Turbidity. This is a measure of particles in the water, such as sediment and algae, and is related to the depth sunlight can penetrate into the water. Higher turbidity reduces the penetration of sunlight in the water and can affect aquatic life species that survive in the water body. The standard for turbidity is impacted by a) natural coloration of water, b) natural productivity of the eutrophication process, and c) the suspended sediment sources in the watershed.

    These items are affected by regional variability and the relationship must be discovered during the TMDL process. Current standards are more reflective of a point source discharge rather than a regional fishery need (designated use).

    b) Ammonia. Ammonia is toxic to fish. It is generated by both point and nonpoint sources so both a load allocation and waste-load allocation may be required. Ammonia concentrations are variable in nature so require a longer monitoring period to quantify.

    c) Low oxygen. Oxygen is necessary to maintain a healthy ecosystem for fish and other aquatic life in a water body. Low oxygen impairments can be driven by eutrophication or direct input from biodegradable materials. TMDL studies on low oxygen impairments often require higher rigor because of the complex issues that must be considered when revising effluent limits for point sources as part of the waste load allocation. Intensive monitoring is also required.

    d) Biotic impairments. This is the divergence from the expected biological condition of a lake, stream, or wetland. The cause and effect linkages in the water body for biotic impairments need to be discovered which makes this a very complex problem for which to develop a TMDL. Acute impairments can be intermittent and must be discovered over a long period of time and the science of physical impairments is developing.

2. "Geographic Scale" of a project can affect complexity because there are more pollutant sources, tributaries, and land uses that need to be assessed. There are also more stakeholders and more staff time required to monitor and travel in a large watershed.

3. "Number of Listings" can increase the complexity of a project, especially if there are multiple pollutant parameters among the listings in each project.

4. MPCA staffing. It is estimated that Level 1 projects would require an average of 0.3 full-time equivalents (FTEs) per project year over the 2-4 years of the project. Level 2 projects would require 1 FTE per project year over the 4-6 years of the project.

    The workload tasks listed below were evaluated for time requirements using the Clean Water Partnership program experience (see Appendix B) and benchmarking with other state's TMDL programs. In Minnesota, more stakeholder involvement is desired so other states' programs do not always translate into equivalent workload projections. Efficiencies in staff time allocated to each project are being estimated to double over current levels due to anticipated improvements in local capabilities, increased delegation of work to local government, and other improvements in the program.

Staff workload for each project may vary due to the level of contract support and project complexity. In general, however, here is a list of common project tasks performed by staff:

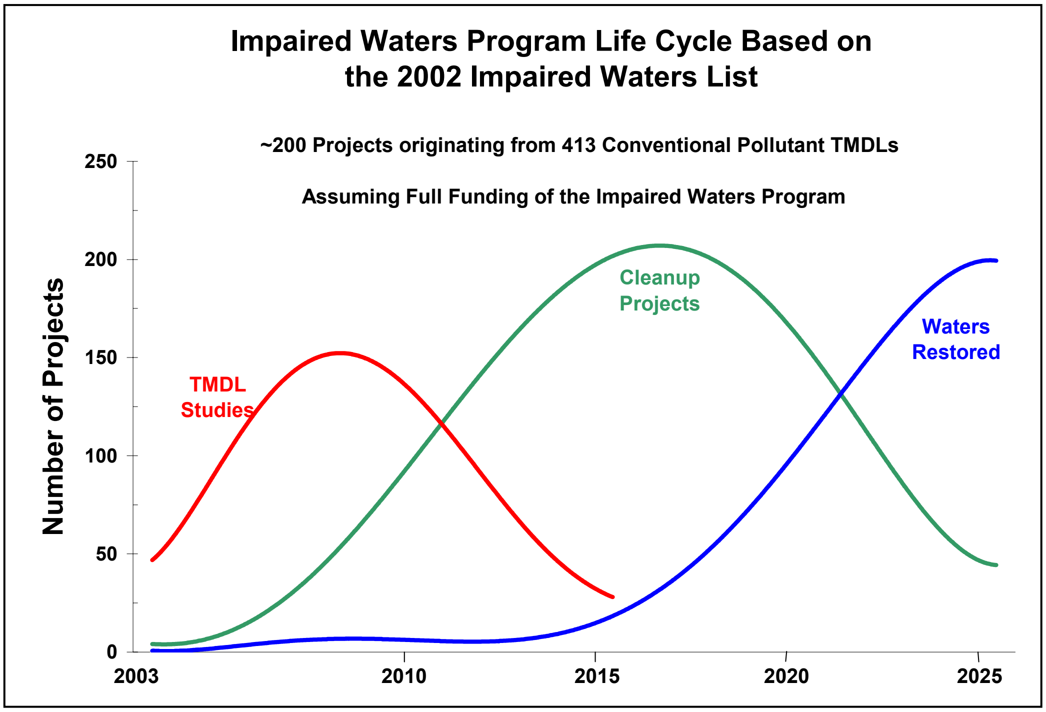
- Development of detailed work plans for TMDL studies.
- Administering contracts with local government and private consultants, as well as general program coordination and management activities.
- Monitoring activities and collection of land use data to determine the sources of the impairment for the TMDL project study. This activity may include the training of local government staff and volunteers to conduct monitoring. During the restoration phase of each project, staff will conduct monitoring to determine the effectiveness of BMPs.
- Analysis of data, including modeling of pollutant reduction scenarios.
- Production of final TMDL document.
- Coordination of stakeholder and public involvement throughout the development of the study, including the public notice period.
- Assisting local government with the development of restoration plans.

The staffing estimate on the 2002 impaired waters list was developed through a four-step process. The first step was grouping the 2002 impaired waters listing into projects (approximately a 2:1 listing to project ratio). The project timelines (number of completed TMDLs per year) were then developed using averaged (versus actual) start and end dates. The next step was allocating the estimated staffing level per project according to the complexity level assigned to the project. Finally, the annual sum of each project's required staffing level was totaled to estimate the entire program's staffing needs for each year.

Project lifecycle for the 2002 impaired waters list

The graph on the next page shows the number of current TMDL "conventional" projects on the 2002 list and the current schedule for the completion of TMDL studies and restoration projects.

The figure below also shows the MPCA's projected timeline of when these projects may restore impaired waters to their designated uses to support swimming or aquatic life. It is important to note that this projection assumes full funding for TMDL development and implementation. Restoring impaired water results in removal of the water body from the impaired waters list, shown in the "Waters Restored" curve. Again, this restoration curve assumes, on average, a 10-year time period for clean-up activities to restore waters to their designated uses. Many of the most impaired watersheds, however, could require 20 years or longer to restore.



Impaired Waters Program Life Cycle Based on the 2002 Impaired Waters List
~200 Projects originating from 413 Conventional Pollutant TMDLs
Assuming Full Funding of the Impaired Waters Program
Number of Projects
250
200
150
100
50
0
2003
2010
2015
2020
2025
TMDL Studies
Cleanup Projects
Waters Restored

Appendix J: Best management practices – definitions and applications

From "Minnesota's 2001 Nonpoint Source Management Program Plan" (NSMPP), available on the Web at www.pca.state.mn.us/water/nonpoint/mplan.html.

Best Management Practices - Definitions

The following Best Management Practices (BMPs) are listed by number and title. This list includes definitions of BMPs to more fully describe BMPs and the pollutant minimized.

PART I: AGRICULTURAL BMPs

Most agriculture BMPs used in Minnesota are based upon the Natural Resources Conservation Service (NRCS) conservation practices described in the NRCS National Handbook of Conservation Practices, and modifications set forth in the Minnesota NRCS Field Office Tech Guide.

1. **Access Road -** A road constructed to minimize soil erosion while providing needed access.

2. **Biological Control of Pests -** Use of natural enemies as part of an integrated pest management (IPM) program which can reduce the use of pesticides.

3. **Brush Management -** Management and manipulation of brush to improve or restore a quality plant cover in order to reduce soil erosion.

4. **Conservation Crop Rotation-** Growing crops in a recurring sequence on the same field to improve the soil, control erosion and pests, balance plant nutrients and provide food for livestock.

5. **Contour Farming -** Farming sloped land on the contour in order to reduce erosion, control water flow, and increase infiltration.

6. **Correct Application of Pesticides -** Spraying when conditions for drift is minimal. Mixing properly with soil when specified. Avoiding application when heavy rain is forecast.

7. **Correct Pesticide Container Disposal -** Following accepted methods for pesticide container disposal.

8. **Critical Area Planting -** Planting vegetation to stabilize the soil and reduce erosion and runoff.

9. **Cultural Control of Pests -** Using cultural practices, such as, elimination of host sites and adjustment of planting schedules, to partly substitute for pesticides.

10. **Deferred Grazing -** Postponing grazing for a prescribed period to improve vegetative conditions and reduce soil loss.

11. **Diversion and Terraces** - Channels with a mound or ridge along the lower side, constructed across a slope to divert runoff water and help control soil erosion. Grassed or lined waterways and subsurface pipes are used to handle water from terrace systems.

12. **Fencing** - Enclosing a sensitive area of land or water with fencing to exclude or control livestock.

13. **Field Border** - A border or strip of permanent vegetation established at field edges to control soil erosion and filter nutrients.

14. **Field Windbreak** - A strip or belt of trees established to reduce wind erosion.

15. **Forest Stand Improvement** – Managing species composition, stand structure and stocking to achieve numerous objectives including restoration of natural communities, improvement of wildlife habitat, and increasing quantity and quality of forest products.

16. **Grade Stabilization Structure** - A structure to control the erosion in natural or constructed channels.

17. **Grassed Waterway or Outlet** - A natural or constructed waterway or outlet maintained with vegetative cover in order to prevent soil erosion and filter nutrients.

18. **Integrated Crop Management** - A crop production system that uses a combination of cultural and/or agronomic measures to produce economic returns while lowering inputs and reducing detrimental effects to the environment.

19. **Integrated Pest Management** - Managing agricultural pests including weeds, insects and disease to reduce adverse effects on plant growth, crop production and environmental resources. Management methods may be a combination of cultural, biological and chemical controls.

20. **Irrigation Water Management** - Determining and controlling the rate, amount, and timing of irrigation water application in order to minimize soil erosion, runoff, water use and fertilizer and pesticide movement.

21. **Lined Waterway or Outlet** - A runoff water channel or outlet with an erosion resistant lining to prevent erosion. Applicable to situations where unlined or grassed waterways would be inadequate.

22. **Use Exclusion** - Excluding livestock and other activities from an area to maintain soil and water resources.

23. **Mulching** - Applying plant residues or other suitable materials to the soil surface in order to reduce water runoff and soil erosion.

24. **Nutrient Management** - Managing the amount, form, placement and timing of plant nutrient applications to maximize uses and reduce detrimental off-site effects.

25. **Pasture and Hayland Management**- Proper treatment and use of pasture land or hay land to prolong life of desirable forage species and protect the soil and reduce water loss.

26. **Pasture and Hayland Planting** - Establishing forage plants to reduce runoff and erosion and produce high quality forage.

27. **Pesticide Selection** - Selecting pesticides which are less toxic, persistent, soluble and volatile, whenever feasible.

28. **Prescribed Grazing** - Controlling grazing to improve plant health and vigor, reduce erosion and improve water quality.

29. **Pond Sealing or Lining** - Installing a fixed lining or impervious materials or using soil treatment to prevent excessive infiltration, water loss and to minimize the potential for ground water contamination.

30. **Residue Management (no till, strip till, mulch till and ridge till**) – Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round.

31. **Residue Management-seasonal -** Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed.

32. **Resistant Crop Varieties** - Use of plant varieties that are resistant to insects, nematodes, diseases, etc., in order to reduce pesticide use.

33. **Riparian Buffer** - A strip of land varying in width, along streams and other water bodies in which grass and trees is planted and maintained to filter pollutants from runoff.

34. **Shade Areas** - Lessening the need for animals to enter water for relief from heat by using trees or artificial shelters to provide shade at selected locations.

35. **Slow Release Fertilizer** - Applying slow release fertilizers to minimize nitrogen losses from soils prone to leaching.

36. **Soil Testing and Plant Analysis** - Testing to avoid over-fertilization and subsequent losses of nutrients to surface or ground waters.

37. **Streambank Protection** - Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels against scour and erosion with vegetative or structural means.

38. **Strip cropping** - Growing crops in a systematic arrangement of strips or bands to reduce water and wind erosion.

39. **Timing and Placement of Fertilizers** - Timing and placement of fertilizers for maximum utilization by plants and minimum leaching or movement by surface runoff.

40. **Tree Planting** - Planting trees, especially on critical or highly erodible areas, to prevent erosion, conserve moisture and reduce water quality impacts.

41. **Vegetative Filter Strip** - A strip of land, varying in width, along streams and other waterbodies in which a lush establishment of grass is planted and maintained to filter pollutants from runoff.

42. **Waste Management System** - A planned system to manage wastes from animal concentrations in a manner which does not degrade air, soil or water resources. Often wastes are collected in storage or treatment impoundments such as ponds or lagoons.

43. **Waste Utilization** - Crediting organic wastes for fertilizer in a manner which improves the soil and protects water resources. May also include recycling of waste solids for animal feed supplement.

44. **Water and Sediment Control Basin** - Earthen embankments constructed across a minor watercourse to form a sediment trap and detention basin.

45. **Water/Feeder Location** - Locating feeders and watering facilities a reasonable distance from streams and water courses, and dispersing them to reduce livestock concentrations, particularly near streams, and to encourage more uniform grazing.

PART II: EROSION AND SEDIMENT CONTROL BMPs

1. **Vegetation Establishment** - Establishment of vegetative cover by planting sprigs, stolons or plugs to stabilize fine-graded areas where vegetation is especially suited to the site and establishment with sod is not preferred.

2. **Brush Barrier** - A temporary sediment barrier composed of limbs, weeds, vines, root mat, soil, rock and other cleared materials pushed together to form a berm; located across or at the toe of a slope to intercept and detain sediment and decrease flow velocities.

3. **Construction Road Stabilization** - Temporary stabilization with stone of access roads, subdivision streets, parking areas and other traffic areas immediately after grading to reduce erosion caused by vehicles during wet weather, and to prevent having to regrade permanent roadbeds between initial grading and final stabilization.

4. **Check Dams** - Small, temporary dams constructed across a drainage ditch to reduce the velocity of concentrated flows, reducing erosion of the swale or ditch. Limited to use in small open channels which drain 10 acres or less; should not be used in live stream.

5. **Critical Area Planting** - Establishment of vegetative cover by planting sprigs, stolons or plugs to stabilize fine-graded areas where especially suited to the site and establishment with sod is not preferred.

6. **Diversion** - A permanent channel with a ridge on the lower side constructed across a slope to reduce slope length and intercept and divert storm water runoff to a stabilized outlet to prevent erosion on the slope.

7. **Dust Control** - Reducing surface and air movement of dust during land disturbance, demolition or construction activities in areas subject to dust problems in order to prevent soil loss and reduce the presence of potentially harmful airborne substances.

8. **Filter Strips** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

9. **Grade Stabilization Structures** - A permanent structure or series of structures designed to step water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

10. **Grassed Waterways or Outlets** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

11. **Gravel Inlet Filter** - The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

12. **Level Spreader** - An outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope to convert concentrated, sediment-free runoff to sheet flow and release it onto areas of undisturbed soil stabilized by existing vegetation.

13. **Mulching** - Application of plant residues or other suitable materials to disturbed surfaces to prevent erosion and reduce overland flow velocities. Fosters plant growth by increasing available moisture and providing insulation against extreme heat or cold. Applicable to all seeding operations, other plant materials which do not provide adequate soil protection by themselves, and bare areas which cannot be seeded due to the season but which still need soil protection.

14. **Outlet Protection** - The installation of paved and/or riprap channel sections and/or stilling basins below storm drain outlets to reduce erosion from scouring at outlets and to reduce flow velocities before storm water enters receiving channels below these outlets.

15. **Paved Flume** - A permanent concrete-lined channel constructed to conduct concentrated runoff from the top to the bottom of a slope without causing erosion on or below the slope.

16. **Permanent Seeding** - Establishment of perennial vegetative cover by planting seed on rough-graded areas that will not be brought to final grade for a year or more or where permanent, long-lived vegetative cover is needed on fine-graded areas.

17. **Riprap** - A permanent, erosion-resistant ground cover of large, loose, angular stone usually underlain by erosion mat or filter fabric installed wherever soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that soil may erode under design flow conditions.

18. **Silt Fence** - A temporary sediment barrier constructed of posts, filter fabric and, in some cases, a wire support fence, placed across or at the toe of a slope or in a minor drainageway to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill erosion or small concentrated flows may be a problem. Effective life is six months.

19. **Sodding** - Stabilizing fine-graded areas by establishing permanent grass stands with sod. Provides immediate protection against erosion, and is especially effective in grassed swales and waterways or in areas where an immediate aesthetic effect is desirable.

20. **Sod Inlet Filter -** The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

21. **Storm Drain Inlet Protection -** The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

22. **Storm Water Conveyance Channel** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

23. **Straw Bale Barrier** - A temporary sediment barrier composed of straw bales placed across or at the toe of a slope to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill erosion from low to moderate channel flows may be a problem. Effective life is three months.

24. **Subsurface Drain** - A perforated conduit installed beneath the ground to intercept and convey ground water. Prevents sloping soils from becoming excessively wet and subject to sloughing, and improves the quality of the vegetative growth medium in excessively wet areas by lowering the water table. Can also be used to drain detention structures.

25. **Surface Roughening** - Grading practices such as stair-stepping or grooving slopes or leaving slopes in a roughened condition by not fine-grading them. Reduces runoff velocity, provides sediment trapping and increases infiltration, all of which facilitate establishment of vegetation on exposed slopes. Applicable to all slopes steeper than 3:1 or that have received final grading but will not be stabilized immediately. Also recommended for other exposed slopes.

26. **Temporary Diversion Dike -** A ridge of compacted soil located at the top or base of a sloping disturbed area to divert off-site runoff away from unprotected slopes and to a stabilized outlet, or to divert sediment-laden runoff to a sediment trapping structure.

27. **Temporary Fill Diversion** - A channel with a supporting ridge on the lower side cut along the top of an active earth fill to divert runoff away from the unprotected fill slope to a stabilized outlet or sediment trapping structure; applicable where the area at the top of the fill drains toward the exposed slope and continuous fill operations make the use of a Temporary Diversion Dike unfeasible. Effective life is one week.

28. **Temporary Gravel Construction Entrance** - A gravel pad, located at points of vehicular ingress and egress on a construction site, to reduce the mud transported onto public roads and other paved areas.

29. **Temporary Right-Of-Way Diversion** - A ridge of compacted soil or loose gravel constructed across a disturbed right-of-way or similar sloping area to shorten the flow length within the disturbed strip and divert the runoff to a stabilized outlet. Earthen diversions are applicable where there will be little or no construction traffic within the right-of-way, and gravel structures are applicable where vehicular traffic must be accommodated.

30. **Temporary Sediment Basin** - A basin with a controlled storm water release structure, formed by constructing an embankment of compacted soil across a drainageway, to detain sediment-laden runoff from disturbed areas greater than 5 acres for enough time to allow most of the sediment to settle out. Can be constructed only where there is sufficient space and appropriate topography. Effective life is 18 months unless designed as a permanent pond.

31. **Temporary Sediment Trap** - A small pond area, formed by constructing an earthen embankment with a gravel outlet across a drainage swale, to detain sediment-laden runoff from small disturbed areas for enough time to allow most of the sediment to settle out. Effective life is 18 months.

32. **Temporary Seeding** - Establishment of temporary vegetative cover on disturbed areas by seeding with appropriate rapidly-growing plants on sites that will not be brought to final grade for periods of 30 days to one year.

33. **Temporary Slope Drain** - A flexible or rigid tube or conduit, used before permanent drainage structures are installed, intended to conduct concentrated runoff safely from the top to the bottom of a disturbed slope without causing erosion on or below the slope.

34. **Topsoiling** - Preserving and using topsoil to provide a suitable growth medium for vegetation used to stabilize disturbed areas. Applicable where preservation of importation of topsoil is most cost-effective method of providing a suitable growth medium.

35. **Tree Preservation and Protection** - Protecting existing trees from mechanical and other injury during land disturbing and construction activity to ensure the survival of desirable trees where they will be effective for erosion and sediment control and provide other environmental and aesthetic benefits.

36. **Trees, Shrubs, Vines and Ground Covers**- Stabilizing disturbed areas by planting trees, shrubs, vines and ground covers where turf is not preferred. These plant materials also provide food and shelter for wildlife as well as many other environmental benefits. Especially effective where ornamental plants are desirable and turf maintenance is difficult.

37. **Waterway Drop Structure** - A permanent structure or series of structures designed to step water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

38. **Fertilizer Application Control** - This practice involves managing the use of fertilizer so as to keep it on the land and out of our waterways. Implementation will result in maximum effectiveness of the nutrients on vegetation and reduced nutrient loads in our waterways. The practice covers concepts such as public education, the need for soil testing, and the proper timing of fertilizer applications.

39. **Pesticide Use Control** - This practice involves eliminating excessive pesticide use by proper application procedures and the use of alternatives to chemical pest control. The goal is to reduce the load of pesticide-related contaminants in urban storm water runoff. The practice covers legal requirements for pesticide application, methods of application, equipment cleaning, disposal of unused chemicals and empty containers, pesticide storage, alternative pest control methodologies, and public education. Both commercial-scale application and private home use are discussed.

40. **Solid Waste Collection and Disposal -** This practice involves the routine management and handling of urban refuse, litter and fallen leaves in ways that will prevent their becoming water pollutants. Recommendations range from municipal trash and leaf collection and disposal operations to public education concerning collecting procedures and schedules to concepts such as recycling wastes. Responsibility for implementation lies equally with the municipality and the citizenry.

41. **Source Control on Construction Sites -** This practice encourages the use of good management and "housekeeping" techniques on construction sites to reduce the availability of construction-related pollutants that contaminate runoff water and, where runoff contamination cannot be avoided, to retain the pollutants and polluted water on the site. Concepts covered include erosion and sediment control, equipment maintenance and repair, storm sewer inlet protection, trash collection and disposal, the use of designated washing areas for cleaning equipment, proper material storage, dust control at demolition sites, use of proper sanitary equipment and pesticide use control.

42. **Street Cleaning -** This practice involves sweeping, vacuuming, flushing, or otherwise cleaning streets, parking lots and other paved vehicular traffic areas. The objective is to remove dry-weather accumulations of pollutants, especially fine particulate matter, before washoff can occur, thus reducing the potential for pollution impacts on receiving waters. In the past, street cleaning operations were conducted primarily for aesthetic purposes; however, they are now known to be an effective method for improving the quality of runoff when utilized during the appropriate time of the year.

43. **Concrete Grid and Modular Pavement -** This practice involves the use of a special pervious paving material in low traffic areas. The pavement consists of concrete grids or other structural units alternated with pervious fillers such as sod, gravel or sand. The resultant pavement provides an adequate bearing surface and yet allows a significant amount of infiltration thereby reducing runoff volume, discharge rate, pollutant load and improving the water quality.

44. **Detention Basins -** This practice involves the construction or modification of surface water impoundments in a manner which will protect downstream areas from potential water quality degradation, flooding, and stream channel degradation due to upstream urban development. The objective is to detain storm water and release it at a controlled rate. Downstream water quality is improved through sediment removal, plant uptake of nutrients, chemical transformation, and other processes.

45. **Exfiltration Trenches -** This practices involves the excavation of pits or trenches which are backfilled with sand and/or graded aggregates. Storm water runoff from impervious surfaces can be directed to these facilities for detention and infiltration. Permeable soils are a prerequisite. The potential for ground water pollution must also be carefully evaluated.

46. **Grassed Waterway (Swale) -** This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

47. **Parking Lot Storage -** This practice involves the use of impervious parking areas or landscape islands as temporary impoundments during rainstorms. Parking lot storm water

systems can be designed to temporarily detain storm water in specially designated areas, and release it at a controlled rate. The objective is to protect downstream areas from increased flooding, stream channel degradation and pollutant loads caused by urban development. It is important that these facilities be designed to minimize potential safety hazards and inconvenience to motorists and pedestrians.

48. **Porous Pavement -** This practice involves the use of a special asphaltic or concrete paving material which allows storm water to infiltrate at a high rate. Infiltration water is stored below the pavement in a high-void aggregate base. This practice provides for storm water detention and, in some cases, increases infiltration into the ground. Use of the practice can contribute to reduced sewer overflows, decreased flooding and stream channel degradation, and improved water quality. This type of pavement offers many other benefits not related to water quality, including enhanced visibility, increased safety and reduced drainage system costs.

49. **Retention Basins -** This practice pertains to the construction of infiltration reservoirs or basins (usually dry) to provide complete on-site storage of a specific volume of storm water runoff. For pollution control purposes, these facilities are usually designed and constructed to divert and percolate runoff volume associated with the first flush of storm water pollutants leaving the site. The practice incorporates both pollution control and ground water recharge concepts into the design. Such facilities are practical wherever permeability is sufficient to allow rapid percolation between storms. Potential ground water contamination may be a problem associated with these systems and must always be considered in their design.

50. **Rooftop Runoff Disposal -** This practice encourages the disposal of rooftop runoff by systems and techniques that avoid or replace direct connections of roof drainage systems to storm sewer systems. The objective is to help reduce storm sewer flows. Proposed alternatives to sewer connection include surface drainage through swales, subsurface infiltration, and runoff collection and storage.

51. **Storage/Treatment Facilities -** This practice involves the use of some water treatment unit operations applied at such a scale that they are less involved and less costly than treatment plant technology. These procedures are most applicable when used in conjunction with other BMPs to remove contaminants from collected storm water. Unit operations considered applicable are the physical processes of settling, filtration, and screening; and the chemical processes of flocculation and disinfection.

52. **Underdrain Storm Water Filter Systems -** This practice usually consists of a conduit, such as a pipe and/or a travel filled trench which intercepts, collects, and conveys drainage water following infiltration and percolation through the soil, suitable aggregate, and/or filter fabric. Underdrain or filtration systems may be used in combination with a variety of storm water management measures where space, soil permeability or high water table conditions limit the magnitude of pollutant removal that can be achieved through natural percolation, sedimentation, or other means. Pollutant removal primarily occurs as the prescribed volume of storm water passes through the sand, gravel, and filter cloth which usually surrounds the conduit.

PART III: OTHER CULTURAL AND STRUCTURAL BMPs

BMPs listed under Part III are defined by their title.

53. Adequate Containers for On-Site Solid Waste

54. Aeration of Lawns

55. Compost Production and Use

56. Correct Use of Soils for Septic Tanks

57. Dry Weather Flow Testing of Storm Sewers and Ditches

58. Increase Flow Distances

59. Lane Absorption Areas and Use of Natural Systems

60. Leash Laws and Clean Up After Your Pet Programs

61. Maintain Set Backs From Surface Waters

62. Maximum Recycling of Solid Waste

63. Prompt Clean-Up of Chemical Spills

64. Proper Installation of Septic Tanks and Drainfields

65. Proper Maintenance of Motorized Equipment

66. Routine Maintenance of Septic Tank Systems

67. Soil Testing and Plant Analysis

68. Training for Pesticide Home Applicators

69. Waste Treatment System, Publicly Owned Treatment Works (POTWs)

Additional Water Quality Protection BMPs

- Alum treatments of lakes to stop internal loading once watershed inputs have been addressed
- Storm water chemical treatment systems (alum addition system that treats storm water in-line using alum to remove phosphorus, or ponds that use polymer addition to bind phosphorus)
- NPS ordinances (phosphorus fertilizer use restrictions)
- Wetland restoration
- Rock drain tile inlets
- Land idling/retirement

BEST MANAGEMENT PRACTICES (BMP) MATRIX

This Best Management Practices (BMPs) matrix is a compilation of BMPs defined above. This list helps to illustrate that many BMPs, individually or in combination can be used effectively for many nonpoint pollution sources. Most of the BMPs listed below are from the Natural Resources Conservation Service (NRCS) formally (Soil Conservation Service) Field Office Technical Guide Volume 4.

BMP Matrix

BMP	Feedlots	Ag Erosion	Ag Nutrients	Agl Pesticides	Urban Runoff	ISTS	Biosolids By-Products Com. Waste
Part I. Agricultural BMPs							
1. Access Road		X					
2. Biological Control of Pests				X			
4. Conservation Crop Rotation		X	X	X			
5. Contour Farming	X	X					
6. Correct Application of Pesticides				X			
7. Correct Pesticide Container Disposal				X			
8. Critical Area Planting	X	X					
9. Cultural Control of Pests				X			
10. Deferred Grazing	X						
11. Diversions and Terraces	X	X					
12. Fencing	X	X				X	
13. Field Border		X					
14. Field Windbreak		X					
16. Grade Stabilization Structure		X					
17. Grassed Waterway or Outlet	X	X					
19. Integrated Pest Management				X			
20. Irrigation Water Management		X	X				
21. Lined Waterway or Outlet	X	X					
22. Use Exclusion	X	X					
23. Mulching		X					
24. Nutrient Management	X		X				X
25. Pasture and Hayland Management	X	X					
26. Pasture and Hayland Planting	X	X					
27. Pesticide Selection				X			
28. Prescribed Grazing	X	X					
30. Residue Management (annual)		X					
31. Residue Management (seasonal)		X					
Part 1 Agricultural BMPs, (continued)							
32. Resistant Crop Varieties				X			
33. Riparian Buffer	X	X					
34. Shade Areas	X						
35. Slow Release Fertilizers			X				X

BMP	Feedlots	Ag Erosion	Ag Nutrients	Agl Pesticides	Urban Runoff	ISTS	Biosolids By-Products Com. Waste
36. Soil Testing and Plant Analysis	X		X				X
37. Streambank Protection		X					
38. Stripcropping		X					
39. Timing and Placement of Fertilizers			X				X
40. Tree Planting		X					
41. Vegetative Filter Strip	X	X					
42. Waste Management System	X						
43. Waste Utilization	X						X
44. Water and Sediment Control Basin	X	X					
45. Water/Feeder Location	X						

BMP	Feedlots	Ag Erosion	Ag Nutrients	Ag Pesticides	Urban Runoff	ISTS	Biosolids By-Products Com. Waste
Part II Erosion and Sediment Control BMPs							
1 Vegetation Establishment					X	X	
2 Brush Barrier					X		
3 Construction Road Stabilization					X		
4 Check Dams					X		
5 Critical Area Planting					X		
6 Diversion					X		
7 Dust Control					X		
8 Filter Strips	X		X		X		
9 Grade Stabilization Structures					X		
10 Grassed Waterways or Outlets					X		
11 Gravel Inlet Filter					X		
12 Level Spreader	X				X		
13 Mulching					X		
14 Outlet Protection					X		
15 Paved Flume					X		
16 Permanent Seeding					X		
17 Riprap					X		
18 Silt Fence					X	X	
19 Sodding					X		
20 Sod Inlet Filter					X		
21 Storm Drain Inlet Protection					X		
22 Storm Water Conveyance Channel					X		
23 Straw Bale Barrier					X		
24 Subsurface Drain	X				X		
25 Subsurface Roughening					X		
27 Temporary Fill Division					X		
28 Temp. Gravel Construction Entrance					X		
29 Temporary Right-Of-Way Diversion					X		
30 Temporary Sediment Basin					X		
31 Temporary Sediment Trap					X		
32 Temporary Seeding					X		
33 Temporary Slope Drain					X		
34 Topsoiling					X	X	
35 Tree Preservation and Protection					X		
36 Trees, Shrubs, Vines and Ground Covers					X		
37 Waterway Drop Structure					X		
38 Fertilizer Application Control			X		X		
39 Pesticide Use Control					X		
40 Solid Waste Collection and Disposal					X		
41 Source Control on Construction Sites					X		
42 Street Cleaning					X		
43 Concrete Grid and Modular Pavement					X		
44 Detention Basins					X		

BMP	Feedlots	Ag Erosion	Ag Nutrients	Ag Pesticides	Urban Runoff	ISTS	Biosolids By-Products Com. Waste
Part II BMPs (continued)							
45 Exfiltration Trenches					X		
46 Grassed Waterway (Swale)					X		
47 Parking Lot Storage					X		
49 Retention Basins					X		
50 Rooftop Runoff Disposal	X				X		
51 Storage/Treatment Facilities	X				X		
52 Underdrain Storm Water Filter Systems	X				X		
Part III Other Cultural and Structural BMPs							
50 Adequate Containers for On-Site Solid Waste					X		
55 Compost Production and Use	X				X		
56 Correct use of soils for septic systems					X	X	
57 Dry Weather Flow Testing of Storm Sewers and Ditches					X		
58 Increase Flow Distances					X		
59 Lane Absorption Areas and Use of Natural Systems	X				X		
60 Leash Laws and Clean Up After Your Pet Programs					X		
61 Maintain Set Backs From Surface Waters	X				X		X
62 Maximum Recycling of Solid Waste					X		
63 Prompt Clean-Up of Chemical Spills					X		
64 Proper Installation of Septic Tanks and Drainfields					X	X	
65 Proper Maintenance of Motorized Equipment					X		
66 Routine Maintenance of Septic Tank Systems					X	X	
67 Soil Testing and Plant Analysis					X		
68 Waste Treatment System, Publicly					X		

Additional Water Quality Best Management Practices:
- alum treatments of lakes to stop internal loading once watershed inputs have been addressed
- stormwater chemical treatment systems (lake alum addition system that treats stormwater in-line using alum to remove phosphorus, or ponds that use polymer addition to bind phosphorus)
- NPS ordinances - like phosphorus fertilizer use restrictions and broader categories of NPS ordinances (zoning provisions, permitted/non-permitted and conditional uses)
- rock drain tile inlets
- land idling/retirement