Minnesota Environmental Quality Board

2010 Minnesota Water Plan

Working together to ensure clean water and healthy ecosystems for future generations

November 2010

Environmental Quality Board

The Environmental Quality Board (EQB) brings together the Governor's Office, five citizens and the leaders of nine state agencies in order to develop policy, create long-range plans and review proposed projects that would significantly influence Minnesota's environment and development. *Minnesota Statutes* (see Chapters 103A, 103B, 116C, 116D, and 116G) directs the EQB to:

- Ensure compliance with state environmental policy
- Oversee the environmental review process
- Develop the state water plan and coordinate state water activities
- Coordinate environmental agencies and programs
- Study environmental issues
- Convene environmental congresses
- Advise the Governor and the Legislature

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Upon request, the *2010 Minnesota Water Plan* will be made available in alternate format, such as Braille, large print or audio tape. For TTY, contact Minnesota Relay Service at 800-627-3529 and ask for the Environmental Quality Board. For more information or for paper copies of *2010 Minnesota Water Plan*, contact the Environmental Quality Board at:

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Photographs by Princesa VanBuren Hansen.

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Executive Summary

The *2010 Minnesota Water Plan* defines a vision for Minnesota's water resources that ensures healthy ecosystems and meets the needs of future generations. It recognizes that Minnesota is a leader in managing land and water resources, but that there are opportunities for these programs to improve and adapt.

In 2008, the citizens of Minnesota voted to dedicate special tax revenue to protect and restore the state's land, water, habitat, trails and cultural resources. These valued resources define our identity as Minnesotans, and with this special revenue comes a responsibility to set priorities wisely and in a manner that can most effectively make a difference. We have been given a 25-year timeframe in which to make the investments needed to help Minnesota secure a sustainable future.

In recent years, state agency activities have grown in response to increased needs and associated funding. The state water plan gathers together information regarding these efforts in a single document, while also recognizing contributions from numerous additional concurrent efforts. The goal of this report is to define a broad framework that can be adapted and applied to specific land and water activities.

The water plan has three main parts:

- *Reflecting on the Past* summarizes key points from past decadal planning efforts and presents significant issues and events that have influenced our understanding of natural resource priorities.
- *Evaluating the Status of Minnesota's Water Resources in the Present* provides an overview of the status of the state's groundwater and surface water resources, as well as monitoring efforts and trends.
- *Charting a Roadmap for the Future – Implementation Principles and Strategies* is the foundation of the water plan, identifying key strategies and principles for achieving the vision of sustainable water resource management.

Implementation Principles

The following principles define how state agencies must work together with local and federal partners to ensure effective progress.

1. Optimized coordination – Coordination of efforts must be optimized across local, state and federal entities to maximize the benefits of combined actions.

2. Prioritized resources – Priorities must be set to most effectively target resources and maximize opportunities.

3. Comprehensive land and water management – Sustainable water resources can be achieved when land and water are managed as a holistic system.

4. Adaptive management – Adaptive management must be employed to support informed decision-making while supporting the collection of information to improve future management.

5. Goals and measures – A system to define targets and measure progress must be in place to determine whether water management strategies are achieving desired outcomes.

6. Education and outreach – Effective water resource management efforts must bring together both science education and outreach.

7. Shared, long-term vision – Application of the *Minnesota Water Plan* vision to achieve sustainable water management can unite people into cooperative action, inspiring them to work together for a common future.

Strategies

These strategies identify critical activities that state agencies have set out to accomplish in the coming 10 years, and beyond.

1. Increase protection efforts – Groundwater and surface water supplies are protected from depletion and degradation, recognizing that protection is often more feasible and cost effective than restoration.

2. Promote wise and efficient use of water – Water quality degradation and water quantity conflicts are minimized through the promotion of wise and efficient use of water.

3. Restore and enhance local capacity – Recognition and support for local capacity and actions is increased.

4. Employ water resource management units – State-level water resource management activities are improved by defining water resource management units for coordinating a systems approach to management.

5. Collect information necessary for water management decisions – Information necessary to support sustainable water management decisions is collected efficiently and collaboratively.

6. Improve access to environmental data – Decision-makers and the public have ready access to environmental data to support sound management decisions.

7. Provide current implementation tools – Water resource concerns are addressed through the use of an adaptive approach to updating management tools.

8. Employ a targeted approach for protection and restoration – Land management projects are targeted to high risk areas to protect and restore water resources.

9. Apply a systematic approach for emerging threats – A systematic approach is developed for identifying, assessing and responding to emerging threats.

State agencies are mandated to manage and protect the state's water resources and are committed to continuously adapting programs and direction to achieve water sustainably. The Environmental Quality Board and its member agencies recognize the need to continue to improve coordination of efforts, adapt programs to new information, present clear quantity and quality targets, and communicate these initiatives and progress to the public in the days and years ahead. These implementation principles and strategies define a plan, building upon today's foundation, to set Minnesota on a course to an improved and sustainable future.

The challenges and obstacles are significant, and overcoming them depends on all partners working together to realize sustainability. State agencies provide a framework for collecting information and delivering technical support and funding, but rely extensively on local government, stakeholders and landowners to apply conservation practices and restoration efforts. Equally important is the support from and open communication with elected officials. Only by working together as local, state and legislative partners can Minnesota effectively protect and improve its natural resources.

Chapter 1 Introduction

The *2010 Minnesota Water Plan* defines a vision for Minnesota's water resources that ensures healthy ecosystems and meets the needs of future generations. Minnesota is a leader in managing land and water resources, but recognizes that there are opportunities for these programs to improve and adapt. The *2010 Minnesota Water Plan* brings together in a single document recent work of state water agencies and articulates targeted strategies for the future.

The Environmental Quality Board is charged with coordinating comprehensive long-range water resources planning and policy through a *Minnesota Water Plan* every 10 years. The plan also presents information on the status of the state's water resources. Although the law requires the EQB to develop a state water plan each decade, and while the plan should guide state activities through the decade, the planning horizon should be viewed as long term.

This plan does not set out to touch on every water issue challenging the state. Rather, the goal of the plan is to inform state agency programs that are responsible for addressing the multitude of water challenges facing Minnesotans, and to communicate to the Legislature and public the commitment of the agencies toward working on sustainable water management. This document strives to outline the framework that will be implemented over the coming years to improve water management and the delivery of information. This report is not all-inclusive, but is designed to help set priorities and inform decision-making. Readers of this report are also encouraged to review the appendices for much greater detail on the status of Minnesota's water resources and programs for monitoring and managing them.

Purpose

This plan seeks to integrate the work of state agencies and identify ways that work can usefully guide the activities of local, regional and state agencies. 2010 represents an exciting time for water resource management in Minnesota. While the state is blessed with abundant water and natural resources, these must be managed as an interconnected system to achieve sustainability. Managing for water quality and quantity, while balancing the needs of natural systems with human activity and development, is complex and challenging. But it is critical.

103B.151 COORDINATION OF WATER RESOURCE PLANNING.

The Environmental Quality Board shall:

(2) coordinate comprehensive long-range water resources planning in furtherance of the Environmental Quality Board's "Minnesota Water Plan," published in January 1991, by September 15, 2000, and each ten-year interval afterwards.

The passage of the 2008 Clean Water, Land and Legacy Amendment signals the importance of water resources, habitat and environmental health to the state's citizens, and represents the opportunity to bring all participants and stakeholders together to achieve what is best for nurturing Minnesota's economy, communities, human health, recreation and environment.

Values

Minnesotans truly value their water resources. Through the current University of Minnesota Water Sustainability Framework process, a survey was created to gather input from citizens in the state. Results indicate that citizens consider drinking water as the most important use of water, followed by ecological services. Although resources vary across the state, there is consensus about the need to be protective of drinking water and ecology above other uses. Additionally, survey results show that citizens are most concerned about chemical pollution, but close behind is recognition that nutrient pollution, non-native species and loss of wetlands threaten the quality and character of Minnesota's waters. Survey respondents said they supported equal investment in restoring impaired waters and protecting still-healthy resources; and similarly seemed equally committed to investing in ground and surface waters.

Historical Perspective

Similarly, Minnesotans have long recognized the importance of water resource protection. Specific to groundwater resources, the Groundwater Protection Act of 1989 articulated specific protection goals: "*It is the goal of the state that groundwater be maintained in its natural condition, free from any degradation caused by human activities. It is recognized that for some human activities this degradation prevention goal cannot be practicably achieved. However, where prevention is practicable, it is intended that it be achieved. Where it is not currently practicable, the development of methods and technology that will make prevention practicable is encourage*d" (*Minnesota Statutes* section 103H.001).

103A.204 GROUNDWATER POLICY.

(a) The responsibility for the protection of groundwater in Minnesota is vested in a multiagency approach to management.

(b) The Environmental Quality Board shall prepare a report on policy issues related to its responsibilities listed in paragraph (a), and include these reports with the assessments in section 103A.43 and the "Minnesota Water Plan" in section 103B.151.

The Clean Water Legacy Act of 2006 (*Minnesota Statutes* Chapter 114.10) calls for protecting, restoring and preserving the quality of Minnesota's surface waters. The Legislature, in passing the law, noted in findings that:

- *There is a close link between protecting, restoring, and preserving the quality of Minnesota's surface waters and the ability to develop the state's economy, enhance its quality of life, and protect its human and natural resources;*
- *Achieving the state's water quality goals will require long-term commitment and cooperation by all state and local agencies, and other public and private organizations and individuals, with responsibility and authority for water management, planning, and protection; and*

- *All persons and organizations whose activities affect the quality of waters, including point and nonpoint sources of pollution, have a responsibility to participate in and support efforts to achieve the state's water quality goals*.

In more recent legislation, the Clean Water, Land and Legacy Amendment (Legacy Amendment), passed by Minnesota voters on November 4, 2008, was created to:

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

In response to the Legacy Amendment, the Legislature established the Clean Water Fund (CWF), into which one-third of the Legacy Amendment sales tax proceeds are deposited. *Minnesota Statutes* Section 114D.50 further specifies the allowed uses of the Clean Water Fund:

- Supporting measures to prevent surface waters from becoming impaired, and
- Supporting measures to prevent the degradation of groundwater in accordance with the groundwater degradation prevention goal under section 103H.001.

Recent Activities

State and local agencies have increased their activities associated with water monitoring, planning and aquifer resource evaluation within the last several years. Some of these recent efforts include:

- A Department of Natural Resources (DNR) plan to "*Develop a Groundwater Level Monitoring Network for the 11-County Metropolitan Area*"
- The Metropolitan Council's seven-county Twin Cities Metropolitan Area Master Water Supply Plan and regional groundwater model
- Minnesota Department of Agriculture (MDA) funding to acquire additional analytical equipment to support increased monitoring capacity and an expanded pesticide analyte list
- Minnesota's involvement as a pilot state for a proposed National Groundwater Monitoring Network
- The Environmental Quality Board's water availability reports, "*Managing for Water Sustainability: Report of the EQB Water Availability Project,*" and "*Use of Minnesota's Renewable Water Resources: Moving toward Sustainability*"
- The Freshwater Society's report, "*Water is Life – Protecting A Critical Resource For Future Generations"*
- The Minnesota Pollution Control Agency's (MPCA) redesigned ambient groundwater monitoring network
- MDA and Minnesota Department of Health (MDH) partnership for monitoring community water supplies for pesticides and pesticide degradates
- United States Geological Survey's National Water Quality Assessment research

- The incorporation of groundwater considerations in county water plans
- Improved groundwater data management by MPCA through the EQuIS database
- Studies by the Minnesota Geological Survey and DNR on Minnesota's aquifer resources,
- A cooperative effort with MDA, MPCA, MDH and the Southeast Minnesota Water Resources Board to obtain pesticide data in conjunction with long-term nitrate data collection
- United States Geological Survey's low-flow study on the Mississippi River as it relates to metropolitan surface water supply planning
- The University of Minnesota's water sustainability framework planning efforts
- Continued progress in the advancement of the County Geologic Atlas program
- Second-generation water supply plans for water suppliers
- DNR's Groundwater Technical Work Group assessment of models and tools needed to manage water availability and sustainability
- MPCA's report to the Legislature, "*Statewide Endocrine Disrupting Compound Monitoring Study 2007 – 2008*"

This list is far from exhaustive; many efforts are ongoing or have been completed recently; the bibliography in this report serves as a resource for many of the other documents that detail work and findings.

Contributions from Many Groups

This plan recognizes that sustainable water resource management, monitoring and planning depend on partnerships with and participation of many groups and stakeholders. Federal, state, regional and local government partners are critical to providing effective resource management programs. In addition to these partners, cities, watershed districts, citizen groups and others monitor Minnesota's resources. Many public and private partnerships conduct education and outreach activities. Local and state entities and many other groups and organizations effectively plan for an improved future. Academia, industry and other fields provide research and improvement tools.

While each of these contributions is essential, this plan focuses on state executive branch responsibilities and charges, including, when applicable, the activities and involvement of the Metropolitan Council.

Chapter 2 Reflecting on the Past

The Environmental Quality Board has a long history of preparing decennial Minnesota water plans. Since the board's inception in 1973, each decade has been marked with a commitment to protect and restore Minnesota's water resources. Separately and collectively, these documents express great vision, transformational ideas and indications of progress. There are also recurring thoughts and reflections of barriers that impede Minnesota's ability to realize the articulated visions. It is our challenge, and responsibility, to look to the past to learn and to move forward with a renewed commitment to enact progress. The following passages highlight key issues and findings from earlier state water plans, which in turn have informed the development of the *2010 Minnesota Water Plan*.

"Water is precious to Minnesotans. It is a symbol of our state and our people. Protecting and conserving water resources is an investment in Minnesota, not a cost.

The rich outdoor experience that we value, and that so typifies our state, centers on our lakes, wetlands, and streams. Beneath the surface, we also share the hidden treasure of abundant, pure ground water.

We have come to realize in recent years that our water resources are at risk. We cannot stand pat and maintain the quality of Minnesota's water.

We have begun to understand a very simple principle - the ecological principle of interdependence. What we do on the land affects water quality and availability. When we seek to protect our water quality, we had better understand quantity. When we think to use surface water, we need to realize that ground water may also be affected.

Minnesotans across the state have joined in a unique grassroots campaign called "comprehensive local water planning." The word "comprehensive" signals a recognition of the principle of interdependence; the word "local" means that the people involved are close to the real issues and solutions.

The Minnesota Water Plan sets an ambitious agenda for protecting and conserving our water. It is an agenda in which each of us has a part to play."

Governor Arne Carlson
1991 Minnesota Water Plan
Letter of introduction

Minnesota Watermarks: Gauging the Flow of Progress 2000-2010

Minnesota Watermarks, developed through the EQB Water Resources Committee in September 2000 with assistance from the Water Management Unification Task Force, river basin teams and many others, puts forth four statewide goals and nine objectives:

- **Minnesotans will improve the quality of water resources.**
  - Protect and improve water quality in rivers, streams and other water courses
  - Protect and improve lake water quality
  - Protect and improve groundwater quality

- **Minnesotans will conserve water supplies and maintain the diverse characteristics of water resources to give future generations a healthy environment and a strong economy.**
    - Maintain groundwater levels to sustain surface water bodies and provide water supplies for human development
    - Maintain the hydrologic characteristics of surface water bodies that support beneficial uses
- **Minnesotans will restore and maintain healthy aquatic ecosystems that support diverse plants and wildlife.**
    - Ensure that aquatic environments have conditions suitable for the maintenance of healthy self-sustaining communities of plants and animals
    - Limit geographic range of exotic species
- **Minnesotans will have reasonable and diverse opportunities to enjoy the state's water resources.**
    - Provide access to water-based recreation sites
    - Improve or maintain the quality of water recreation

The report evaluated water resources across the state's seven major basins and concluded that while resources, challenges and priorities varied significantly across the state, six conditions and problems were consistent throughout:

- **Local planning and funding.** Strengthening local planning and ensuring adequate financial resources for local water management were key issues in most basins.

- **Land use.** Land use and its relationship to the condition and quality of lakes, streams and groundwater were of interest in every basin.

- **Prevention.** Most basin teams noted the high quality of water resources and the importance of maintaining these resources in top condition.

- **Education and stewardship.** Water resources are greatly affected by the actions of individuals, who sometimes unknowingly pollute.

- **Climate effects.** All basin teams, recognizing the interrelationship of all aspects of the environment, noted that weather and climate change must be considered in planning for Minnesota's water resources.

- **Coordination.** A continuing, cooperative effort is needed because multiple groups and units of government have an interest in water or are charged with managing them.

Minnesota Water Plan: Directions for Protecting and Conserving Minnesota's Waters

Minnesota Water Plan: Directions for Protecting and Conserving Minnesota's Waters, issued by the EQB in 1991, set an ambitious agenda for protecting and conserving water resources in the state. It identified the principles, policies and actions required for managing water in the 1990s and beyond.

Minnesota's Water Goals:

- To improve and maintain the high quality and availability of Minnesota's water for future generations and long-term health of the environment.
- To ensure that our uses of water are sustainable, and that in meeting our needs for water, we recognize its limits and interconnections, accept its changing and variable nature, and adjust our demands upon it when necessary to safeguard it for future needs.

Minnesota's Water Principles are that we:

- Manage water's interconnections
- Focus on the resource
- Manage hydrologic units
- Make partnerships work for water
- Make prevention the focus
- Put public health and safety first
- Recognize the importance of information
- Understand the importance of research
- Think long-term
- Accept limits to growth
- Make those who benefit pay
- Let citizens make a difference
- Educate people to change behavior
- Make government understandable, adaptable and accountable

Understanding water's interconnections

Water quality cannot be considered without quantity. Availability hinges upon quality as well as quantity. Surface waters are connected to groundwater. Land use affects both quality and quantity of water. Air quality effects water quality. Clearly, the environment must be managed well to protect water, just as water must be managed well to protect the environment.

(A principle from the 1991 water plan)

The 1991 Minnesota Water Plan included 28 recommendations for Minnesota's water resources and for its programs. They were designed to help Minnesota meet the objectives for water management and were framed by the following four overarching categories:

- Integrating water management
- Focusing on the resource
- Protecting and conserving water resources
- Managing water's interconnections

Toward Efficient Allocation and Management: A Strategy to Preserve and Protect Water and Related Land Resources

In June 1979, the Minnesota Water Planning Board, which was merged with the EQB in 1983, published "*Toward Efficient Allocation and Management: A Strategy to Preserve and Protect Water and Related Land Resource*s" with funding from the Legislative Commission on Minnesota's Resources. The report was prepared in response to the previous year's drought. The report set forth four requirements to meet if Minnesota were to achieve its potential:

- A stronger focus on effective management – a cornerstone of Minnesota policy in the past, but even more important in the future.
- Greater emphasis on the efficient allocation and use of water resources and rejection of the concept of water as a limitless, free good.
- Improved collection and dissemination of information for use in making critical water and related land resources decisions.
- Planning, research and decision-making that deal with the interdependence of issues and places increased emphasis on the state as a unit.

Lessons Learned

Review of these historical documents confirms that Minnesotans have long known the challenges they face in protecting human and ecosystem health from the potential threats caused by using land and water. Nationwide, many efforts have led to significant progress and adoption of sound management practices. As an example, according to a recent report released by the Natural Resources Conservation Service, soil erosion on U.S. cropland decreased 43 percent between 1982 and 2007 through increased implementation of conservation practices. While a very laudable accomplishment, more work remains to address both longstanding issues and emerging threats.

Looking back, many of the goals and objectives are essentially unchanged. However, over the past decade, we see a series of challenges and opportunities that uniquely define the environmental, economic and social considerations of today. Challenges to resource management include:

- Increasing pressures on finite resources due to population and economic growth;
- Increasing level of complexity of the issues (a trend that is expected to continue) through increased understandings of dynamic systems and growing threats to them ; and
- Decreasing state funding for local government that has led to inadequate resources in much of the state to support the capacity of local government, upon which state agencies rely for implementing non-regulatory and land-use related management activities.

Similarly there are unique opportunities upon which to build a plan for the future, including:

- Increasing attention to these issues, especially impaired waters, emerging threats and climate change;
- Increasing resources available to do this work through the Clean Water Legacy Act, and more recently the Clean Water Land and Legacy Fund; and
- Improving strategies that water agencies are employing to address the goals and objectives.

Transformational Milestones

Transformational milestones are events or issues that significantly impact water resource management. They can be events that raise public awareness of a topic or problems of such concern that they affect fundamental change in a program's operations. Regardless, transformational milestones help define the state's course in water resource management.

The way in which water resources are viewed continues to evolve. Increased visibility of the need to protect and restore resources has arisen from attention to such issues as climate change and hypoxia in the Gulf of Mexico. These issues, along with other events and milestones, impact the work of state agencies and help characterize today's challenges and needs.

Population Growth

The state's population has grown by almost 500,000 people since publication of the 2000 state water plan. That growth increases the pressure on finite resources and reflects a nationwide trend that offers few if any easy answers.

Ecosystem Fragmentation

Continued development on the landscape further fragments ecosystems. This fragmentation adversely affects biology, water quality, hydrology and connectivity, degrading the ecological functions that support healthy watersheds.

Climate Change

Climate change is a recognized threat with the potential for far-reaching impacts on land, water and habitat. Increased modeling and characterization of future scenarios has raised its visibility while fostering development of

Ten years ago few Minnesotans talked about impaired waters and even fewer used the TMDL acronym. But today thousands of Minnesotans have been engaged in Total Maximum Daily Load efforts and agencies have adapted their programs to new monitoring and priority efforts. No one has a crystal ball to predict what will transpire in the coming years, which is why state agencies must be ready to respond with adaptive management techniques and coordinated efforts. Looking back over the last decade the following issues and events have driven programmatic change:

- ***Population growth and increased competition for resources***
- ***Ecosystem fragmentation***
- ***Climate change***
- ***Hypoxia in the Gulf of Mexico***
- ***Contaminants of emerging concern, including endocrine active compounds***
- ***Impaired waters and TMDLs***
- ***2006 Clean Water Legacy Act and the2008 Clean Water Land and Legacy Amendment***
- ***Sustainability as a goal***

Looking forward there will be unforeseeable challenges, but a system can be developed to guide a strategic response. Working together, the citizens, local governments, agencies and Legislature can move successfully toward a goal of sustainability.

interagency teams with federal, state, local, industry and academic members. There are, however, inherent complexities in measuring climate changes and forecasting likely impacts. Consequently, developing response mechanisms that must also be easily adaptable is a significant challenge.

Hypoxia

Recent media attention regarding hypoxia (oxygen deprivation in the Gulf of Mexico caused by excess nutrients discharging to the Mississippi River) has increased scrutiny of land-use practices in the Upper Mississippi River Valley. This is a complex issue, with many sources contributing nutrients to the river, including runoff from urban areas, wastewater discharges and industrial discharges, as well as others. Minnesota and its Midwest neighbors recognize that farming practices, while critical for feeding people and supporting the economy, impact water quality within and beyond the state's borders and that there is a continuing need to enhance conservation practices.

Contaminants of Emerging Concern

The Minnesota Pollution Control Agency and the departments of Agriculture and Health are working on efforts to characterize and respond to contaminants of emerging concern (CEC), including endocrine active compounds, pharmaceuticals and personal care products. The state continues to be active in assembling information about the presence, extent and potential impact of these chemicals.

Impaired Waters and TMDLs

Since the drafting of the 2000 state water plan, thousands of Minnesotans have been engaged in Total Maximum Daily Load (TMDL) efforts, which focus on evaluating whether waters are meeting quality and designated use standards. This process has increased understanding of the status of the state's water resources, while also helping the public to better appreciate the connection of land activities with water quality.

Clean Water Legacy Act and Legacy Amendment

Minnesota is dedicating important resources to tackle these challenges. The 2006 Clean Water Legacy Act, the 2008 Legacy Amendment and subsequent water resource funding support programs are increasing monitoring and reporting, promoting the understanding of a dynamic land and water system, and enhancing water restoration and protection activities.

Sustainability as a Goal

Water quality has been a significant public policy topic for decades, but more recent discussion is focused on sustainability. A commonly defined goal of achieving sustainability has led to continued coordination among programs and an acceptance that "…water use is sustainable when the use does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs (Minnesota Session Law 2009 c172)." A recognized goal is better understanding of the flow through surface water and groundwater so that allocations of water may be made without adverse impacts on human or ecosystem health.

Improved technology, data transfer programs and online support tools have increased the knowledge base of local governments and other support systems. While information sharing has improved, local partners have struggled with diminished financial resources, limiting their ability to implement local protection and restoration efforts.

Early efforts based on the Federal Clean Water Act focused primarily on point sources. Programs since then have addressed most point sources, successfully improving the environment. Today, nonpoint sources of pollution present the greatest challenge. Effective responses will depend on the use of multiple tools, new technologies and enhanced education efforts.

Looking back, transformational milestones have helped define priorities and needs. There have been significant accomplishments, laudable advances and new challenges. Working together, citizens, local governments, agencies and the Legislature can create an improved future where sustainability of waters and ecosystems is the common goal.

Chapter 3 Evaluating the Status of Minnesota's Water Resources in the Present

Monitoring Dynamic Systems

State agencies conduct a variety of water monitoring activities to assess quality and quantity; have regulatory and technical and financial assistance programs to aid in compliance with regulation of water resources; and coordinate activities to avoid overlap of agency responsibilities and maximize efficiency. Minnesota's landscape, weather patterns and land and water use are continually changing, making assessments of progress in water resource management efforts challenging but ever more important. Significant improvements in management of water quality and quantity in one area of a watershed, for example, may be offset by negative changes in another. It is important to consider changes in land and water use and demography to provide a context for monitoring and assessing changes in water quality.

Understanding the Context of Trends

As an example, water quality monitoring may indicate that a particular stream impaired for its type and quality has not improved significantly over the past 20 years. That might be either encouraging or discouraging, depending on what is happening upstream. If there has been a large increase in development and impervious surfaces upstream (e.g. from home construction) but no decrease in water quality, then it may be that improvements in storm water management practices on individual sites have resulted in no net increase in impact to the water body, despite a significant potential for damage compared to historical storm water management practices.

Similarly, there may have been significant improvements in protecting groundwater within a wellhead protection area but, because of the slow rate of travel, it may take years or decades before the effects of those improvements can be detected at groundwater monitoring sites. Additionally, in recent years analytical capabilities and methods have dramatically increased the ability to detect new potential contaminants in the environment. At the same time, public and stakeholder interest in previously unidentified contaminants, as well as other threats to water resources such as from invasive species and climate change, have increased the complexity of water management in Minnesota.

The key goal for water resource management is to have enough water of the quality desired for the intended use at the location where it is needed now and for future generations. That is, while it may not be possible or practicable to protect or restore all waters of the state to the highest levels of quality (e.g. pre-settlement conditions), the state must be strategic in its water protection and restoration efforts to help ensure that ground and surface waters of the quality and quantity desired are available and that standards are met. Therefore, trend information is critical to defining a strategy that will address threats to water resources and ensure effective policies and plans that direct activities toward protecting and restoring water quality and quantity.

Context for Reporting

The Environmental Quality Board (EQB) is charged in statute for consolidating the water quality, quantity and planning assessments detailed in M.S. 103A.43, 103H.175 and 473.1565. This section of the *Minnesota Water Plan* summarizes four agency reports (Appendices A through D) to provide current status information on surface and ground water quality and quantity and metropolitan planning activities. This context is important for understanding the relationships of land use to water quality and quantity and, most importantly, the relationship of human health to water resource and ecological health. This section of the Minnesota Water Plan has three parts:

- Status of Minnesota's Water Quality
- Status of Minnesota's Water Quantity
- Status of Metropolitan Area Water Supply Planning

103A.43 WATER ASSESSMENTS AND REPORTS

The Environmental Quality Board is charged in statute for consolidating the water quality, quantity and planning assessments detailed in M.S. 103A.43, 103H.175 and 473.1565.

Status of Minnesota's Water Quality

Minnesota employs a multi-agency approach to monitoring surface and groundwater that requires a wide range of technical expertise to evaluate and assess resources. It requires the concerted effort of all responsible state agencies, along with local and federal partners as well as citizens, to build a comprehensive picture of the status of the state's water quality. Two agency reports on the status of Minnesota's water quality are summarized in this section.

Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts

Minnesota Statutes 103A.43 instructs the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Agriculture (MDA) to conduct a biennial assessment of water quality trends (Appendix A). Assessing water quality trends in both surface and groundwater is very timely because the information regarding status and trends aids in setting priorities for data collection, research and implementation. Additionally, with recent communication efforts related to impaired waters, as well as threats to drinking water, it is a topic of great interest to state agencies, the Legislature and the citizens of Minnesota.

103A.43 WATER ASSESSMENTS AND REPORTS

(b) The Pollution Control Agency and the Department of Agriculture shall provide a biennial assessment and analysis of water quality, groundwater degradation trends, and efforts to reduce, prevent, minimize, and eliminate degradation of water. The assessment and analysis must include an analysis of relevant monitoring data.

Report Overview - Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts

This MPCA and MDA biennial assessment provides an overview of relevant monitoring data and efforts to reduce, prevent, minimize and eliminate sources of water pollution to Minnesota's ground and surface water resources. This document draws from existing reports and information to highlight current water quality conditions and program activities.

The report summarizes relevant water quality monitoring data for both ground and surface water in Minnesota from the MPCA and MDA. The report also consolidates information from a number of individual reports, documents and databases on the status and trends of the state's water quality resources. Because of the large amount of information available, this report is summary in nature and directs the reader to additional information through web-based links.

Information on groundwater quality is presented first, highlighting nitrates, pesticides, volatile organic compounds, chlorides and contaminants of emerging concern. The groundwater information is followed by descriptions of the efforts to prevent and eliminate groundwater degradation through program activities conducted by the two agencies.

Surface water quality information is presented next by water resources (i.e. lakes, streams and wetlands) and emphasizes the status and trends of Minnesota's surface water quality. Lake water transparency data, pesticide detections, trends in water quality indicator parameters and impaired waters listings are presented to highlight Minnesota's surface water quality conditions. As with groundwater, efforts to reduce and minimize surface water degradation include multiple program activities conducted by the MPCA and MDA.

Conclusions and Recommendations - Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts

The MPCA and MDA collect water quality information in response to both broad and specific statutory mandates to explore water quality issues of current and emerging concern and, in accordance with formal interagency agreements, through continuous cooperation and coordination.

Significant progress has been made by MPCA, MDA and stakeholders in addressing sources of groundwater contamination, particularly through remediation, permitting and best management practices. However, concerns still exist, and continued effort is needed, to fully realize the state's groundwater quality goals.

Improvements in surface water quality have also been significant, along with voluntary and regulatory reduction of point and nonpoint sources of pollution through MDA and MPCA programs and stakeholder support. Coupled with these gains are opportunities for continued improvements, along with additional actions that are needed to realize Minnesota's surface water quality goals.

For both ground and surface water resources, ongoing monitoring is required to characterize vulnerable aquifers and landscape settings. Additionally, MDA and MPCA must continue to identify and investigate contaminant problems, including the presence and extent of emerging contaminants. Ongoing monitoring provides the trend data that are critical in evaluating progress and refining management actions. Protection strategies, whether regulatory or voluntary, must be developed to avoid the occurrence of new problems. Furthermore, all strategies should be periodically re-evaluated and refined in order to adapt to changing situations in chemical and land use.

2010 Groundwater Monitoring Status Report

The 1989 Groundwater Protection Act (*Minnesota Statutes* 103H.175) requires the Minnesota Pollution Control Agency (MPCA), in cooperation with other agencies participating in the monitoring of water resources, to report on the status of groundwater monitoring to the Environmental Quality Board for review in each even-numbered year. The *2010 Groundwater Monitoring Status Report* (Appendix B) fulfills this requirement.

103H.175 GROUNDWATER QUALITY MONITORING

"In each even-numbered year, the Pollution Control Agency, in cooperation with other agencies participating in the monitoring of water resources, shall provide a draft report on the status of groundwater monitoring to the Environmental Quality Board for review and then to the house of representatives and senate committees with jurisdiction over the environment, natural resources, and agriculture as part of the report in section 103A.204."

Report Overview - 2010 Groundwater Monitoring Status Report

The *Groundwater Monitoring Status Report* details groundwater monitoring efforts at three scales: national, statewide and regional. Monitoring of both quality and quantity is performed by the U.S. Geological Survey, MPCA, Minnesota Department of Agriculture (MDA), Minnesota Department of Natural Resources (DNR) and Metropolitan Council and includes work by consultants and the citizen monitoring network. This multi-level team approach provides for a more comprehensive assessment of the resources.

At the state agency level, the MPCA, MDA and Minnesota Department of Health (MDH) each have important statutory responsibilities in protecting the quality of Minnesota's groundwater. The MPCA and MDA conduct statewide ambient groundwater quality monitoring. The MDH conducts groundwater monitoring for the purpose of regulating public and private water supply wells and evaluating the risk of contaminants in groundwater to human health. In addition to these agencies, the DNR monitors groundwater quantity conditions across the state through a network of monitoring wells. The groundwater monitoring roles conducted by these agencies, as stipulated by state statute, are shown in Figure 1.

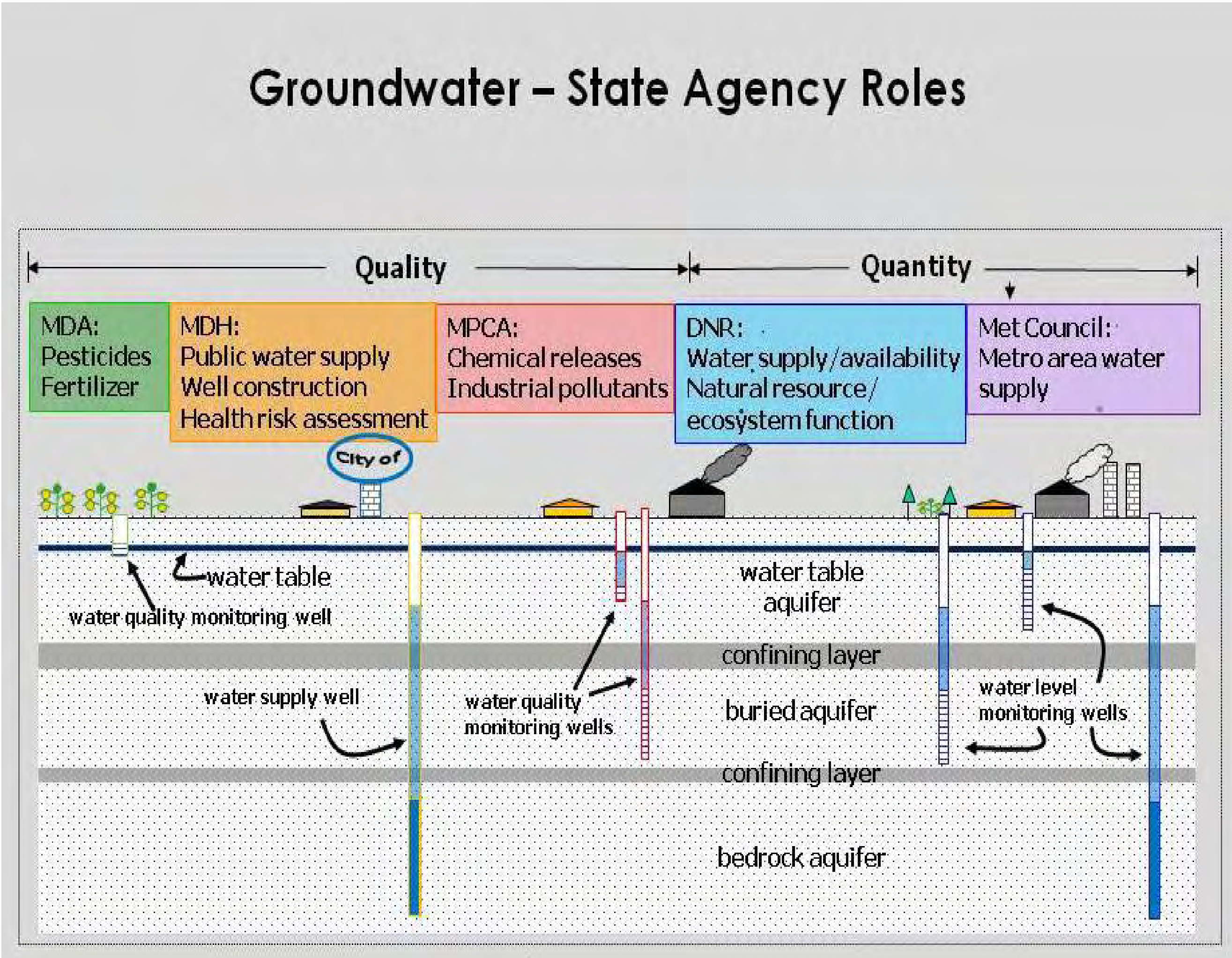

Figure 1. Coordinating roles in water management.

Conclusions and Recommendations - 2010 Groundwater Monitoring Status Report

Monitoring efforts to date in Minnesota have identified that groundwater quality generally is good and in compliance with drinking water standards. However, human-caused impacts to groundwater quality are apparent in many areas of the state. Those areas of impacted groundwater correlate with land use practices known to cause the observed quality impacts. Groundwater monitoring continues to verify the presence of elevated concentrations of nitrates, low concentrations of pesticides and their degradation by-products, and chlorides in more sensitive aquifers within the state. The more recent detections of contaminants of emerging concern CECs and perfluorochemicals (PFCs) in groundwater require additional monitoring efforts to evaluate the extent of their presence.

The need for monitoring groundwater quality and quantity continues. A long-term commitment to the collection and analysis of groundwater data is necessary to identify changes in water quality and quantity over time and to provide information that is necessary to effectively manage and protect this critical resource. Groundwater movement is generally slow and often requires years of monitoring to assess the trends and impacts of human activities on this resource.

Long-term monitoring networks coupled with adequate systems by which to share groundwater data are necessary to determine whether the quality and quantity of Minnesota's groundwater resources are at risk and to inform management decisions. Continued investments are required to understand and protect groundwater systems to ensure that future generations will also have an abundant source of clean water.

Status of Minnesota's Water Quantity

2010 Water Availability Assessment Report

Minnesota Statutes section 103A.43 instructs the Department of Natural Resources (DNR) to conduct an assessment of water use and availability on a five-year basis, with reports from even years compiled in the decadal state water plan (Appendix C). The goal of this charge is to provide a status update on the availability of Minnesota's water resources as well as trends in appropriations and water resources. The latest report, completed in 2007 jointly by the EQB and DNR, builds on a 2000 DNR report, *Minnesota's Water Supply: Natural Conditions and Human Impacts*. The DNR more recently prepared an additional report, *Long-term Protection of the State's Surface and Groundwater Resources*, to define options and funding as they relate to programs necessary for providing adequate protection of the state's water resources.

103A.43 WATER ASSESSMENTS AND REPORTS

(c) The Department of Natural Resources shall provide an assessment and analysis of the quantity of surface and ground water in the state and the availability of water to meet the state's needs.

The *2010 Water Availability Assessment Report* was prepared in response to M.S. 103A.43. The report discussed that the availability of water to meet the state's needs is determined by three basic factors: climate and global weather patterns, human changes to flow pathways and to water use, and human changes to water quality. Of these, climate and global weather patterns are challenging to manage directly. Conversely, people have great ability to affect water quality and water pathways. In order to address the long-term sustainability and availability of water and natural resources, the DNR must engage in long-term thinking and planning efforts. In this report, the agency details trend information related to precipitation, stream flows, lake levels, groundwater levels and water use.

Report Overview - 2010 Water Availability Assessment Report

The DNR is charged with overseeing the state's Water Appropriation Permit Program to ensure that water quantity is managed wisely to protect the long-term viability of the water resource for people and the environment. *Minnesota Statutes* 103G.265 requires the DNR to manage water resources to ensure an adequate supply to meet long-range seasonal requirements for domestic, agricultural, fish and wildlife, recreational, power, navigation and quality control purposes.

Minnesota's climate provides an ample supply of water. A relatively good network exists for understanding precipitation patterns, lake levels and stream flow that enable management of surface water systems. However, far less is known about the groundwater system. Since 75 percent of Minnesotans depend on groundwater systems, and because dependence is increasing, aquifer systems will need to be better defined in the future. Additionally, the state will require a better understanding of the relationships between surface and groundwater and the health of Minnesota's ecosystems.

Conclusions and Recommendations - 2010 Water Availability Assessment Report

In conclusion, the report states that an increasing number of Minnesota locations are experiencing water supply problems related to inadequate supplies, unacceptable quality or both. Water availability problems are more evident in places where:

- Water is being consumed faster than it can be replenished;
- Land use choices that are made without proper planning and protective practices are degrading water supplies; and
- The natural landscape has been changed so greatly that the ecosystems that remain are no longer able to provide essential cleansing and recharge functions.

> Waters that become impaired by contaminants are still available for use; however, the cost of removing contaminants may be so expensive that the resource becomes undesirable and is not considered available.

Well-managed industry, agriculture, housing, manufacturing, power generation and public water supply systems are all necessary elements for nurturing and sustaining communities. To maintain all the natural resource features that contribute to Minnesota's attractive quality of life, including fish and wildlife habitat and recreational opportunities, each growth and development decision must include consideration of its effect on the water supply and associated water resources. Careful consideration of the effect each use may have on the available water supply is essential for the sustainability of the water supply and the water supply's ability to be recharged for future growth, development and enjoyment. Ensuring the future of Minnesota's water supply will require practicing thoughtful water supply management, including conservation, restoration, study and protection. Only in this manner will Minnesotans continue to wisely control their water resource destiny.

Past management systems were designed around managing the consequences of an individual project to prevent an adverse impact on the natural system. While largely successful in this endeavor, the challenge for all levels of government in Minnesota will be adapting to understand and manage the impacts on public, economic and environmental health from the collective actions of all land use and water supply management decisions.

The report states that to begin to eliminate current problems and avoid future water availability problems, Minnesota must improve both understanding and the quality of management decisions in the following areas:

- We need to significantly increase our understanding of how water moves into, through and out of the earth beneath us.
- We will need to learn how to reduce our withdrawal of water to not exceed the rate of recharge nor adversely impact local resources. As we pump groundwater from the aquifer system, withdrawals have the potential to reach a point after which they will not be sustainable and competition and conflicts will ensue.
- We will need to manage land uses to ensure that water recharge to our groundwater systems has had sufficient time or treatment to remove contaminants before entering subsurface flow pathways.
- And finally, we will need to learn more about how our surface waters are dependent on groundwater systems for supply throughout the year so we can prevent undesirable impacts in lakes and wetlands, rivers and streams, and in natural and rare plant communities that all provide important functions toward the quality of life we have enjoyed in Minnesota.

The report concludes the greatest threat to having sufficient water to assure our many and varied needs comes from how we have manipulated the landscape without due consideration of its impacts on water quantity, water quality and the ecosystem. The ecosystem functions of natural plant communities that slow water flow and remove nutrients and other compounds can reduce problems through better landscape planning and management choices that retain these essential functions. Looking forward, Minnesota must become much wiser about how it is managing the lands and waters of the state if there is hope for the desired availability and quality of water to provide the quality of life we desire.

Status of Metropolitan Water Supply Planning

Metropolitan Area Water Supply Planning: Report to the Legislature as part of the 2010 Minnesota State Water Plan

The Metropolitan Council is directed in *Minnesota Statutes* 473.1565 to submit findings, recommendations and planning activities to the EQB for inclusion in the *2010 State Water Plan*. The report, *Metropolitan Area Water Supply Planning*, is Appendix D.

473.1565 METROPOLITAN AREA WATER SUPPLY PLANNING ACTIVITIES

The council must submit reports to the legislature regarding its findings, recommendations, and continuing planning activities under subdivision 1. These reports shall be included in the "Minnesota Water Plan" required in section 103B.151, and five-year interim reports may be provided as necessary.

The Metropolitan Council is responsible for carrying out planning activities that address the water supply needs of the metropolitan area. Planning activities include the development of a *Twin Cities Metropolitan Area Master Water Supply Plan*. This plan was developed in cooperation with the Metropolitan Area Water Supply Advisory committee, the Minnesota Department of Natural Resources and additional stakeholders to provide guidance, emphasize conservation, promote inter-jurisdictional cooperation and inform long-term sustainability with consideration for reliability, security and cost effectiveness.

Report Overview - Metropolitan Area Water Supply Planning

The plan for the seven-county area, approved in March 2010, summarizes five years of community outreach, data collection and technical analysis. The framework in the plan guides long-term water supply planning at the local and regional level. The plan uses an adaptive approach to water supply management, setting forth a dynamic process for the collection of new information, updating analytical tools, and improving guidance to address anticipated water resource issues and to ensure supplies are developed sustainably.

The Council's planning activities were organized into two phases. During the first phase, culminating in a report to the 2007 Minnesota Legislature, the Council conducted a preliminary evaluation of water supply availability, examined the water supply decision-making and approval process and explored the need for a regional role in water supply safety, security and reliability. The second phase refined the water resource availability assessment and culminated in the *Metropolitan Area Master Water Supply Plan*. Phase II analyses focused on the following stakeholder-identified issues that have limited water supply availability in the past and may occur in the future:

- Impact to surface water features
- Significant aquifer drawdown
- Well interference
- Impact to trout streams or calcareous fens
- Aquifer vulnerability
- Presence of special well construction areas

Definitions

Traditional groundwater sources are sources that are currently used by each community.

Alternative water sources include other aquifers, surface waters and neighboring water supply systems.

The analysis conducted as part of the planning effort indicates that, overall, the region's water resources are adequate to meet projected demands for the foreseeable future. However, local issues are predicted to continue to arise if traditional sources are developed to meet those demands. The issues include impacts to surface waters, unacceptable groundwater declines and the potential for interference with private wells.

Conclusions and Recommendations – Metropolitan Area Water Supply Planning

The Master Plan provides a framework for long-term water supply development at the local and regional level that does not harm ecosystems, degrade water quality or compromise the ability of future generations to meet their needs. The plan recognizes the benefits of identifying, early in the process, issues that communities need to address.

The plan presents the results of the metropolitan area water supply availability assessment at both a regional and community scale. The region-wide water supply assessment highlights potential problem areas so that they can be considered in the development of region-wide plans. The plan also provides enough detail on the potential local problems to ensure that water suppliers will be aware of what must be addressed as part of development. This scale variability is intended to identify and coordinate water supply planning activities among utilities, local, regional and state planners and resource managers, reducing the likelihood that water supply problems will develop "under the radar."

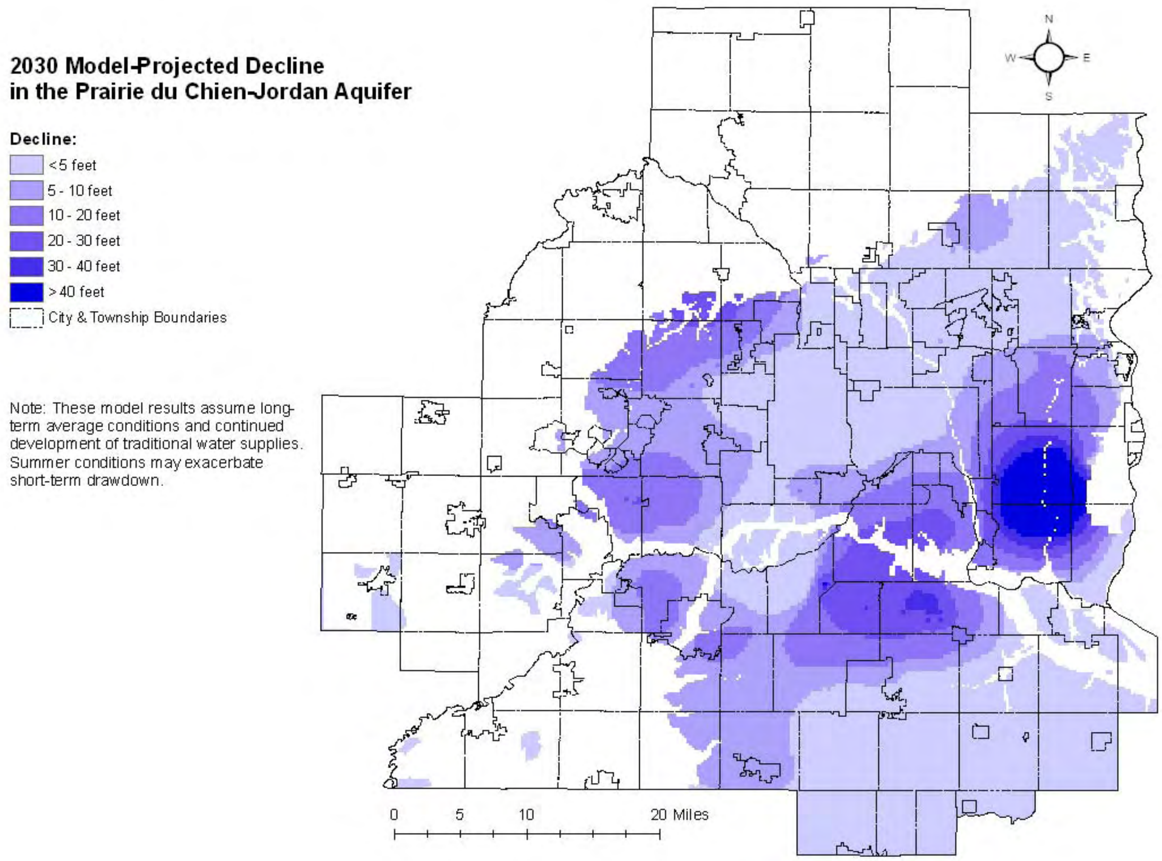

Figure 2: The analysis shows potential groundwater level drawdown primarily in outer-ring suburbs that rely primarily on groundwater. Should these communities continue to use their traditional groundwater sources, aquifer water levels are expected to decline significantly in some areas. Use of alternative water sources may neutralize predicted impacts.

The plan presents local information in community-specific water supply profiles. The profiles provide information about each community's current and projected water demand, current potential supply sources and issues identified through the technical analysis. In addition, the plan provides guidance to communities for addressing the issues identified in their profiles. With this information, communities will be aware of potential water supply issues and the range of appropriate solutions before investing significant time and money in infrastructure planning.

The 2010 master water supply plan expands upon recommendations identified in the 2007 legislative report, particularly those that support an adaptive management framework. The master water supply plan stresses ongoing data collection, analysis and tool updates for water supply decisions. As the regional planning process continues, these tools will support the development and implementation of long-term sustainable water system decisions. Lessons learned through this process are expected to result in future recommendations to ensure the sustainable development of water supplies.

Chapter 4 Charting a Roadmap for the Future – Implementation Principles and Strategies

In preparing for the *2010 Minnesota Water Plan*, the EQB convened an interagency team to identify strategic directions for guiding the water-related functions of the agencies over the next 10 years and beyond. While the next state water plan is scheduled for 2020, the vision of these directions is long-term, extending well beyond that date.

Planning, reporting and stakeholder involvement activities regarding Minnesota water resource management needs and challenges contributed to the foundation of this plan. In the last five years alone, agency personnel have engaged in coordination and planning efforts that have called on the expertise of hundreds of state professionals and thousands of engaged citizens. The results of these efforts, including the needs expressed and ideas for an improved future, contributed to the development of this plan.

The Legislature charges several state agencies with managing and protecting Minnesota's water resources. These agencies are committed to continuously adapting programs and direction to ensure sustainable water management. However, these programmatic changes take time. Furthermore, benefits are often complex and thus should be thoughtfully communicated to the public because the pace and presence of change can be inconspicuous. Additionally, land and water interactions are highly complex and dynamic systems; land and water improvement efforts often take years to demonstrate change, or change may be masked by other environmental conditions. Looking forward, the EQB and its member agencies recognize the need to continue to improve coordination of efforts, adapt programs to new information and communicate these initiatives and successes to the public.

Principles to Guide Implementation

The strategic directions frame the work that will occur, while these principles guide their implementation:

- Optimized coordination
- Prioritized resources
- Comprehensive land and water management
- Adaptive management
- Goals and measures
- Education and outreach
- Shared, long-term vision

This report outlines nine *strategies for guiding the work of agencies.* During the development of these *strategies*, certain overarching *principles* were recognized that cut across boundaries and are critical to each strategy. *These principles define how the work of the strategies will be implemented*. The implementation principles are discussed first, followed by a presentation of the strategies.

Implementation Principle #1 – Optimized Coordination

Coordination of efforts must be optimized across local, state and federal entities to maximize the benefits of combined actions.

Natural resource challenges are great, the implications of decision-making are significant and the resources to address the challenges are finite. There has been a clear call for improved coordination, and a responding increased effort among state agencies that is now expanding to include local government, the research community, federal entities and other interests.

The majority of day-to-day coordination efforts lack visibility because they are routine – but nonetheless critical – to successful water management. Effectively administered coordination leads to improved efficiencies and program adaptation. Coordination must continue to be promoted and expanded, as well as communicated to the public and Legislature.

Implementation Principle #2 – Prioritized resources

Priorities must be set to most effectively target resources and maximize opportunities.

Agencies recognize a need to effectively prioritize resources to maximize the effectiveness of their efforts by directing them to areas where the need is greatest and the impact is expected to produce the most beneficial results. Examples include:

- Monitoring – Gather data where the need is greatest, or in ways that are better coordinated with related efforts
- Protection – Target protection measures with consideration for factors such as where the threat is most imminent, or the land and water resource is considered of highest value
- Restoration – Apply restoration in concert with other activities based on consideration of the value of the resource, the potential impact of the proposed restoration, and the engagement of the local stakeholders, along with other site specific factors
- Research – Define the questions that are most in need of answers
- Problem identification – Identify the most critical water resource problems and target actions and/or resources to address them
- Stakeholder engagement – Target stakeholder engagement in concert with monitoring, protection or restoration activities
- Outreach – Target outreach efforts in a timely manner and where they are most needed (e.g. in advance of future resource management activities so that those activities will be done by engaged and informed citizens, industry and local government)

In a time when decisions often need to be made with incomplete data, it is critical that agencies at all levels of government prioritize their activities and dedicate personnel and resources toward areas that have the greatest need and can provide the highest benefit.

Implementation Principle #3 – Comprehensive Land and Water Management

Sustainable water resources can be achieved when land and water are managed as a holistic system.

Land and water must be viewed and managed holistically using a systems approach that recognizes their complex interconnections. A raindrop that begins as surface water may soon become groundwater, only to be discharged later to the surface water system. Comprehensive water management recognizes this – and the way in which quantity and quality are intricately linked.

If water is not of sufficient quality for its defined use, it will not be available, without treatment, in the necessary quantity. Furthermore, both quality and quantity are directly connected to land management practices and land use changes, including those that result in water consumption. Vegetative habitat affects water quantity and quality in ways that directly impact the biology of the stream, all of which are indicators of ecosystem health. A degraded ecosystem can often be used as an indicator of a system from which water or fish may also be harmful for human consumption. Conversely, a healthy aquatic system often indicates a system that is adequate for sustaining human health. Looking to the future, no single part of the system can effectively be managed alone; rather, it must be evaluated and managed as a system with consideration of all respective interactions.

Implementation Principle #4 – Adaptive Management

Adaptive management must be employed to support informed decision-making while supporting the collection of information to improve future management.

Adaptive management is a structured, iterative process of optimal decision-making relative to changing demands, environmental conditions and uncertainty, with a goal of addressing change and reducing uncertainty over time by adequately monitoring the system and its response. In this way, decision making simultaneously optimizes resource objectives and generates information needed to improve future management. Adaptive management is often characterized as "learning by doing."

Minimizing Risk through Application of Adaptive Management

Managing water resources for the goal of water sustainability requires decision-making in the face of uncertainty. Waiting for the collection of more information is a decision in itself, with risk associated in waiting to act.

Some or all of the principles of adaptive management have been used to some degree in water resource management in the state for decades. Conversely, some programs and management strategies have not adequately responded to the need for change relative to improved understanding, while others have not been developed to collect sufficient information to assess effectiveness. Agencies involved with water management are more robustly integrating adaptive management into their respective programs and will continue to employ this approach in the months and years ahead. State programs must be transparent about what has worked and what hasn't, and how the modified response will address what has been learned. Additionally, adaptive management calls for periodic examination of progress and review of each program's defined goals. As an example, the impaired waters process was intentionally designed to be an iterative effort, informed by newly generated information.

Water resources must be managed to meet a growing number of competing needs, at multiple scales, and over the long-term and in many situations where high levels of uncertainty exist. A foundational premise of adaptive management is that knowledge of water resources, and the services that they provide, is not only incomplete but elusive. However, these resources are and need to continue to be used, even in the face of uncertainty. Decision-making must take place using the best available information at the time. Adaptive management allows future decisions to improve based on new data. The ability to act must be supported by the ability to react – quickly and with the best resources currently available – when information indicates uses are unsustainable.

Restoring water quality, hydrology and ecosystems that have been degraded by significant human alteration of natural systems over decades will be challenging; progress may also take decades. Implementing effective programs that will result in environmental improvements requires the recognition that some trial and error is necessary. There also must be recognition that the complexity of natural systems which are being managed is so great that despite significant scientific work and understanding, even in the most well-studied systems, uncertainty will persist. However, with an appropriately designed monitoring and evaluation process, management decisions can be periodically refined to improve effectiveness and ultimately achieve management goals.

One tenet of the Great Lakes Compact (*Minnesota Statutes* section 103G.801) is "*to promote an adaptive management approach to the conservation and management of basin water resources, which recognizes, considers and provides adjustments for the uncertainties in, and evolution of, scientific knowledge concerning the basin's waters and water dependent natural resources,*" demonstrating the state's commitment to utilize an adaptive management approach in water resource management.

Implementation Principle #5 – Goals and Measures

A system to define targets and measure progress must be in place to determine whether water management strategies are achieving desired outcomes.

State agencies in recent years have begun to explicitly define targets and measures, and track them to gauge performance. It is critical to develop these measures specifically for the outcomes sought. These measures may be water resource improvement trends, indicators of social change or measures of adoption of best management practices or urban conservation practices.

TMDL Implementation Plans are written to include specific targets and defined measures, such as number of conservation practices adopted, pollution reduction schedules (e.g. a 25% reduction in phosphorus loading by the year 2020), and water quality improvement trends.

Passage of the Clean Water, Land and Legacy Constitutional Amendment in 2008 sent a clear message to the Legislature and Executive Branch that the citizens of Minnesota strongly value natural resources, habitat, trails and parks. However, the 25-year commitment demands that progress must be achieved and that resources must be distributed wisely. Tracking measures of effectiveness demonstrates that Minnesota is improving its environment, gathering information that can support the adaptive management principle, and communicating progress to the citizens. An interagency team is developing measures specific to the Amendment resources and will be recommending long-term measures and targets to track:

- Agency performance, including activities and outputs;
- Financing, such as local efforts and leveraged funding;
- Environmental changes related to water resource trends; and
- Societal changes, such as adopting new homeowner practices.

None of these efforts are easy to track; both environmental and societal changes are particularly hard to measure because they take time to mature, and cause/effect relationships are hard to untangle. Regardless, the end goal is wise use of resources and progress toward a sustainable environment.

Implementation Principle #6 – Education and Outreach

Effective water resource management efforts must bring together both science education and outreach

State agencies recognize that the desired actions to protect water resources must take place on the landscape, which often results from the actions of individual landowners, communities, local government and the business community. Landowners and decision-makers can benefit when the state provides guidance and direction based on the best available science and data. Thus, while strong water management demands good data and a sound understanding of system dynamics, there must also be a commitment to partner with landowners, stakeholders and local government.

Environmental education takes place in many different ways. Mechanisms include the traditional K-12 education, but also community programs, summer camps, environmental organizations, community education efforts and many others. Complementary to the work of state agencies is communicating with customer bases; engaging in active stakeholder efforts; communicating generally through print and electronic publications and mailings; and working with traditional educators in developing curriculum. These efforts must continue and grow in the future to affect positive actions and change on the landscape. Mutually beneficial partnerships will need to be fostered to ensure that education by nongovernmental groups complement agency outreach and stakeholder efforts.

Success in achieving the water plan vision depends on all levels of government working in coordination on its implementation. State agencies provide the framework in which information is collected and programs are administered, but rely heavily on local government, stakeholders and landowners to apply conservation practices and restoration efforts. Equally important is the support from and open communication with our elected officials. Only working together as local, state and legislative partners can we effectively improve our natural resource trends. Education and outreach are important components to ensuring all partners have access to the same information and that effective dialogues take place.

Implementation Principle #7 – Shared, Long-Term Vision

Application of the Minnesota Water Plan vision to achieve sustainable water management can unite people into cooperative action, inspiring them to work together for a common future.

The *2010 Minnesota Water Plan* defines a shared vision of strategies to move the state toward long-term water sustainability. This document defines a long-term vision in which water is managed comprehensively for quantity and quality; for healthy ecosystems and citizens; and in a way that doesn't jeopardize the resources of future generations. For success, Minnesota must apply this shared vision; Minnesotans must commit to memory that water sustainability is our common goal and that achieving it will require sustained adaptive long-term action.

Minnesota Water Plan Defines Vision

The 2010 state water plan details a shared, long-term vision – one in which water is managed comprehensively for quantity and quality, for healthy ecosystems and citizens, and in a way that doesn't jeopardize the resources of future generations.

Summary of the Implementation Principles

These seven implementation principles are broad, overarching principles relevant to each of the strategies in this plan. The principles describe how the work of the agencies in carrying out the strategies should take place. In this next section, the nine strategies of the state water plan articulate critical activities that the state agencies have set out to accomplish in the next 10 years and beyond.

Strategy #1 – Increase Protection Efforts

Goal – Groundwater and surface water supplies are protected from depletion and degradation, recognizing that protection is often more feasible and cost effective than restoration

Minnesota has relatively abundant surface and groundwater supplies that are vital to human health, quality of life and economic stability. The significant value of water requires that Minnesotans protect their resources and prevent degradation and depletion.

Strategies

The ***strategies*** are ordered starting with those that are protective and involve local partners, followed by management areas and their associated data and information needs, and ending with decision-making tools.

1. Increase protection efforts
2. Promote wise and efficient use of water
3. Restore and enhance local capacity
4. Employ water resource management units
5. Collect information necessary for water management decisions
6. Improve access to environmental data
7. Provide current implementation tools
8. Employ a targeted approach for protection and restoration Apply a systematic approach for emerging threats

Value of Groundwater

Healthy and robust groundwater systems are critical. Though the citizens of the state may have difficulty visualizing groundwater or understanding its complexity, they rely on the services it provides every day. Three-quarters of Minnesotans rely on groundwater as their drinking water source. Groundwater also is the source of a majority of the state's surface water systems, which support sensitive ecosystems and recreational economies throughout Minnesota. Healthy ecosystem functions help maintain the health of surface and groundwater supplies. Due to slow travel times within most aquifers, the consequences of unwise actions today can be challenging to detect as they occur, and may take years to be measured through groundwater monitoring efforts. If a contaminant is introduced, it cannot usually be immediately detected and, once detected, may be extremely difficult and expensive to clean up. All of these factors make sustainable groundwater management challenging and highlight the necessity of employing adaptive management.

Value of Surface Water

Many citizens in Minnesota's major metropolitan areas depend on surface water as their drinking water source. Surface waters support ecosystems, fisheries, recreation, navigation, power generation, industrial cooling and a multitude of other activities. Healthy surface waters help define Minnesota and support its economy. Yet, monitoring conducted by the MPCA indicates that at least 40 percent of the state's surface waters don't meet their designated uses and are considered "impaired." Similar to groundwater impacts, restoration and quantification of associated improvement is a slow and expensive process. Limited water and financial resources make protection a high priority.

Benefits of Protection

The importance of protection has long been recognized. Specific to groundwater resources, the Groundwater Protection Act of 1989 articulated specific protection goals. The Clean Water Legacy Act of 2006 was passed for the purpose of protecting, restoring and preserving the quality of Minnesota's surface waters. And in more recent legislation, the Clean Water, Land and Legacy Constitutional Amendment passed by Minnesota voters on November 4, 2008 stresses protection.

The need for greater focus on protection extends beyond preserving water supplies: Preventing water quality problems before they occur is a key tenet of the 1972 Clean Water Act and state water quality laws and rules, equally as relevant today as it was in the past. The Department of Natural Resources' January 2010 report, *Long-Term Protection of the State's Surface and Groundwater Resources*, detailed a series of recommendations for the long-term protection of surface and groundwater using many of the same tools and strategies detailed in the *Minnesota Water Plan*.

Minnesota state agencies, in cooperation with the Clean Water Council, have developed groundwater and surface water protection strategies that reflect that well-managed land leads to healthy aquatic systems. Implementation of the strategies will take place in coming years through the *Minnesota Water Plan* strategies and other efforts. Protecting water resources leads to ensuring that the state will have adequate supplies of sufficient quality now and in the future. Many of the following recommendations recognize the steps that have been started; however, commitment to their continuation and advancement are key to their success.

Recommendations – Increase Protection and Prevention Efforts

- Continue development of protection and implementation strategies for groundwater and surface water resources and communicate the results of these efforts to stakeholders.
- Continue to identify and proactively address potential problems by focusing on protection activities and tools for preventing degradation, including pollutant source reduction, conservation and the fostering of sustainable practices.
- Recognize the importance of local partnerships in identifying and capitalizing on prevention opportunities. Work with local government to incorporate protection into local planning efforts.
- Employ compliance and enforcement techniques and voluntary practices as tools to prevent degradation and overuse while supporting the ongoing refinement of state management tools and techniques (e.g. refinement of water quality standards) to more precisely protect water resources.

Strategy #2 – Promote Wise and Efficient Use of Water

Goal – Water quality degradation and water quantity conflicts are minimized through the promotion of wise and efficient use of water

Unsustainable water withdrawals and allocations can have significant adverse consequences on human and ecosystem health, as well as cause significant financial burdens. Conversely, when water is used efficiently, there are multiple environmental and cost benefits. These benefits include reducing the need for construction and operation of larger supply and wastewater treatment systems; reduced energy and chemical consumption for treating water and wastewater; and protection of environmentally-sensitive features such as in-stream flows, groundwater levels, fens, wetlands and lake levels. Additionally, water quality degradation can be prevented when less water is used or is more efficiently managed. The simple act of conservation benefits both quantity and quality.

> Per capita water use over the last 10 years has increased 6 percent, from 156 to 168 gallons per day (GPD) in the metropolitan area, and 413 to 443 gpd outstate. This trend indicates the likelihood for increased future conflicts.
>
> – DNR *Water Availability Assessment Report* (Appendix C)

It is widely recognized that some areas of the state have limited water resources while others have supplies that appear to be plentiful or even excessive. Despite this disparity, Minnesotans tend to take water for granted in planning for development; expecting to find it available everywhere in a quantity and quality that meets their demands at minimal cost.

Historically, Minnesotans have spent a great deal of time and energy in attempting to rid the landscape of water as quickly as possible, with significant adverse environmental consequences. Additionally, this perception of excess water has affected public understanding regarding the need to conserve. Even in relatively water-rich regions, there are consequences for withdrawals. These include reduced discharge to surface water features and ensuing impacts to aquatic life; impacts on neighbors; potential influences on the migration of contaminants; and the rising costs associated with constructing new wells and associated infrastructure. While there are clear benefits from efficient use, it is also true that most Minnesotans rarely experience shortages or are even aware of them; therefore there is no sense of urgency to conserve. With growing demand for water and more limits on supplies for both quantity and quality reasons, water conservation will require much more serious attention by all users in years to come.

> Metro communities use roughly 2.6 times more water on the peak summer day than an average day presumably to accommodate lawn watering. This leads to costly construction of new municipal wells, treatment and storage facilities and increases the risk of water quality degradation. More importantly, it depletes the limited reserve of water more quickly.

Minnesota's laws have long recognized the benefit associated with employing water efficiencies, as well as the respective savings to both users and the state. However, the challenge is continuing to communicate this message to citizens and industry in a state that has many resources and relatively inexpensive access to water. Tools that are being used, and will continue to be important in the future, include:

- State agencies are developing programs and leading efforts for water conservation, guided by *Minnesota Statutes* sections 103A.205 and 103A.206.
- *Minnesota Statutes* section 103G.101 requires that the commissioner of the Department of Natural Resources (DNR) develop a water resources conservation program for the state that includes conservation, allocation and development of waters for the best interests of the people.
- *Minnesota Statutes* section 103G.301 also allows for consideration of alternatives to the actions proposed in permit applications, including conservation measures to improve water use efficiencies and reduce water demand.
- *Minnesota Rules* 6115.0770 state that "*in order to maintain water conservation practices…it is necessary that existing and proposed appropriators and users of waters of the state employ the best available means and practices based on economic considerations for assuring wise use and development of the waters of the state in the most practical and feasible manner possible to promote the efficient use of waters*." The rule goes on to allow the DNR to "*require a more efficient use of water to be employed by the permittee or applicant*."
- The DNR, in review of all appropriation requests, considers efficiency of use and intended application of water conservation practices (*Minnesota Rules* 6115.0670). In addition, *Minnesota Statute* section 103G.291 requires that public water suppliers serving over 1,000 persons employ water use demand reduction measures including a conservation rate structure and education program prior to requesting additional appropriations.
- *Minnesota Statutes* chapter 115.03 requires that applicants for wastewater discharge permits evaluate in their applications the potential reuses of the discharged wastewater.
- Public water suppliers provide information on their water conservation programs as part of a water supply plan (*Minnesota Statutes* section 103G.291); most have a conservation payment rate structure in place, or will by 2013, to meet statutory requirements.

Water Conservation Programs

Many suppliers have some type of watering restrictions in place over the summer. These are typically odd/even restrictions that help reduce peak day demands, allowing utilities to develop systems for lower peak volumes. Communities also provide water conservation messages through bill inserts, websites, newsletters and other local media. Other conservation measures employed by water utilities include leak detection, tree or topsoil requirements and metering or monthly billing.

While it is clear that the DNR has an explicit statutory and regulatory role in ensuring wise use through the water appropriation permit requirements and review of municipal water supply plans, the remaining state agencies have a role in promoting water conservation. All are in agreement with the need to incorporate conservation and promotion of water-use efficiencies in their water programs. Therefore, the agencies will seek opportunities to promote water conservation and wise use in all aspects of water management. Despite the variability in water availability across the state, a coordinated, consistent message from state agencies that wise and efficient use of all the state's water is critical. Similar to the first strategy, many of the recommendations in this section recognize that important steps have begun, but commitment to their continuation and advancement are key to their success.

Recommendations – Promote Wise and Efficient Use of Water

- Continue to promote water efficiency and seek opportunities to further advance water conservation and wise use in all aspects of water management.
- Encourage other entities with a role in managing land and water resources to incorporate water conservation goals into local water plans while evaluating options for incorporating water use efficiency in regulatory programs.
- Ensure a coordinated, consistent message that wise, efficient use of all the state's water is important.
- Develop guidance materials on best management practices for water conservation as well as explore and support opportunities for alternative methods to efficiently use resources such as storm water and wastewater.

Strategy #3 – Restore and Enhance Local Capacity

Goal – Recognition of and support for local capacity and actions is increased

The state is highly dependent on the day-to-day activities of local governments, nonprofits and landowners to meet its land and water management goals. State and community partnerships continue to achieve significant accomplishments, harkening back to the earliest organized approaches of watershed management initiated by the federal Soil Conservation Service in the 1930s. The state recognizes that in order for water management to be effective, support is necessary from local governments, non-profits and landowners. While the assessment, funding and overall goals may originate with the state, implementation occurs at the local level.

Aligning Self and Public Interest for Clean Water

By Annie Levenson-Falk, Citizens League, July 16, 2010

During our study on water governance last year, I found a gem of a quote from a Citizens League report back in 1993:

"State lawmakers should embrace the view that the purpose of government is to design environments where individual citizens and institutions are systematically oriented to accomplish public purposes, and where they meet their own interests in the course of doing so."

This is exactly what we need to do to address problems like water pollution. The biggest water quality problems we're dealing with today are not the major industrial polluters of the past; they're caused by pollution from the activities of the millions of individuals, businesses, and communities on the land across the state. Reducing pollution is going to require the public (i.e., us) to acknowledge that we're the source of the problem and to take a central role in the solutions.

Science and engineering have told us a lot about what we can do to improve our waters. The question for the rest of us is not so much what can we do, but how are we going to do it?

Most of our water pollution comes from our activities on the land. And most of the land is in private ownership. So the people who own and care for the land are the ones who need to make the changes.

The key water policy question, not asked frequently enough, is:

How does Minnesota set up the environments in which individuals, businesses, farms and other organizations all work together with government toward the goal of clean water, because they meet their own interest in the process of doing so?

In recent years, the foundation on which water resource management implementation largely depends – especially for addressing nonpoint source pollution – has eroded as local government funding reductions have limited local capacity for water resource management in some areas of Minnesota. For the state's efforts to be successful, existing capacity must be supported and lost capacity must be rebuilt. Increasing funding for local projects is not the only answer. While money needs to be provided for local projects, there also needs to be recognition of the capacity required for the local entity to apply for, receive and make the best use of the project funds. This capacity must be sustained across funding cycles.

Coordination of Local Effort

The health and sustainability of surface water and groundwater resources are directly related to land uses within watersheds that drain to surface water features and recharge aquifers. Land-use management and decision-making is conducted by local governmental units in coordination with private land owners and land managers. Decisions at the local level individually and cumulatively have the greatest impact on water resource management within the state. The local capacity to understand, access and evaluate information, as well as support and encourage good land use decisions and water resource management practices, is highly variable across Minnesota. A key aspect of the state water plan strategy is to ensure that local governments have access to needed information and use that information as part of decision-making, education and outreach efforts. New levels of coordination with local government (cities, counties, SWCDs, watersheds) are essential for implementation of sustainable water resource management.

Shoreland Management Act

The Shoreland Management Act is an example of recognizing the importance of local land use regulation to statewide water resources. Shoreland and riparian areas are critically important to water quality, flow regime, recharge and ecosystem function. The concept of the Shoreland Management Act is to provide statewide minimum standards for land uses in shoreland areas, which are then implemented by local governments through land use ordinances. This component of riparian land use management is a critical piece of water resource management that needs additional resources for updates and implementation.

Local Engagement

State government tends to interact with its local partners on a program-by-program and project-by-project basis, rather than in an integrated way. Opportunities to solve root problems or address larger state and community concerns may sometimes be missed. Local capacity to manage water and related land resources is limited, and some local governments are concerned that they must navigate through a maze of multiple federal and state agency interests, perspectives and requirements. The state is currently exploring opportunities to engage local governments across issues and at a variety of scales, including major watersheds and groundwater management areas, and increasing program delivery through local governments to accomplish better outcomes for Minnesota communities and natural resources.

Recommendations – Restore and Enhance Local Capacity

- Implement organizational structures that enhance local contacts and coordination with local governments. Explore programmatic opportunities to attract additional funds for local implementation by using state funds to leverage federal, local and landowner contributions.
- Deliver assessed data and trend information to local managers.
- Participate in the established 10-year planning cycles at the community level.
- Look for opportunities for federal-state-local fund to be co-leveraged for multiple benefit projects and activities.
- Utilize local governments to cost-effectively provide state program services when appropriate by integrating functions with other local services.
- Increase recognition of and stabilize support for local capacity and actions – local capacity cannot thrive while going from potential grant to potential grant.
- Continue to explore ways to support state and local collaboration to provide consistent messages and information to local interests.
- Develop a system of incentives to reward local units of government that incorporate water availability and sustainability considerations into their water and land use plans and decisions.
- Build and maintain the capacity to work across projects, programs and agencies to meet local as well as state needs.

Strategy #4 – Employ Water Resource Management Units

Goal – State-level water resource management activities are improved by defining water resource management units for coordinating a systems approach to management

One of the big challenges for the state in effectively managing its water resources is organizing and coordinating management efforts at a scale that promotes efficiency, engagement and implementation success. Experience has shown that addressing water resources at a too-small scale, such as a waterbody-by-waterbody approach, can miss opportunities to identify related problems and address them more comprehensively and, in the process, realize economies of scale. Conversely, selecting a management area that is too large – such as the state as a whole, ecoregions or even river basins – can make it difficult to coordinate activities with the area's many federal, state and local partners and can present barriers to fostering local engagement. Delineation of surface and groundwater management units provides a way to define the natural resource to improve coordination of mapping, monitoring and management.

Water Resource Management Units

- Surface water managed through the 81 major watersheds
- Groundwater managed using source water protection areas and groundwater management units

Surface Water Management Units

A key strategy that has emerged from the implementation of the Clean Water Legacy Act and activities supported by the Clean Water Fund is the use of the state's 81 major watersheds as the organizing framework for surface water quality management under the act (Figure 3). The major watersheds, while large enough to provide a systems approach to solving problems and to gain economies of scale, are small enough to promote targeted and coordinated efforts and are hydrologically-based units. Additionally, a coordinated watershed approach enables addressing protection and restoration for multiple impairments simultaneously. This does not mean that the major watersheds are a one-size-fits-all scale to address every question. Rather, this strategy is about using the appropriate scale to achieve resource goals. Other management scales (individual water bodies, basins, etc.) continue to be valuable; the employment of the major watershed scale is simply a tool for enhancing the coordination and efficiency of monitoring and management.

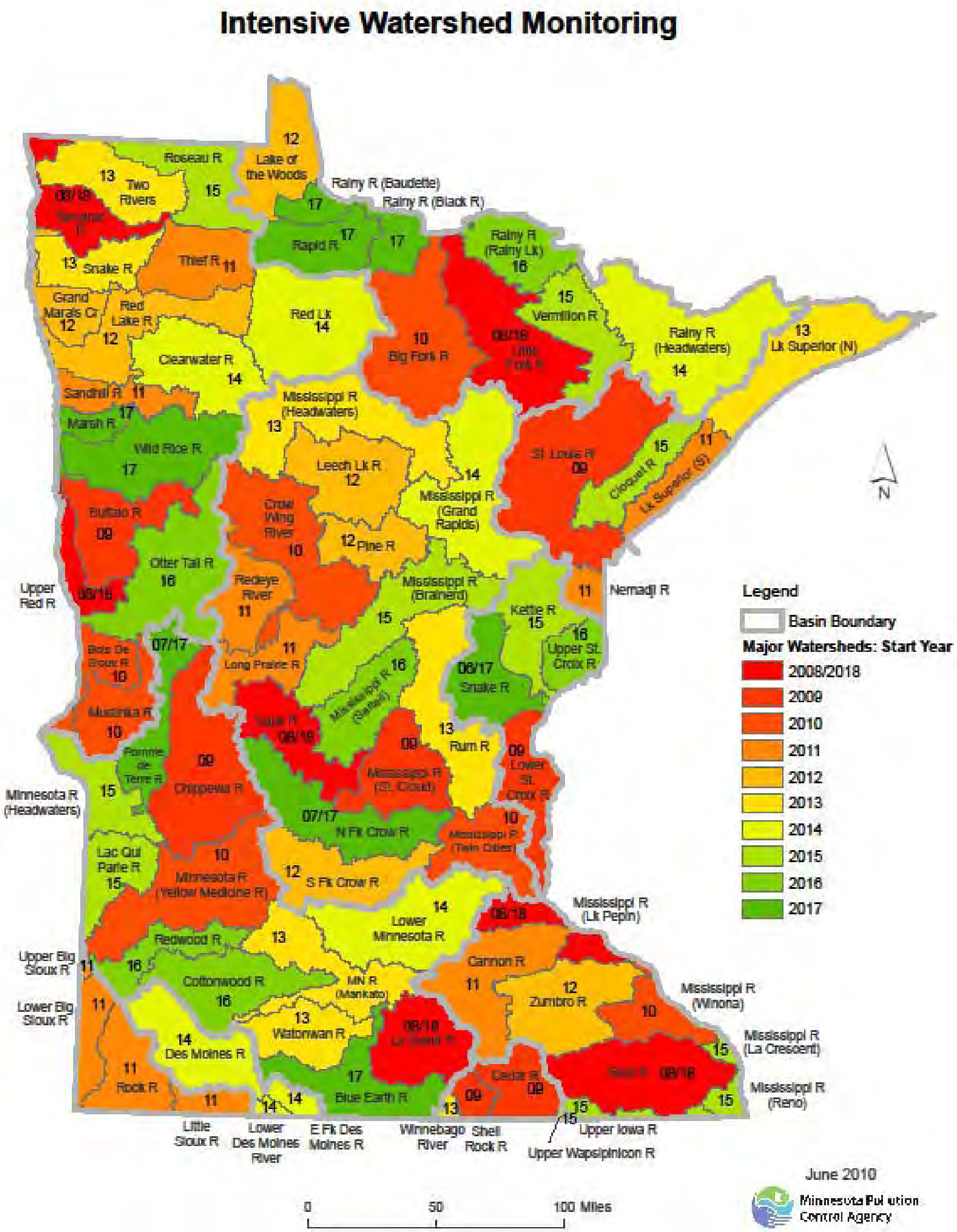

Figure 3. Minnesota's 81 major watersheds and their respective monitoring schedule.

Groundwater Management Units

Similarly, for groundwater, source water protection areas and groundwater management areas are being developed to define the boundaries and flow pathways for subsurface water movement. While it is recognized that surface watershed and groundwater aquifer boundaries are different, both systems need to be managed in an integrated manner when possible, recognizing that land-use management choices will impact the sustainability of human and ecological health. Merging the understanding of surface and groundwater movement will foster increased coordination and collaboration among state agencies and with federal and local groups as the state and its partners continuously improve management tools based on new information and system understanding. Additionally, characterizing the larger system will improve quantification of flow through the resource to enhance management of sustainable withdrawals.

Defining Benefits

The benefits of this "water resource management unit" approach to organizing and coordinating the work of water resource protection and restoration are many, including:

- Identifying most, if not all, water resource problems in an area at one time. Additionally, enabling the opportunity to address the problems through a coordinated, efficient process.
- Fostering increased local understanding of how water moves through, across and beneath the landscape, which will help identify causes and solutions to both water quality and quantity issues.
- Providing citizens, stakeholders and local government an opportunity to proactively engage in the resource management work, first through volunteer and local monitoring activities, and then through implementation efforts. This up-front engagement helps set the stage for local involvement in water resource management and enhances the information available for good planning efforts and successful implementation of restoration and protection strategies.
- Developing effective management strategies based on hydrologic boundaries.

This approach also provides an opportunity to integrate and prioritize protection and restoration efforts at the management unit scale, relying on data to determine what actions are needed and how resources can be most effectively allocated. With this approach, protection becomes an integral part of the identified management strategies and management and implementation efforts can then include both protection- and restoration-focused activities.

Recommendations – Employ Water Resource Management Units

- Utilize water management units to organize and communicate data, trend information and preferred strategies to local planning processes and organizations.
- Continue to employ a major watershed approach to protecting and restoring surface water quality, while enabling scaling efforts up or down as appropriate.
- Define and employ groundwater management areas.

- Achieve the goal of a 10-year cycle for monitoring and assessment, Total Maximum Daily Load allocation and protection strategy development, and implementation of regulatory and nonregulatory actions to protect and restore surface water quality.
- Develop schedules collaboratively for groundwater monitoring, mapping and management activities to foster cross-agency coordination and efficiency.
- Align major watershed and source water protection or aquifer management area monitoring, planning and implementation schedules where possible to foster a better understanding of surface water/groundwater interactions, identify opportunities to concurrently meet groundwater and surface water management needs, and help avoid unintentionally transferring problems from one water resource to another.
- Use and enhance existing local delivery systems to deliver conservation locally within water resource management units.

Strategy #5 – Collect Information Necessary for Water Management Decisions

Goal – Information necessary to support sustainable water management decisions is collected efficiently and collaboratively

The state is employing a thoughtful, integrated and collaborative approach for collecting prioritized information, in targeted locations, and within timeframes that will inform water management decisions. It has long been recognized that effective water resource management requires sufficient data and information about the hydrologic systems to inform sound decision-making. While a great deal of information has been collected, an understanding of status, trends, stressors and interactions (between groundwater and surface water, water and land use, climate and recharge, ecosystem components, etc.) is essential to identifying and achieving water resource goals and supporting adaptive management principles.

> *"Sustainable water management requires sound data to support understanding of the various elements of the hydrologic system. This includes high resolution landscape and soils information, precipitation, aquifer recharge, aquifer discharge, aquifer withdrawals, ecosystem services needs, surface water quality, ground water quality, evapotranspiration, surface water and groundwater interconnections and flow pathways, among other traits."*
>
> 2008 EQB report, *Managing for Water Sustainability*

The state has made significant progress towards meeting this need in recent years, particularly in the surface water arena with the advent of the Clean Water Legacy Act and Clean Water Fund support for monitoring and information-gathering efforts. Furthermore, there has been a renewed effort in the past year to generate new critical groundwater data. While gaps remain, the state is on a trajectory to address many of those gaps over the next 10 years, provided that funding continues.

Each agency has a specific need for collecting information relevant to its statutory mandates and agency objectives. To gain a more complete understanding of the hydrologic system, these information sources must be considered together. State agencies routinely coordinate ground and surface water sampling activities to eliminate redundancy and maximize efficient use of limited resources. In addition, information collected for a variety of purposes is routinely shared across agencies. This collaborative approach is working well, and is further enhanced by efforts to identify and employ "water resource management units" (discussed in Strategy 3) to prioritize, schedule and communicate future data collection efforts.

While discussion of the collection of water information often occurs in the context of surface and groundwater, it is important to remember that these systems are connected and also include landscape and biological systems. The following sections on surface water, groundwater/surface water interaction, and groundwater provide further discussion on the collection of existing information as well as priorities for collecting additional information.

Surface Water

The state is on track to monitor and assess its surface waters on a 10-year cycle and to monitor the outlets of major watersheds for flood warning, pollutant trend and adaptive management purposes. The Clean Water Legacy Act and the Clean Water Fund have greatly accelerated data collection for surface water quality (biology, physical characteristics and chemistry). There is a need to continue that effort over the 10-year cycle, expand the effort through local parternships and use adaptive management concepts to measure progress and identify information gaps.

Additional efforts are needed to collect information that will assist in determining the water quality and quantity requirements of healthy ecosystem functions and drinking water. Typical approaches to address ecosystems have tended to orient around the minimum requirements (quantity and quality) of an ecosystem, rather than what is needed to support a healthy ecosystem. The natural variability of flows within a year (season to season) and between years (dry to wet years) is a factor that biota have adapted to and depend upon. Understanding and addressing the variability requirements of ecosystems continues to be a challenge for water managers.

Five Key Components for Ecological Functions

- Hydrology
- Connectivity
- Biology
- Geomorphology
- Water quality

The relationship of surface water to the landscape or watershed is also critically important to understanding the system. For example, information is needed about the role of small headwater streams and wetlands in overall system health. This better understanding will be used in the development of predictive tools utilizing hydrology, connectivity, biology, geomorphology and water quality information to assess watershed health. These tools will ultimately help inform land use decisions that are protective of water resources.

Groundwater and Surface Water Interaction

Groundwater and surface water management has traditionally occurred independently of the other, which has led to unintended consequences. Groundwater pumping, for example, can reduce aquifer levels that adversely impact seeps, springs, wetlands and discharge to streams. Conversely, groundwater recharge from unsustainable land use and surface water can transport chemical constituents into the groundwater system. Additional information on site-specific geology, hydrology and identification of sensitive landscape features will better inform water appropriations, best management practices and land use decisions to avoid adversely affecting ground and surface water interactions. An improved understanding of surface and groundwater interactions will help ensure that both components of water resources are being protected, and we are not inadvertently transferring problems from one component to another (i.e. from surface water to groundwater, or vice versa).

Groundwater

Efforts to develop information for understanding groundwater systems are ongoing. Agencies are making significant progress toward addressing information gaps related to aquifer characteristics, water quality and water sustainability. While trend data is available for several important pollutants, it is still lacking for others; monitoring and information gathering efforts being implemented through recent funding initiatives are designed to address some of these gaps. Regardless, sufficient time is necessary for collection of data that support rigorous trend analysis.

Continuing development of county geologic atlases and development of groundwater monitoring networks, such as the groundwater level monitoring network for the 11-county metro area, are examples of ongoing efforts that will better inform land and water management decisions. However, additional information is required to better understand aquifer characteristics such as recharge, storage and movement of water in these underground systems, and to identify areas at high risk for depletion and/or contamination.

Groundwater systems data are particularly challenging because the main information source is typically a single point (i.e. a well) on the landscape, requiring significant interpretation between points (wells) to define the system. For these reasons, it is important to maximize the information obtained from each point and prioritize those areas of investment for information collection. State agency programs will need to increase monitoring requirements and coordinate efforts under existing authorities to ensure enough information is collected to understand and manage groundwater systems.

Concurrently, more work is necessary to characterize the quality of private drinking water wells. Monitoring efforts exist for public water supplies (through the Department of Health), and ambient groundwater quality (through the Pollution Control Agency and the Department of Agriculture). With the exception of a requirement for testing newly constructed wells, Minnesota lacks a systematic effort to monitor and understand private drinking water well quality. Traditionally, well owners have been encouraged to conduct annual testing of their water, but few do and the data that is generated is not aggregated in a single location for public use. There have been some recent efforts coordinated by counties with state agency support – most notably the Southeastern Minnesota Nitrate Study – but more work is needed to assure that these water supplies, which are outside the Source Water Protection Program, are sufficiently understood and protected.

Recommendations – Collect Information Necessary for Water Management Decisions

- Continue work on collaborative and integrated systems of groundwater and surface water information collection.
- Continue recently accelerated data and information gathering efforts, such as the 10-year cycle of watershed monitoring, enhanced groundwater monitoring, and increased efforts to better understand aquifer characteristics.
- Focus on the following priority areas for additional information collection:
  - Water quality and flow requirements to sustain healthy ecosystems
  - Ground and surface water interactions
  - Aquifer characteristics such as recharge, use, storage and transmissivity
  - Resource thresholds and performance standards to inform management decisions
- Identify defensible criteria for assessing the critical water levels or flow conditions required to support ecosystems. The criteria should consider ecosystem-sensitive practices that protect critical components of the hydrograph, including:
  - A habitat- and population-based minimum flow
  - A high flow protection standard that protects critical habitat-forming and silt-flushing high flows
  - Protections for downstream needs
  - Protections for the natural variability of flows over time (hydrograph shape)
- Increase efforts to characterize the quality of private drinking water wells.

Strategy #6 – Improve Access to Environmental Data

Goal – Decision-makers and the public have ready access to environmental data to support sound management decisions

Good data have diminished value if they are not readily accessible. Agencies are committed to making easy and efficient access to data a high priority of their respective programs. Many reports call for improved data collection and monitoring efforts, but it is equally important to ensure access to the data to support planning efforts.

Recent Progress

Great strides have been made recently. Agencies have focused on strengthening their water monitoring efforts and defining clear, long-term plans for data collection and communication of trends. Concurrent with enhanced data collection efforts, agencies have made significant progress in recent years toward enhancing access to environmental data through web portals, such as the Minnesota Pollution Control Agency's Environmental Data Access site (which includes Department of Agriculture monitoring data), and the use of data standards such as Department of Health's County Well Index unique well number.

The Department of Natural Resources (DNR) recently received resources to implement a foundational water level monitoring program in the 11-county metropolitan area. As a part of this project, the DNR will begin the development of a groundwater level data management framework that will improve storage, access and sharing of data between agencies and other levels of government. Additionally, the Metropolitan Council, DNR and MPCA are working together on defining better database tools.

The MPCA received a modest Clean Water Fund allocation to begin development of a "Watershed Information Management System" that will serve as a portal that will connect multiple sources of water data and information. These efforts are foundational and should be built upon to ensure that resource managers and decision-makers have access to the information they need to support a more sustainable water resource management system.

Defining Goals

Easy access to accurate data and information ensures sound management decisions and efficient use of resources. Furthermore, to ensure cost-effective use of existing information and funds, agencies will accelerate cooperative efforts to share and simplify public access to environmental and technical data. The goal will be to provide information in a variety of formats to encourage adoption by citizens, interest groups, local units of government, watershed groups and other interested parties and to facilitate the exchange of information among professionals. A well-designed data access system will improve the state's ability to clearly communicate trends in areas such as surface water discharge, groundwater withdrawals, water quality conditions and ecosystem health.

Recommendations – Improve Access to Environmental Data

- Establish data standards that provide a common format for accessing and sharing identified categories of water data (e.g. surface and groundwater quality, surface and groundwater quantity, biological, and meteorological data, etc.).
- Identify and prioritize gaps in the current data management system. For example, state agencies are aware of the need for a repository for storing and sharing surface water and groundwater flow data collected by local government and other partners, and are actively evaluating options for meeting this need.
- Develop an implementation plan for enhanced data management that includes system requirements, a prioritized list of needs, agency roles and responsibilities and a work plan and cost for filling gaps and implementing identified improvements.
- Continue to provide more and better opportunities to share water data and information through web portals, analytical tools (such as the DNR's Watershed Assessment Tool and the Environmental Quality Board's Water Availability Information System), map interfaces and upload/download functions.
- Continue efforts to develop and apply water sustainability models and planning tools, integrating new information and research results, as well as additional social, economic and environmental data.

- Provide the contextual information needed to understand and use water data, such as standards and benchmarks, trend information and supporting data about land use, climate, hydrogeology, geomorphology, soils, native plant communities, protected features and ecosystems.
- Identify water quality and quantity targets and use an improved data access system to measure progress towards them.
- Build on recent and current data access projects to identify the users of state water data and their information needs, and use that knowledge to guide future data access enhancement projects.
- Develop guidance information for the public on agency monitoring, mapping and management activities. Clearly articulate the roles and responsibilities of the various entities involved in natural resource management.

Strategy #7 – Provide Current Implementation Tools

Goal – Water resource concerns are addressed through the use of an adaptive approach to updating management tools

A variety of management tools are used by state agencies, local governments and stakeholders to protect and improve water quality. These tools can take many forms – community-based outreach efforts; voluntary best-management practices and guidance; incentives; and regulatory rules and standards based on scientific information that supports policy objectives. It is important that these tools are current and effective to ensure that protection and restoration efforts are successful.

The selection of one or more management tools to address water quality and quantity concerns may be driven by the scope of the problem, by the water quality issue being addressed (i.e., is it acute or chronic in nature?), or by other complexities that require development of other tools.

Best management practices (BMPs) offer guidance to users regarding the management of pollutants, processes, land and waste. BMPs and other tools offer guidance so that impacts on water quality are prevented or resource degradation is minimized to the greatest extent possible. Certain conservation practices help protect against or reverse damage to water and adjacent land resources to ensure that ecological and resource protective functions are maintained or improved.

Examples of Water Resource Protection Management Tools

Successful management tools can include such efforts as education, rules, enforcement and incentives:

- Stormwater drain stenciling
- Construction site silt fencing
- Liquid waste management and recycling guidance
- Local ordinances regarding land management and impervious surfaces, including shorelands
- Best management practices for use of pesticides in agricultural and residential settings
- Rules for management of feedlots and the land application of manure
- Regulations for industrial and non-industrial discharges to waterways
- Enforcement programs for compliance with storage tank rules and containment structure requirements
- Incentives or recommendations for alternative crop rotations, production systems or land management approaches in agricultural settings
- Incentives to protect healthy ecosystems such as conservation design developments and transfer of development rights

When BMPs and other recommended practices fail to be effective or are not adopted, despite their practicality, other solutions – such as the development of incentives or regulations based on science and stakeholder input – may be necessary.

Management practices, protection incentives and regulations should continue to be optimized and refined over the next 10 years. For example:

- Considerable progress has been made refining management practices, rules and standards to reflect new understanding of water quality and ecosystem interactions, and to address changing land-use conditions. Continued refinement is needed as new information becomes available and to reflect new issues and opportunities.
- Many water resource protection laws and rules are working well and achieving desired results. Others are not as effective, which could be due to myriad factors such as inconsistent adoption across the state, lack of adequate funding or the need for additional education and technical assistance. These tools should be fully optimized to enhance water resource protection and restoration.
- Efforts to avoid problems before they occur through pollution prevention, compliance activities, education and product stewardship have accelerated in recent years. These activities should continue to improve our ability to address potential threats to water resources before they become costly restoration problems.

Ultimately, recommended practices, guidance and law, supported by adequate education and outreach, should create a set of extremely flexible, robust and diverse tools that are periodically reevaluated to ensure their effectiveness and practicality and incorporate new information and learning.

Practices to protect land and water systems are detailed in the following two sections. However, these tools apply to all of Minnesota's landscapes. The sections include examples related to agriculture, but the same practices are relevant to any activity across the state that modifies the landscape, including forestry, mining, urban development and industry.

Water Quality Best Management and Conservation Practices

For many groundwater and surface water contaminants, recommended management practices (e.g., Best Management Practices) and conservation practices are the primary tools for protecting and restoring water quality. However, the cost and effectiveness of many practices can vary considerably depending on multiple variables. One size does not fit all, and what may be beneficial for one area of the state, one municipality or one business may not be appropriate in another. Some practices may be more difficult or expensive to implement or may have undesired consequences on non-targeted contaminants. In some situations, the practices and technologies promoted may be less effective in certain settings, may change over time, or understanding may advance since the practice was last revised. For these reasons, and to ensure that limited funding is spent wisely, it is important to periodically review and quantify, to the extent practical, the costs, benefits, limitations and environmental outcomes, both intended and unintended, from specific management and conservation practices.

In a similar manner, BMPs can be applied for enhancing water quantity. These water quantity conservation practices are detailed more explicitly in Strategy 2 to promote wise and efficient use of water.

Agricultural Best Management Practices

BMPs for agricultural contaminants often need to be developed or updated to address environmental concerns and to keep pace with evolving technologies and crop production practices. New plant hybrids or new methods for the precise application of fertilizer are examples of innovations that may require new BMPs. Because agricultural BMP development depends on understanding and incorporating multiple variables, and for reasons outlined above, it is important to develop and implement a step-wise systematic process to review BMPs.

There are three steps in this process. The first step is to establish a systematic process to screen existing BMPs and identify those that require a more detailed review; gaps in current BMPs; and new practices or technologies which may require a BMP. There should be an easily understood, transparent process for the systematic review of BMPs and the identification of issues or concerns regarding their implementation. This process should determine whether there are sufficient technical data to develop a BMP and, if not, recommend additional required projects to acquire such data. The process should also include a feedback loop in which growers and crop advisors can provide input into the review process on the obstacles for their successful implementation.

The second step is to undertake BMP evaluation projects to fully understand and quantify their costs, benefits, limitations and environmental impacts. BMPs may vary from extremely simple practices that are easy to implement to potentially complex and expensive ones that might require considerable funding and knowledge for their implementation. For many agricultural BMPs, to fully understand and optimize their implementation will require plot-scale or field-scale evaluation supported by water monitoring and computer modeling.

The third step in the process is to support local BMP demonstration sites that facilitate their successful adoption. Demonstration sites for BMPs will help refine the BMPs to address potential variability in conditions that frequently exist on a regional or local scale. For example, a local demonstration site would help educate farmers on how a specific practice will complement their cropping system. Demonstration sites also help address the human dimension of BMP adoption because an individual will be much more likely to adopt a practice if a friend or neighbor can personally explain and demonstrate that it works. Demonstration sites should be integrated into local and regional efforts to promote BMPs.

Research that is used for agricultural BMP development should be easily available to the public online. The BMPs should be compiled in an easily accessible format that identifies where, when and how they might be used, as well as the potential tradeoffs between different contaminants or practices that might be impacted by the BMP.

Agricultural BMPs are an important tool for protecting water quality. They are also a fundamental building block for other actions, including regulations, to protect groundwater and surface water. If they are not effective, the state is at risk of expending considerable resources without achieving the desired improvements in water quality.

Recommendations – Prioritize Development, Evaluation and Implementation of Water Quality Protection Management Tools

- Develop a summary of existing laws and rules that are not yet fully implemented and identify the barriers (financial, policy, administrative, etc.) that are preventing their effective implementation.
- Provide appropriate guidance to landowners and local government to ensure that all management and conservation practices are adopted in the most effective manner for their site-specific application.
- Support efforts to evaluate, develop and advance management and conservation practices.
- Develop a systematic process to screen existing management practices, further refine existing practices when appropriate and develop new practices. Part of this process is to understand and quantify the costs, benefits and limitations of formal BMPs and other management and conservation practices.
- Support local demonstration sites to facilitate the successful adoption of BMPs and other practices. Share findings of research studies used for BMP and conservation practice development through an easily available online access point.
- Continue to refine standards and rules as needed to reflect new information and issues.
- Identify connections between regulation, education, incentives and protection activities, and continue to optimize the use of these tools, in combination, to achieve water quality goals.

Strategy #8 – Employ a Targeted Approach for Protection and Restoration

Goal – Land management projects are targeted to high risk areas to protect and restore water resources

The state applies a targeted approach to implement protection and restoration projects to ensure that limited resources are allocated in a manner that provides the greatest possible return on investment. Effective deployment of implementation tools begins with a tailored understanding of where on the landscape activities are impacting water resources. Minnesota targets activities on two levels: broad targeting occurs at the state program level while refined, smaller-scale targeting is employed at the local level. This two-tier approach increases the effectiveness of the strategy. This strategy is strongly linked with the second implementation principle that calls for prioritizing limited resources to be applied where the greatest benefit may be realized.

In some situations, a relatively small section of the landscape may be contributing a disproportionately high percentage of contaminants. Identifying these vulnerable areas, also known as priority management zones, is a necessary first step in implementation. Once these priority management zones are identified, quantifying the change needed to protect or restore water resources is also necessary.

It is important to note that using a targeted approach does not signify that best management practices or other implementation tools are ignored in less vulnerable land areas. A certain percentage of funding and effort should be allocated to promoting BMPs in all areas where their adoption will provide increased protection of ecosystem functions and water resources. However, it is intended that increased resources should be expended in those locations that pose the greatest risk as sources of contaminants, or that will have the most benefit.

Tools to Identify High Risk Areas

A successful targeted approach requires the existence of tools for identifying high risk areas on the land. For example, recent developments in the use of LiDAR technology, as well as enhancements in modeling and stressor identification capabilities, are enabling a new level of risk identification. The detailed topographic maps provided by LiDAR can be combined with soil, wildlife, floodplain and other data to create GIS layers that, when used in conjunction with computer models and field evaluation sites, form the basis for a much more precise method for targeting than has previously been available. These and other landscape-based methods will have applications for both urban and agricultural settings.

Similar tools for targeting high-risk areas are also available for potential sources of groundwater and drinking water contamination. The capture zones, times of travel and hydrogeologic vulnerability of aquifers are already defined in Source Water Protection Areas (SWPAs) for municipal water supply wells. More detailed hydrogeologic vulnerability maps could be created, possibly incorporating crop or other source-specific GIS layers in areas outside of SWPAs.

Broader Application of Targeting

The strategy of "targeting" is important to apply in a variety of areas. Targeting allows the best application of resources to the areas in which they are most needed or effective, including monitoring, protection and restoration efforts.

State agencies already use targeting to set priorities for water quality sampling; monitoring of flows in rivers and streams; enrollment of conservation easements; and to inform installation of wells for groundwater level assessments. Local plans then refine targets for local conditions.

Risk Inventory

Identification of ecologically intact locations on the landscape will allow targeting of areas that are providing high-quality ecological services (water quality, infiltration, flood retention, habitat, etc.) within the watershed. These areas are high risk in the sense that allowing degradation of these functions would result in degradation of water resources in the area as well. There is an important correlation between intact ecological function and sustainable water resources. Information from the Watershed Assessment Tool, combined with Minnesota County Biological Survey data, can be used to identify areas that need to be maintained to prevent ecological degradation.

In addition to targeting intact ecological areas, the state must focus on areas of degraded ecological function that provide the best restoration opportunities. The National Wetland Inventory Update project will eventually allow coarse evaluation of wetland functions that can be used to target restoration of ecological functions that are limited within a watershed. These information sources should also be used in combination with other information, such as soils, hydrology and land cover type, to target sites that are providing some ecological services but have stressors that are limiting the function of the system.

Risk Evaluation

Once high-risk areas are identified, a systematic approach should be used for selecting and funding the appropriate management and conservation practices given the unique landscape, land use and specific contaminants of concern in the watershed or area. Two considerations are especially important in the selection of recommended practices.

First, it should be recognized that for many land uses there may be a significant cost and complexity to changing land-use practices. For example, if a farmer has been using the same crop rotation, or has a significant investment such as an irrigation system, it might be very difficult, expensive and risky to implement a major change in practices. Conversely, there might be some practices that are relatively easy to adopt. Priority should generally be given to those practices that have the greatest probability of success and environmental benefit with consideration for cost.

Second, in some watersheds or aquifer recharge areas there may be more than one contaminant of concern and practices that may help minimize adverse impacts of one contaminant may increase negative impacts of another.

For example, soil incorporation may be a desired practice to reduce runoff of nutrients or pesticides, but it may also increase the runoff of sediment, which may be the more significant concern in the watershed. This potential for tradeoffs and unintended consequences is very real and is likely to increase over time as more waters are listed as impaired for multiple contaminants.

To help address this concern, the state should develop and make accessible lists of contaminants of concern for specific water resource management units. The state should also develop lists of practices for specific contaminants and resource protection goals and the potential contaminant and resource tradeoffs with other practices. Local land use managers and local governmental units (LGUs), with the assistance of state technical personnel, should select appropriate practices in consideration of the contaminants of concern, land use, land characteristics and potential tradeoffs.

It may be expensive to implement major changes in land use practices. For example, changes in an agricultural setting may include implementing an alternative crop rotation or removing land from production. For some contaminants, such as nitrogen in groundwater, the state should explore options for creating sustainable markets including, if necessary, subsidies for low nitrogen input crop rotations in high-risk areas. A sustainable market-driven alternative crop rotation option such as alfalfa may be a highly desirable solution to local contamination problems. This might be linked to alternative energy crops. The significant cost of implementing major changes in land use practices reinforces the need for careful targeting of land use changes that optimize the use of limited resources.

The state has made significant progress in employing targeted strategies, including progress in adopting BMPs, but still has persistent water quality and quantity concerns. Some of the easier solutions have been employed, leaving the state with a need to rely more heavily on targeting to efficiently and soundly dedicate limited resources in a manner that is as efficient as possible. A targeted approach can be applied in coordination with new tools that have been and are being developed to help with that targeting, including LiDAR and resource models.

Recommendations – Employ Targeted Approach to Identify and Protect High Risk Areas

- Use a targeted approach to optimize locations for monitoring and sampling.
- Use a targeted approach to identify high risk areas on the landscape in greatest need of specific BMPs and ecosystem protection.
- Employ targeting methods to determine the optimal places on the landscape to achieve the maximum benefit from the use of limited resources for protection and restoration efforts.

Strategy #9 – Apply a Systematic Approach for Emerging Threats

Goal – A Systematic approach is developed for identifying, assessing and responding to emerging threats

Minnesota's water resources, while abundant, face a variety of recently recognized threats such as aquatic invasive species, possible changes in climate, PFCs, and endocrine-active compounds, to name just a few. A state strategy for identifying, assessing and responding to new threats to water quality and quantity and ecosystem health is needed to provide a coordinated plan for federal and state agencies, working with local government and citizens in response.

State agencies are working tirelessly to identify emerging issues and threats to water resources, gather relevant information and establish strategies for addressing emerging issues. Many of these efforts have followed an "ad hoc" approach with the lead state agency identifying and investigating the threat, bringing in the other water agencies as needed based on their expertise and authorities regarding the specific issue at hand. This approach has generally worked well, in part because of the concerted efforts of the state water agencies to work together in establishing strong communication and coordination and to clarify roles and responsibilities.

While this ad hoc approach has produced effective results (for example, in addressing contaminants such as PFCs), the continued increase in complexity along with new concerns suggests that a more systematic approach across agencies for identifying and understanding new threats is warranted. It is important to note that it will not always be possible to identify threats prospectively; at times, state agencies will still be in a reactive mode. While this more systematic approach cannot prevent that from occurring, it can help ensure continued strong coordination of agency investigations and responses as new threats emerge.

Recommendations – Systematic Approach for Emerging Threats

- Develop a systematic approach for identifying, assessing and responding to emerging threats in consideration of the following steps:
  - Identify and evaluate emerging threats to water resources on a regular basis
  - Prioritize efforts to investigate and address potential threats, and determine an approach to funding high-priority efforts
  - Clarify and further coordinate roles and responsibilities for investigating threats including presence and extent, impacts (human, aquatic and ecosystem health), stressors and sources
  - Establish diverse teams, including personnel from federal agencies, state government, local government, academia, industry, environmental organizations or other relevant parties, specific to the threat under consideration
  - Identify management tools, both available as well as needed, for addressing the stressors and sources, and coordinate management efforts
  - Share information with interested stakeholders and the public as it becomes available
- Convene interagency teams as needed to address emerging threats to mitigate their potential adverse environmental and health impacts.

Contaminants of Emerging Concern

Progress is being made to better characterize surface and groundwater systems. With that said, there are gaps to be addressed during the next 10 years. One area of need involves contaminants of emerging concern (CECs), including endocrine-active chemicals, pharmaceuticals and personal care products, where the state is continuing to assemble information about the presence, extent and potential impact of these chemicals. A limiting factor can be the lack of available analytical methods for analyzing these chemicals at appropriate detection levels. Also lacking are benchmarks for many of the chemicals, which are needed to help interpret the potential impact of what exists in the environment. As analytical methods improve and new studies from academia, state, federal and other sources are published about CECs, state agencies will need to regularly re-evaluate data collection efforts to ensure we are gathering the information needed to adequately inform decision-making about these chemicals.

Summary of the Strategies

These nine *strategies define what* the state agencies have set out to accomplish in the coming 10 years and beyond. The seven *implementation principles describe how* the strategies will be implemented. The principles are broad in nature and are meant to be applicable to each of the strategies discussed above.

Chapter 5 Conclusions and Next Steps

The face of the water, in time, became a wonderful book – a book that was a dead language to the uneducated passenger, but which told its mind to me without reserve, delivering its most cherished secrets as clearly as if it uttered them with a voice. And it was not a book to be read once and thrown aside, for it had a new story to tell every day.

– Mark Twain, a.k.a. Samuel Langhorne Clemens (1835-1910)

Minnesota – derived from the Dakota language word minisota, meaning “water that reflects the sky” – has a rich history of respectful resource stewardship. Citizens, land and business owners, local and state officials and so many others clearly see the new stories Twain mentions of our changing landscape and of progress made. They also see the challenges ahead for protecting and restoring surface water, groundwater and ecosystem health in the “Land of 10,000 Lakes.”

The 2010 *Minnesota Water Plan* defines a vision for Minnesota’s water resources in which healthy ecosystems will meet the needs of future generations. The plan puts forth a series of strategies and principles to guide state efforts toward protecting and restoring surface water, groundwater and ecosystem health over the next decade. The strategies frame the work that agencies have set out to accomplish, working in partnership with federal and local entities, as well as academia and citizen groups. The principles guide their implementation. The goal, shared across Minnesota, is sustainable water and land management.

In recent years, nonprofit organizations, stakeholder groups, state and federal agencies and academia have led numerous efforts and studies regarding water and water-related issues. Their work endows value, articulates opportunities for growth and informs subsequent activity. Their work also improves understanding and benefits state agencies’ water protection and restoration efforts, which have expanded in recent years. Moving forward, this shared knowledge will become even more important to prioritize limited resources, apply adaptive management principles to programs, and build and foster effective relationships with local government and stakeholders.

Each state agency must also continue its leadership and create collaborative partnerships across boundaries. Agencies must continue to be efficient, identify quantity and quality targets, and discover and deliver improved products together, with engagement of citizens and local government.

The Environmental Quality Board also must provide support to agencies to ensure effective implementation of the plan. In five years, the EQB will revisit the plan to gage its continuing relevance as a guide to achieving Minnesota’s vision of sustainable land and water resource management.

The next steps will be challenging. However, for Minnesota to protect its resources for future generations while continuing to provide goods and services to the world, it will be critical to apply, evaluate and improve these strategies and principles. A strong, sustainable future calls for a proper and prudent balance among Minnesota’s environmental, social and economic priorities. This will ensure many new and good stories for decades to come.

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Appendix A – *Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts, Minnesota Pollution Control Agency and Minnesota Department of Agriculture*

Biennial Assessment of Water Quality Degradation Trends and Prevention Efforts

Minnesota Pollution Control Agency and Minnesota Department of Agriculture

Minnesota Pollution Control Agency

MINNESOTA DEPARTMENT OF AGRICULTURE

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Contents

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Introduction & Executive Summary

In 2008, the Minnesota Legislature modified state agency reporting requirements for water assessments and reports by directing the Minnesota Pollution Control Agency (MPCA) and the Department of Agriculture (MDA) to provide to the Environmental Quality Board (EQB) a biennial assessment and analysis of water quality, groundwater degradation trends, and efforts to reduce, prevent, minimize, and eliminate degradation of water.[1]

This MPCA and MDA biennial assessment, prepared jointly by the two agencies, provides an overview of relevant monitoring data and efforts to reduce, prevent, minimize and eliminate sources of water pollution to Minnesota's groundwater and surface water resources. This report draws from existing reports and information to highlight current water quality conditions and program activities.

This report summarizes relevant water quality monitoring data for both groundwater and surface water in Minnesota from the MPCA and MDA. The report consolidates information from a number of individual reports, documents and databases on the status and trends of the state's water quality resources. Because of the large amount of information available on this subject this report is summary in nature and directs the reader to additional information provided through web-based links.

Information on groundwater quality is presented first, highlighting: nitrates, pesticides, volatile organic compounds, chlorides and contaminants of emerging concern. The groundwater information is followed by descriptions of the efforts to prevent and eliminate groundwater degradation through program activities conducted by the MPCA and MDA.

Surface water quality information is presented next by water resources (lakes, streams and wetlands) and emphasizes the status and trends of Minnesota's surface water quality. Lake transparency data, pesticide detections, trends in water quality indicator parameters, and impaired waters listings are presented to highlight Minnesota's surface water quality condition.

For both groundwater and surface water, efforts to reduce and minimize resource degradation involve multiple program activities conducted by the MPCA and MDA. Efforts summarized in this report include the Pesticide and Fertilizer Registration and Outreach Programs, Agricultural and Pesticide Best Management Plan Programs, Clean Water Partnership Program, TMDL Program, regulation of wastewater discharges, regulation of subsurface sewage treatment systems (SSTS), Animal Feedlot Program, Storm Water Program, and MDA and MPCA monitoring and assessments efforts.

Significant progress has been made by MPCA, MDA and stakeholders in addressing sources of groundwater contamination, particularly through remediation, permitting and BMP activities. However, concerns still exist, and continued effort is needed to fully realize the state's groundwater quality goals.

Improvements in state surface water quality have also been significant, along with voluntary and regulatory reduction of point and nonpoint sources of pollution through MDA and MPCA programs and stakeholder support. Coupled with these gains are opportunities for continued improvements, and additional actions are needed to realize Minnesota's surface water quality goals.

[1] Minn. Stat. 103A.43

Overview: Water Resources – Benefits of Information

The MPCA and MDA collect water quality information in response to both broad and specific statutory mandates to explore water quality issues of current and emerging concern.

This information has historically been assembled and made available to the public in a variety of water quality reports, documents and agency plans. The information was then provided to the EQB for its coordinated biennial water quality assessments submitted to legislative committees and the Legislative-Citizen Commission on Minnesota Resources.

Now, biennial assessments will be prepared directly by the agencies and be integrated by EQB with 5-year groundwater policy reports and 10-year water resource planning documents.

The assessments benefit agencies, legislators and stakeholders interested in taking stock of water resource conditions and water quality trends. Water quality assessments are also useful in planning and implementing prevention and mitigation efforts to protect water resources, and as a means of tracking the impacts of human activity.

Water resource managers have identified multiple benefits of collecting water quality information, including:

- To ensure compliance with permits and water-supply standards;
- To aid development of prevention and mitigation plans for specific contamination problems;
- To guide decisions on industrial, wastewater, or water-supply facilities and domestic well protection;
- To guide research on factors that affect water quality;
- To establish the geographic and temporal scope of water resource conditions; and
- As a foundation for evaluation of existing and future statewide and regional policy decisions and associated consequences.

Adapted from Robert M. Hirsch, Chief Hydrologist, United States Geological Survey.

Groundwater Basics

Groundwater provides nearly 75 percent of Minnesotan's with their primary source of drinking water and nearly 90 percent of the water used for agricultural irrigation as estimated by the MDH and DNR. For these reasons alone it is important that we protect, monitor and report on the quality of this valuable natural resource.

The MPCA and MDA collect large amounts of groundwater quality data. Much of this is collected through contamination cleanup or landfill programs, and is considered investigation and compliance monitoring. However, data is also collected through ambient or "condition" groundwater monitoring efforts. Ambient monitoring has two primary objectives: to determine the status and quality of the groundwater resources, and to identify trends in water quality over time.

In 2004, the MDA, the MPCA, and the Minnesota Department of Health completed a Memorandum of Agreement that clarifies the agencies' roles in operating a statewide integrated groundwater monitoring system. Additional details of this agreement are available online at http://www.mda.state.mn.us/sitecore/content/Global/MDADocs/chemfert/reports/integwqualstrat.aspx.

To understand groundwater quality on a statewide basis it is important to recognize that the groundwater we use occurs everywhere in Minnesota within water-bearing soil or rock formations called aquifers (Figure 1). These aquifers have a combination of physical attributes that can create a complex matrix of groundwater resources in many areas of the state that may yield either abundant or very limited water supplies. The water quality in these aquifers is influenced by both natural processes and anthropogenic (human) influences. This report will focus on reporting the ambient condition of groundwater quality in Minnesota as influenced by anthropogenic effects, in addition to site-specific contaminant releases, with little emphasis on natural influences of groundwater quality.

More recent monitoring of Minnesota's aquifers has identified that for many vulnerable hydrogeologic settings the source of contamination to the aquifers has been attributed to non-point sources including agricultural fertilizers and pesticides, urban runoff, manure applications, septic systems, road salt and storm water infiltration. Some of the most common contaminants detected include nitrates and specific pesticides in rural settings, and volatile organic compounds, petroleum compounds and road salt in urban areas. In addition, new chemicals of emerging concern to groundwater quality, such as endocrine active compounds are being identified.

Surface Water Basics

Streams, rivers, lakes, wetlands. They are all "surface waters" in Minnesota. Their assessment for contaminants and the documentation of surface water quality trends are important functions of state agencies and their cooperators.

For surface water, in 2004, the MDA and the MPCA completed a Memorandum of Agreement that describes monitoring responsibilities for each agency. The agreement is available online at http://www.mda.state.mn.us/sitecore/content/Global/MDADocs/chemfert/reports/swagreement.aspx.

The MPCA follows a ten-year rotation for assessing waters of the state in Minnesota's 81 major watersheds (Figure 2). This is supplemented by annual monitoring at the outlets of the major watersheds to identify trends and statewide quality. The MDA focuses on agricultural and urban areas where agricultural chemicals, like pesticides, are used and may impact surface water resources. The major watershed approach provides an important unifying focus for all stakeholders. For more detail on the watershed approach see http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/basins-and-watersheds/watershed-approach.html.

Minnesota's surface water monitoring has identified that for many vulnerable hydrogeologic settings the source of contamination within a watershed can be attributed to several of the same non-point sources affecting groundwater, e.g., agricultural fertilizers and pesticides, urban runoff, and septic systems, as well as to municipal and industrial wastewater. Some of the most common impacts to surface water come from sediment, phosphorus (agricultural, industrial and residential), coliform bacteria, nitrate, mercury and pesticides. As with groundwater, an emerging concern to surface water quality is the potential effects of endocrine disrupting compounds that affect aquatic life and reproduction.

Figure 1. Minnesota groundwater provinces.

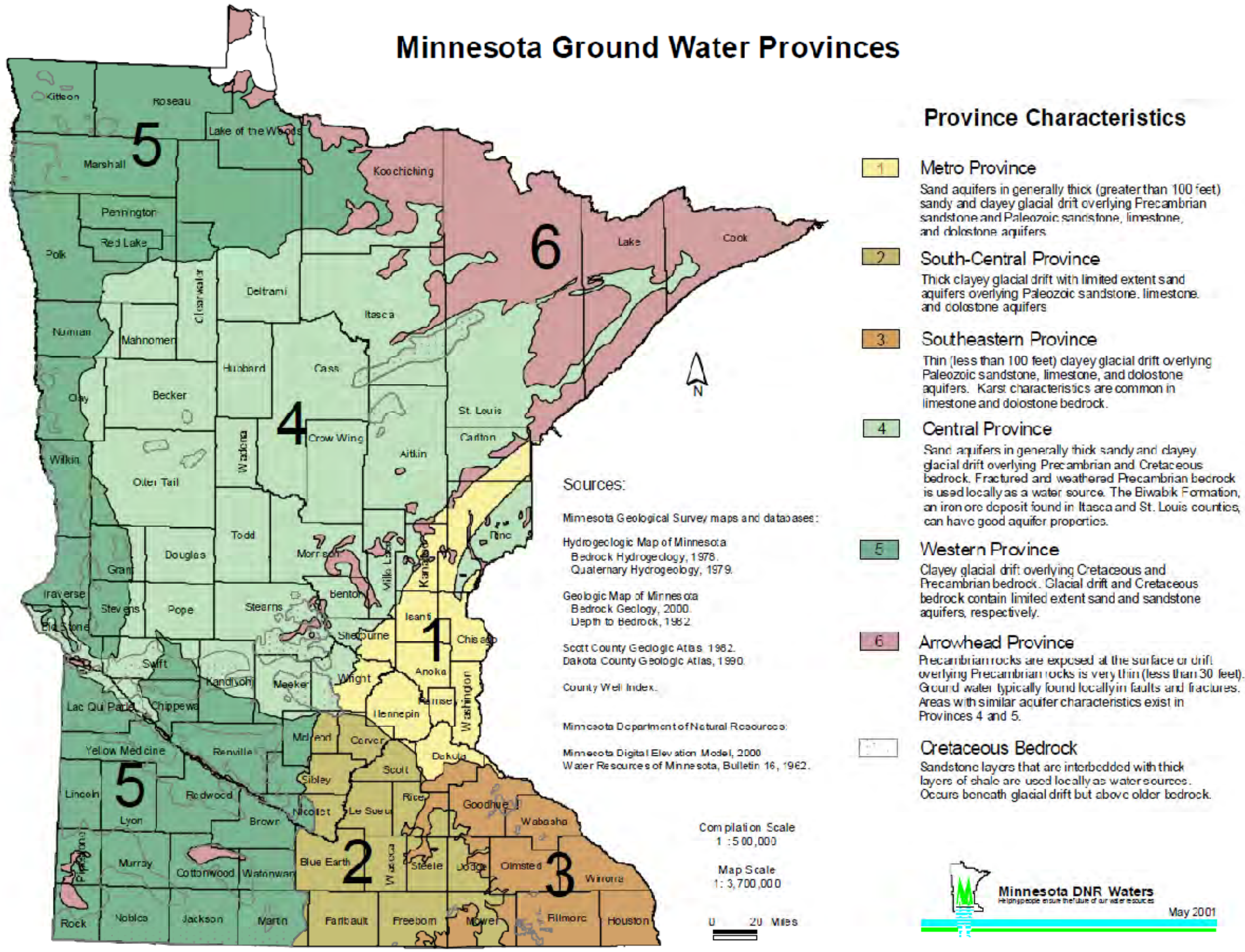
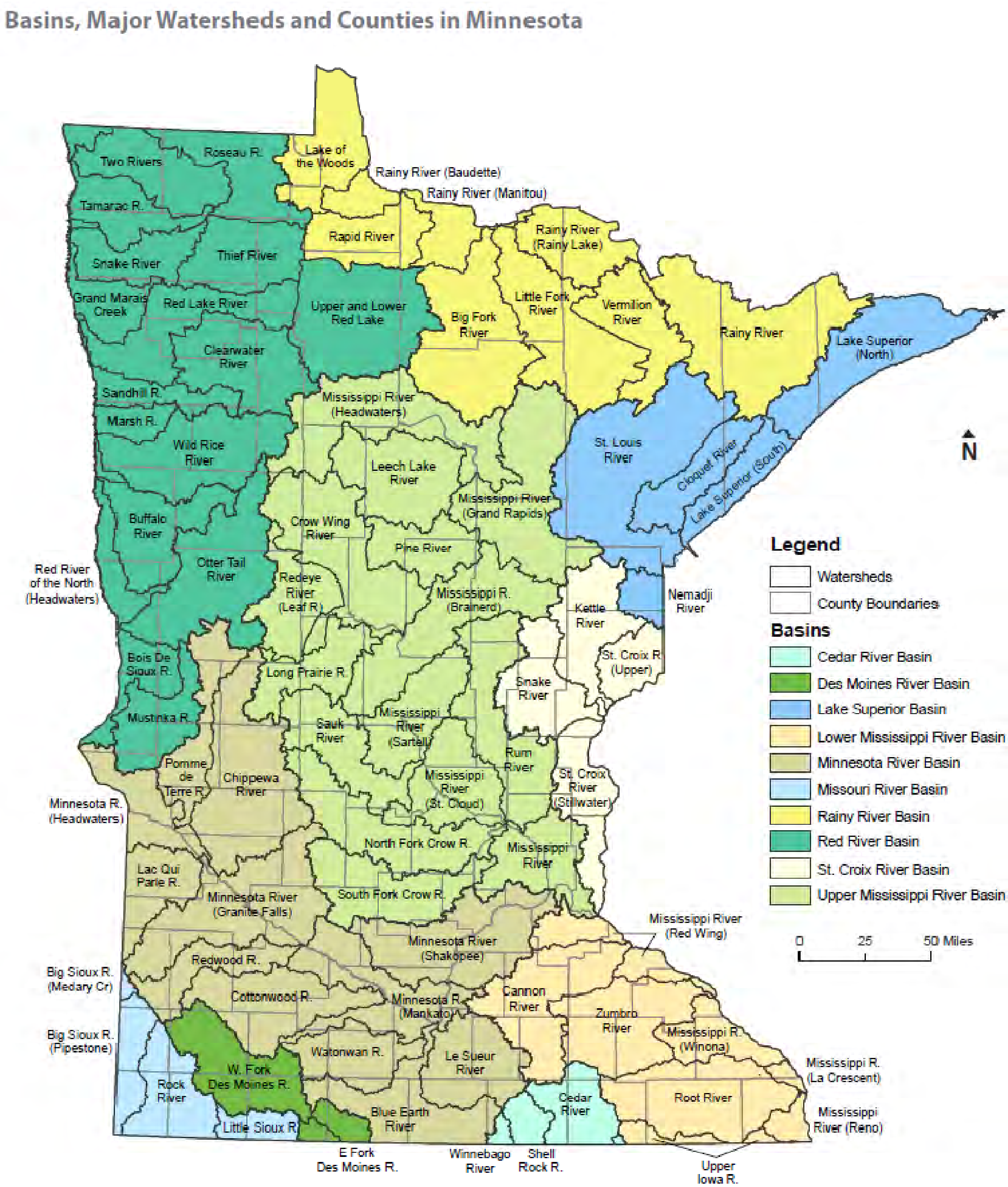


Figure 2. Basins, major watersheds and counties in Minnesota.



Water Quality Concerns

Water resource contaminants can come from human or natural sources. Some contaminants, like arsenic are naturally occurring due to geologic materials dissolved in aquifers. Arsenic can also come from human sources like industrial processes and products. Some contaminants are primarily a concern for groundwater (e.g., volatile organic compounds) while others are primarily a concern for surface water (e.g., phosphorus).

The MPCA and MDA have tracked several key contaminants for years, while other contaminants of emerging concern have recently been discovered in part due to new analytical capabilities and are just beginning to be studied. The water quality analyses contained in this summary address both historical key contaminants and those of emerging concern.

Important water resource contaminants reviewed in this summary, include: nitrate/nitrogen, chloride, volatile organic compounds, pesticides, perfluorochemicals (PFCs), and contaminants of emerging concern (CECs) in groundwater aquifers. The status of surface water quality is reported by water resource (lakes, wetlands, streams,) and includes summaries of impairment status and surface water quality trends. Additional information about these and other contaminants can be found in the source documents cited throughout this summary.

The distinction between various groundwater and surface water resources – and their contaminants – can at times be difficult to make due the many interactions between lakes, wetlands, streams and aquifers. However, the statutes that guide MPCA and MDA monitoring and reporting requirements are often aligned along specific water resources and related terms. Thus, while a contaminant may principally be assessed in one water resource (e.g., lakes and wetlands), that same contaminant may also move to groundwater resources via infiltration from the surface water body to the aquifer. Complicating matters, the impacts to groundwater (rate of contaminant degradation in the aquifer, drinking water concerns, etc.) may be evaluated differently from those associated with surface water resources, and are subject to unique monitoring methods, spatial and temporal considerations, and risk evaluation.

This report, then, provides an overall picture of quality with respect to several contaminants, while recognizing statutory requirements for different agencies to monitor and protect specific water resources from specific contaminants.

Groundwater Quality: Assessment and Analysis

Presented below is information on groundwater quality and trends for select contaminants of known or emerging concern. Additional detail and data for various groundwater monitoring projects and other contaminants in state aquifers and watersheds can be found in MPCA publications at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/groundwater/groundwater.html and in the MDA publications at http://www.mda.state.mn.us/chemicals/pesticides/maace.aspx.

Chloride

Monitoring of Minnesota's groundwater has detected elevated concentrations of chloride within specific land use settings. Chloride is highly mobile in the environment, and numerous studies have documented increased concentrations in groundwater in a variety of environmental settings. The impacts of chloride contamination in groundwater have been connected to the use of road salt in the snow belt of the United States and Canada. In Illinois and other states, municipal and private water supplies have been adversely affected by elevated chloride concentrations in groundwater. In Minnesota, the effects of road salt on groundwater quality are just beginning to be explored.

A recent review of chloride concentrations in the surficial sand and gravel aquifers throughout Minnesota identified the highest concentrations and most exceedances of the chloride secondary drinking water standard of 250 mg/L in urban areas. Groundwater chloride concentrations were higher in urban settings versus agricultural and forested parts of the State. Road de-icing chemicals were identified as the primary source of contamination within urban areas, based on interpretations of chloride/bromide ratios.

Additional details of chloride in Minnesota's groundwater can be found in the MPCA Report on Minnesota's groundwater at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/groundwater/groundwater.html.

Nitrate/Nitrogen

Nitrogen in groundwater is primarily present in the form of nitrate (represented chemically as NO_3^-) and occurs naturally at low concentrations of less than 1.0 mg/L. Studies of groundwater quality in Minnesota over the last two decades have linked elevated nitrate concentrations to land uses where there are anthropogenic sources of nitrate in combination with vulnerable geology.

Most nitrate which enters groundwater comes from anthropogenic sources such as animal manure, fertilizers used on agricultural crops, failing subsurface septic treatments systems (SSTS), fertilizers used at residences and commercially, and nitrous oxides from the combustion of coal and gas. With this array of sources, it is not surprising that nitrate is one of the most common contaminants of groundwater in Minnesota.

Nitrate concentrations in groundwater are monitored by the MPCA and MDA, in rural and urban settings, as a part of their ambient groundwater monitoring programs. The MDA, MPCA and MDH work collaboratively on a number of fronts to address nitrate contamination and assist state and local efforts aimed at protecting drinking water supplies and preventing further groundwater contamination. Other state and federal agencies such as the DNR and USGS have also generated groundwater nitrate data through regional studies of the groundwater.

The MPCA's involvement with nitrate contamination includes providing a framework for local administration of SSTS programs, and administration of the feedlot and storm water programs. The MPCA has also conducted several studies of nitrate concentrations in groundwater relative to non-agricultural land uses. For agricultural uses, nitrate is included as an analyte in MDA ambient monitoring efforts described and reported at www.mda.state.mn.us/monitoring

As noted above, studies of groundwater quality over the last two decades have identified elevated nitrate concentrations in regions of the state where aquifers are more sensitive to infiltration from contaminants on the land surface and where land use activities include anthropogenic sources of nitrogen. In these areas nitrate concentrations will often exceed background levels and in some cases exceed the drinking water standard of 10 mg/L. The areas of the state more vulnerable to nitrate contamination include shallow aquifers underlying sandy soils in central Minnesota, glacial outwash aquifers in the southwest, and the fractured bedrock aquifers in the southeast. In southeast Minnesota, 12% of recently tested domestic drinking water wells had nitrate concentrations equal to or above the 10 mg/L standard, while 61% of wells had concentrations below 1 mg/L. . Preventing and addressing nitrate contamination of aquifers in sensitive geologic areas continues to be a significant challenge to state agencies and their local partners.

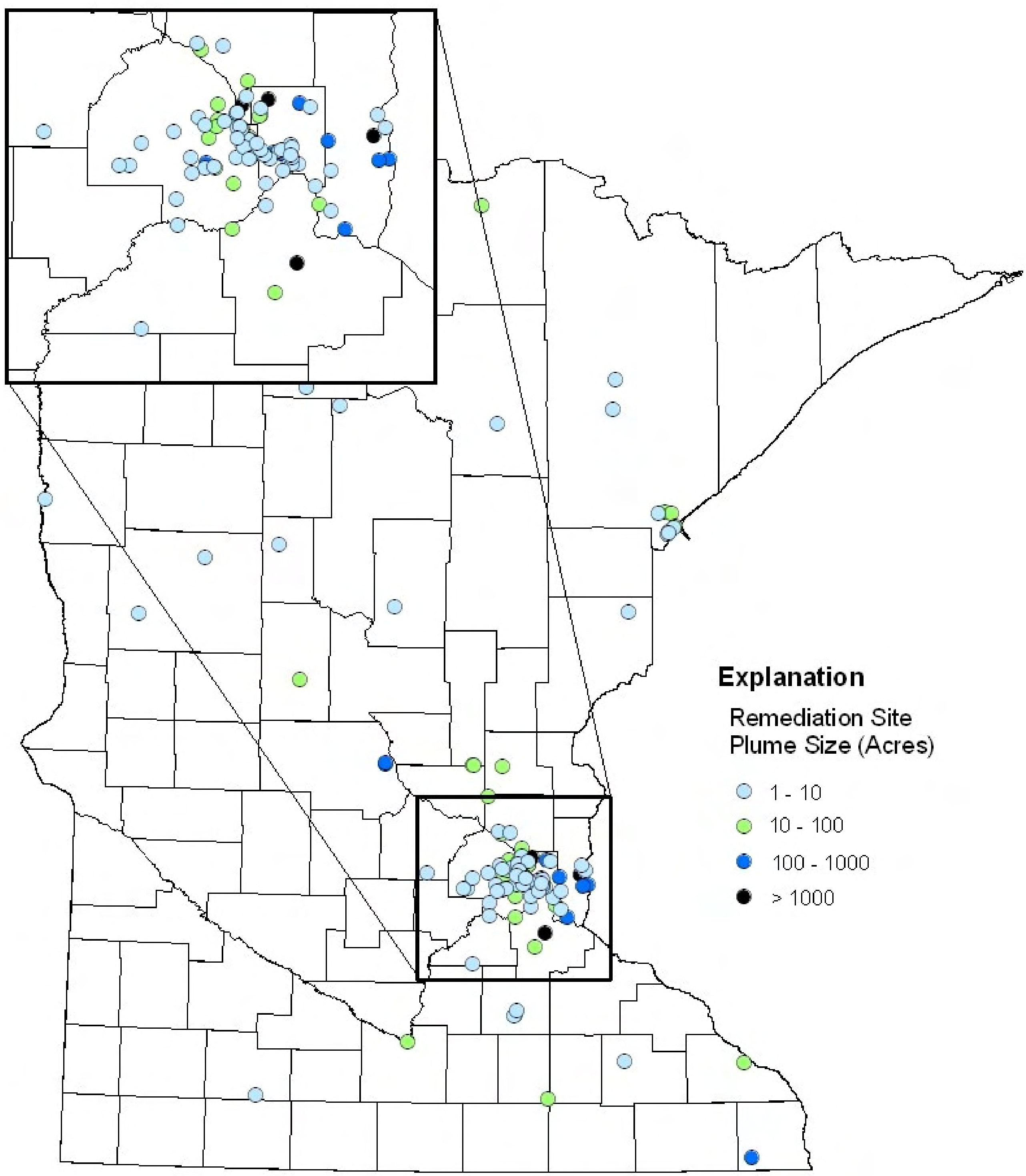
Additional information about nitrate monitoring data in Minnesota is also available in "Minnesota's Ground Water Condition: A Statewide View," in the Southeast Minnesota Water Resources Board 2009 "Volunteer Nitrate Monitoring Network, Final Report" and other MPCA publications found at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/groundwater/groundwater.html.

Volatile Organic Compounds

Volatile organic compound (VOC) contamination of Minnesota's groundwater occurs most frequently in urban settings in association with point source releases of hazardous substances. A review of the MPCA's Remediation Division database identified 178 sites with groundwater contaminant areas (plumes) that are one acre or more in size. Many of these contaminated groundwater plumes are concentrated in the Twin Cities metropolitan area and involve VOCs (Figure 3).

Results from an MPCA study of shallow groundwater in the St. Cloud area revealed low level concentrations of VOCs in nearly all samples collected under commercial and residential areas. The most common VOCs were toluene and xylene, which are products of gasoline, fuel oils, and industrial solvents. Tetrachloroethylene, a chemical widely used by dry cleaners, was found at three of the 17 sampled sites. Another group of VOCs commonly detected in Minnesota groundwater are chlorine disinfection by-products or Trihalomethanes (THMs), which are often a result of chlorine disinfection of water supplies rather than of the actual groundwater.

Figure 3. Statewide and metro-area volatile organic compound (VOC) groundwater plumes.



Pesticides

For pesticides, MDA's groundwater monitoring network provides information on impacts to the state's groundwater from the routine use of agricultural chemicals. Information is made available so management decisions can be made to reduce, or eliminate, impacts to groundwater. The MDA began monitoring groundwater in 1985 and redesigned the program in 1998. New wells were installed in 1999, and the MDA began sampling the re-designed network wells in 2000.

Samples were collected from 169 groundwater monitoring sites in 2009 (Figure 4). Of the total sites, 143 consisted of one or more specifically designed and installed monitoring or observation wells, 14 were private drinking water wells, and 12 consisted of naturally occurring springs emerging from bedrock formations of interest in the southeastern karst area of the state. All of the locations are considered sensitive to contamination from activities at the surface. Network design and sampling protocols are available in the program's groundwater design document on the MDA website at www.mda.state.mn.us/monitoring

A total of 205 samples were collected in 2009. As in recent years, pesticides detected in those samples include acetochlor, alachlor, atrazine, dimethenamid, metolachlor, and metribuzin, along with their degradates. MCPP, simazine and prometon were also detected.

In accordance with statutory requirements in the Groundwater Protection Act (Minn. Stat. chapter 103H), the MDA has determined that five pesticides are commonly detected in groundwater, leading to the development of Best Management Practices to prevent or reduce ongoing degradation of groundwater resources. All five "common detection" pesticides are agricultural herbicides: acetochlor, alachlor, atrazine, metolachlor and metribuzin.

Figure 4 shows the number of "common detection" pesticides detected at each sampling site. The locations showing the greatest number of pesticides per site are concentrated in the central sand plains (Pesticide Monitoring Region 4) and in southeastern Minnesota (Pesticide Monitoring Region 9).

Atrazine and its degradates are the most commonly detected pesticide compounds within the MDA dataset. The best dataset currently available for assessing changes in atrazine impacts to groundwater over time is the concentration data from Pesticide Monitoring Region 4. Concentration time-trend data for atrazine is presented in Figure 5 using the median, 75^{th} percentile, and 90^{th} percentile concentration values for 2000 through 2009. Time-trend analysis on median values is the most widely accepted measure on which to base decisions. The decline in concentration for atrazine plus its degradates was analyzed and found to have a statistically significant downward trend. Additional information about detections, concentrations and time-trend analysis for atrazine and other pesticides can be found at www.mda.state.mn.us/monitoring

The MDA also conducts monitoring projects to assess impacts of pesticides to private and residential drinking water wells. In the spring of 2009, the MDA conducted triazine immunoassay analyses for water samples collected from a pre-existing network of volunteered, private drinking water wells in Minnesota's southeastern karst region to screen for atrazine. The results are considered a representation of vulnerable wells rather than all wells in southeast Minnesota. All samples were collected by the well owner and MDA provided the immunoassay analysis at no charge. Ninety-two of the 100 sample kits mailed out were returned for analysis. County level summary statistics of the project are presented in Table 1. Of the 92 samples, 44 had detectable levels of triazine compounds

Figure 4. Number of common detection pesticides detected in MDA groundwater samples per site in 2009. The MDA's 10 Pesticide Monitoring Regions are outlined in bold.

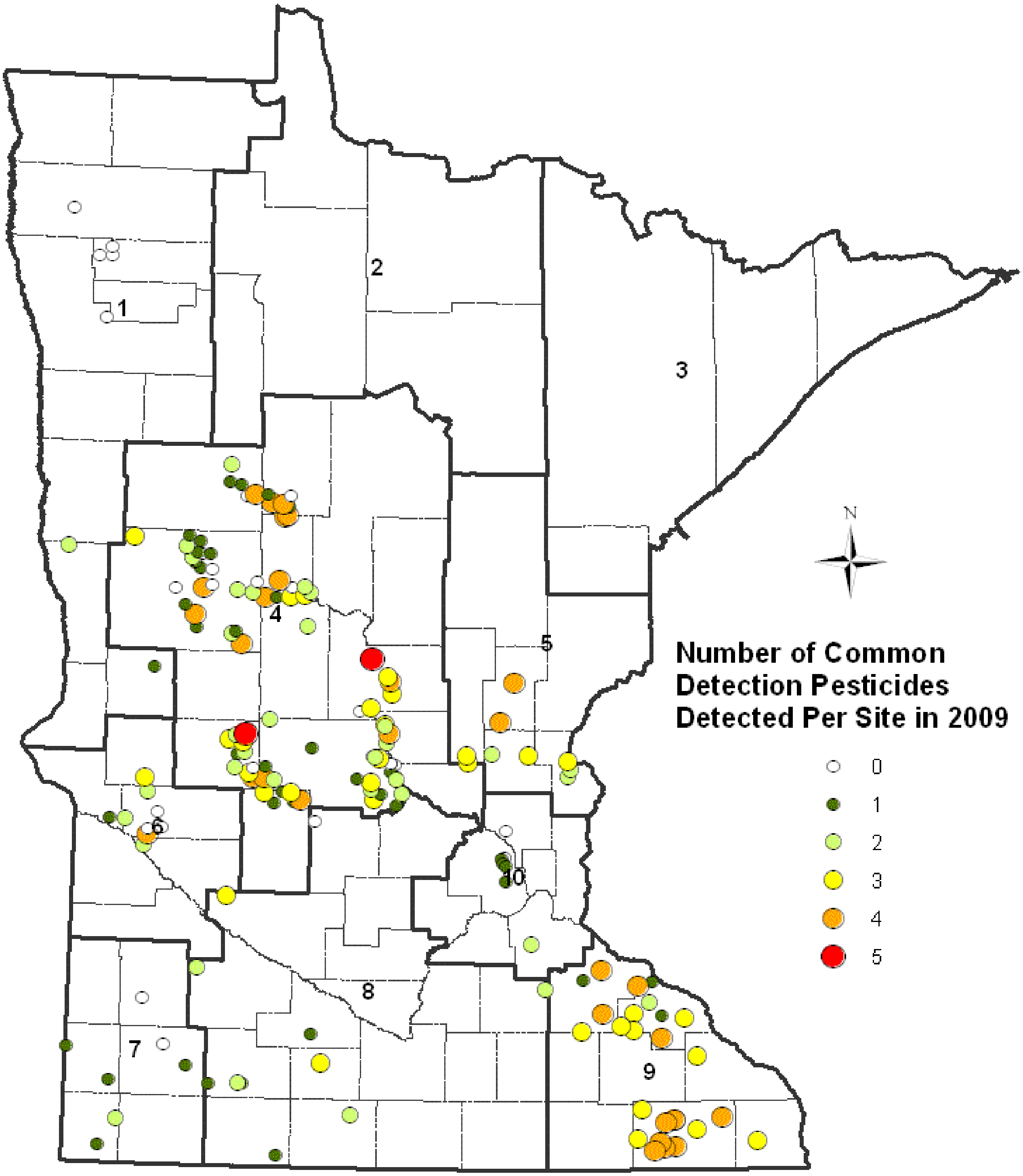


Figure 5. Atrazine and atrazine degradate groundwater sample analysis results over time for MDA PMR 4 (please note scale difference on Y- axis).

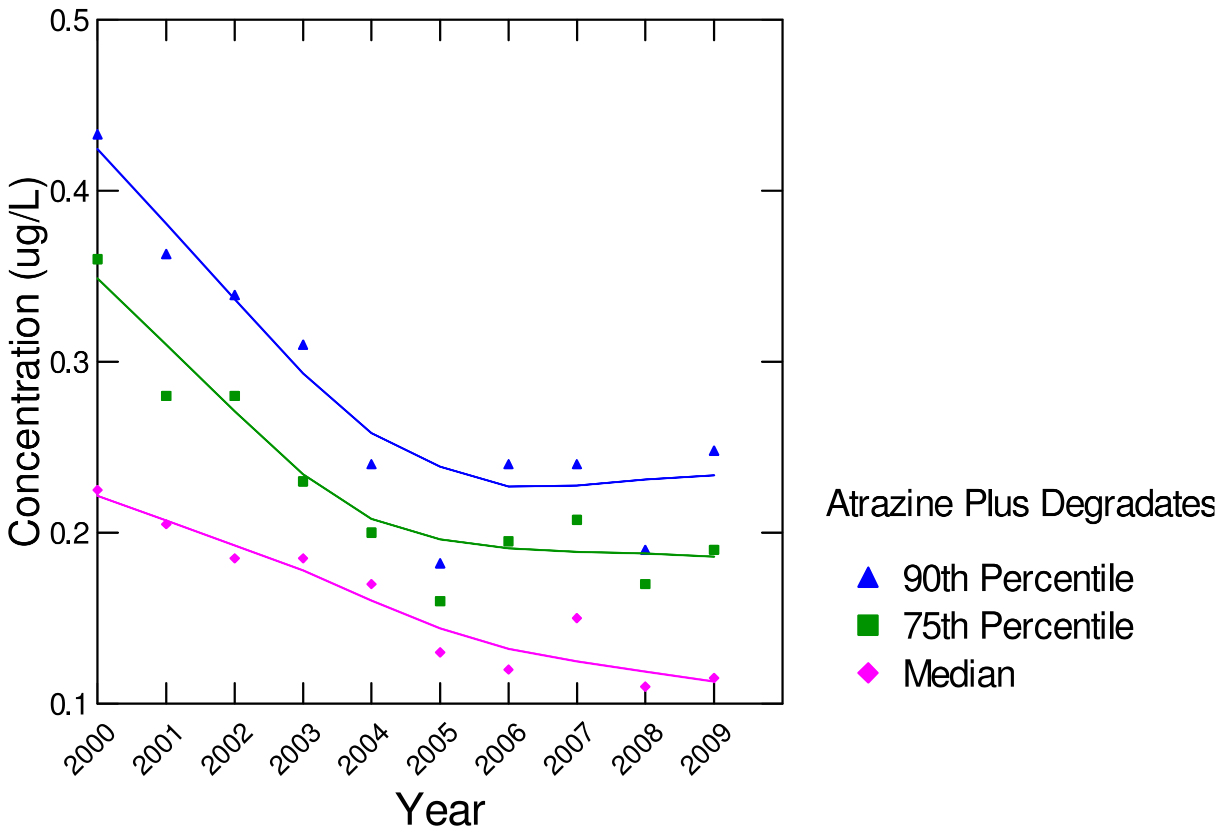


Table 1. County level statistics of the 2009 MDA triazine screen of vulnerable private drinking water wells in southeast Minnesota. Human health risk values are HRL/MCL Parent = 3.0 µg/L; Parent + Degradates = 3.0 µg/L.

County	Samples	Mean (µg/L)	Minimum (µg/L)	25th Percentile (µg/L)	Median (µg/L)	75th Percentile (µg/L)	90th Percentile (µg/L)	Maximum (µg/L)
Dodge	4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fillmore	17	0.09	<0.05	<0.05	0.06	0.10	0.12	0.53
Goodhue	12	0.06	<0.05	<0.05	<0.05	0.11	0.16	0.25
Houston	7	0.24	<0.05	<0.05	0.11	0.17	0.17	1.26
Mower	6	0.05	<0.05	<0.05	<0.05	<0.05	0.30	0.30
Olmsted	9	0.07	<0.05	<0.05	0.07	0.12	0.15	0.15
Rice	8	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.07
Wabasha	16	0.15	<0.05	<0.05	0.12	0.20	0.47	0.68
Winona	13	0.08	<0.05	<0.05	0.06	0.16	0.21	0.24
All	*92*	*0.09*	*<0.05*	*<0.05*	*<0.05*	0.12	0.22	*1.26*

that were assumed to be atrazine compounds. The median triazine concentration across the region was <0.05 µg/L, the 90th percentile was 0.22 µg/L and the maximum was 1.26 µg/L. All 92 sample results were below the currently applicable MDH drinking water guidance value of 3.0 µg/L for atrazine. The results were analyzed in conjunction with additional information on nitrate-nitrogen concentration in the well, well installation date, and the presence, or lack, of an overlaying confining layer. A special MDA report titled: "Use of a Triazine Immunoassay Method in a Volunteer Drinking Water Monitoring Network in Southeast Minnesota to Screen for Atrazine Compounds" was completed in 2009 and is available at www.mda.state.mn.us/monitoring.

Perfluorochemicals (PFCs)

PFCs are a family of synthetic chemicals, initially developed by the 3M Company that have been used for decades to make products that resist heat, oil, stains, grease, and water. 3M phased out manufacture of some PFCs in 2002, but there are other manufacturers of PFCs around the world, and the chemicals are still used in some fire-fighting foams, lubricants, packaging, metal-plating, clothing, and other consumer and industrial products.

In late 2003, the MPCA discovered PFCs in groundwater at and near four dump sites in Oakdale and Woodbury, the 3M manufacturing facility in Cottage Grove, and the Washington County Landfill. In 2004, MPCA began sampling monitoring wells at the disposal sites and nearby private wells, and the MDH sampled city wells in Washington County to identify drinking-water supplies with PFCs.

Groundwater sampling was expanded to a large part of the east Metro where more than 1,600 private wells were sampled, along with more than 50 community wells. Both private and community wells were affected, including a number of private wells in Lake Elmo, Cottage Grove, Grey Cloud Island Township, and several of the city of Oakdale's wells. Based on PFC concentrations found in some wells, MDH advised 83 households not to drink their water.

Continued testing of groundwater in the eastern Twin Cities suburbs over the past several years suggests concentrations of PFCs have remained stable and have not increased. MDH and MPCA staff continue to test wells in the area to monitor any changes in concentrations or movement of the PFC groundwater contamination.

To date, most of the drinking water supplies located away from the eastern Twin Cities suburbs that have been tested have no detectable PFCs. Although perfluorobutanoic acid (PFBA) was detected in several wells, the concentrations found were below levels of health concern established by the MDH. Testing of additional drinking water sources throughout Minnesota will continue to evaluate potential exposure to PFCs through drinking water.

The MDH, MPCA, and 3M have worked with affected parties to provide safe drinking water by supplying alternative sources of water or assisting with water filtration to remove PFCs. Results over the past several years indicate the groundwater plumes emanating from the waste sites are stable, i.e. the areas of contamination are not expanding and concentrations are not increasing. The MDH and MPCA continue to test wells in the area to monitor any changes in concentrations or movement of the PFC groundwater plumes.

Additional details on PFCs in Minnesota's water resources and ambient environment can be found at the MPCA weblink: http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup-programs-and-topics/topics/perfluorochemicals-pfc/perfluorochemicals-pfcs.html.

Contaminants of Emerging Concern (CECs)

The United States Geological Survey (USGS) has played an important role in identifying chemicals of emerging concern (CECs) in the United States. In testimony before Congress the USGS noted that CECs include many chemicals used in our homes, businesses, and industries, such as human and veterinary pharmaceuticals, detergents, fragrances, fire retardants, disinfectants, plastics, hormones and insect repellants. These chemicals have been found to enter the environment via human and animal wastes. Many of these chemicals are used in relatively small quantities and were not expected to be of environmental concern; however, in recent years advances in laboratory technology have allowed scientists to detect CECs in the environment at very low concentrations, usually at less than one part per billion. Despite these extremely low concentrations, investigation is warranted because the limited data suggest some CECs may have adverse effects on human health and the environment at these concentrations. Some of these compounds have been identified as endocrine active chemicals or EACs, which can interfere with the natural regulation of the endocrine system by either mimicking or blocking the function of natural hormones. Exposure to natural and synthetic hormones is associated with increased occurrence of tumors in humans and animals.

CECs have been identified in both Minnesota's groundwater and surface water in national reconnaissance studies conducted by the USGS. A USGS study of pharmaceuticals and organic wastewater compounds (OWCs) in groundwater detected CECs in 81% of the wells sampled from a network of 47 wells across 18 states (four sites were in Minnesota). The most frequent compounds detected were DEET an insect repellant in 35% of the samples, a plasticizer (30% of samples), a fire retardant (30% of samples), an antibiotic (23% of samples), and a detergent metabolite (19% of samples).

In a study specific to Minnesota, the USGS tested for the presence and distribution of pharmaceuticals, antibiotics, household, industrial, and agricultural use compounds, sterols and hormones in wastewater, surface, ground and drinking waters. Groundwater sampling detected 31 compounds, with the greatest number of CECs detected in two wells adjacent to a waste dump. For all of the samples tested the most frequent detections were for cholesterol (commonly associated with animal fecal matter), caffeine, DEET insect repellent, bromoform (a disinfectant by-product of waste and water treatment), beta-sitosterol (plant sterol and a know endocrine disruptor), AHTN (a widely used fragrance in personal care products and suspected endocrine disruptor); bisphenol-A (a plasticizer and known endocrine disruptor); and cotinine (a nicotine metabolite).

The MDA collaborates with and provides assistance to the MPCA and MDH as appropriate and when agricultural chemical use and regulation overlap with interagency CEC concerns.

Additional details of CECs occurring in Minnesota's environment can be found at MPCA http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/endocrine-disrupting-compounds.html and at MDA www.mda.state.mn.us/monitoring

Groundwater Quality: Reducing, Preventing, Minimizing & Eliminating Degradation

Minnesota has been a leader in addressing many sources of ground-water contamination such as Superfund sites, leaking underground storage tanks (LUST), agrichemical incident cleanup, voluntary investigation and cleanup (Brownfield) sites, landfills, and more. Additionally, examples of Minnesota's strong pollution prevention programs include effective permitting and secondary containment requirements for a variety of industrial and public activities. Minnesota has long had one of the strongest pesticide groundwater monitoring programs in the nation, dedicated to the establishment of long-term monitoring well networks in diverse agricultural regions, as well as individual studies to assess specific issues.

In the past, Minnesota has focused its limited state resources on cleanup, source control, and direct protection efforts, and required groundwater monitoring at many sites to determine individual facilities' compliance. More resources are now dedicated to monitoring for changes in local and regional groundwater quality as a result of these efforts. In recent years, Minnesota has increased its emphasis on nonpoint sources, including the development of Best Management Practices (BMPs) for sources such as feedlots, manure management, and agrichemical application.

Efforts to reduce, minimize, prevent and eliminate the degradation of Minnesota's groundwater resources are in almost all cases directed at the source of a specific contaminant or group of contaminants (point source or non-point source) and conducted on a programmatic level by the responsible government agency. The following discussion presents the efforts of MDA and MPCA programs to control (reduce, minimize, prevent and eliminate) specific contaminants or groups of contaminants by their source.

Nitrate/Nitrogen

The MPCA and MDA manage a number of different programs that prevent and reduce nitrate impacts to waters of the state. The MPCA and MDA also partner with the MDH in source water protection area program efforts. These programs address both nonpoint and point sources of nitrate/nitrogen contained in wastewaters and solids discharged to the land and waters of the state, that include: Minnesota's Subsurface Sewage Treatment Systems (SSTS) or septic systems, Animal Feedlot Program, Stormwater Program, TMDL Watershed Projects, Biosolids and Industrial By-Product Land Application programs, pollution prevention efforts, and the NPDES/SDS permit programs for industrial and municipal wastewater facilities. To prevent water quality degradation these programs use a combination of regulatory tools that include: discharge limits, permit requirements, environmental and technical reviews, facility inspections, operator training, technical assistance, compliance and enforcement, guidance documents, fact sheets, BMPs, and more. Some examples of these programs are described below:

Animal Feedlots – Animal manure contains significant quantities of nitrogen which if improperly managed can lead to nitrate contamination of waters of the state. The Animal Feedlot program regulates the land application and storage of manure in accordance with Minnesota Rules Chapter 7020 for over 25,000 registered feedlots in Minnesota. The feedlot program requires that the land application of manure and its storage in manure storage basins is conducted in a manner that prevents nitrate contamination of waters of the state. Manure management plans, facility inspections, permitting, technical assistance and record keeping are all used to manage nitrogen impacts to water quality.

To ensure that manure does not contribute to the impairment or degradation of state waters the feedlot has set program objectives to: 1) maintain a high percentage compliance for NPDES feedlot production areas; 2) inspect all non-NPDES feedlots in sensitive areas by 2015; 3) inspect land application areas for all NPDES sites by 2015; and 4) conduct inspections of land application areas at feedlots with 300 to 999 animal units, that are not covered by NPDES permits. Additional information on the Feedlot Program can be found on the MPCA website link http://www.pca.state.mn.us/index.php/topics/feedlots/feedlots.html.

Subsurface Sewage Treatment Systems (SSTS) – Of the approximate 450,000 septic systems across the state, slightly over 100,000 of them are estimated to be failing and could be sources of pollution to our water resources. A failing system is one that does not provide adequate separation between the bottom of the drainfield and seasonally saturated soil. The wastewater in SSTSs contains bacteria, viruses, parasites, nutrients and some chemicals. SSTSs discharge treated sewage into the ground, ultimately traveling to the groundwater. Additionally, SSTSs located adjacent to surface waters can discharge sewage to these surface waters and cause excessive aquatic plant growth leading to degradation in water quality. Therefore, SSTSs must be properly sited, designed, built and maintained to minimize the potential for disease transmission and contamination of groundwater and surface waters.

The Subsurface Sewage Treatment Systems (SSTS) Program oversees the treatment of sewage discharge to subsurface treatment systems in accordance with state statute and rules (Chapter 7080). The SSTS program requires the proper location, design, installation, use and maintenance of SSTS systems to protect our state’s water resources from the discharge of treated sewage to the groundwater.

The SSTS program is engaged in a number of different efforts to prevent and minimize impacts to water quality degradation that include: incorporating nitrogen BMPs into SSTS rules, requiring registration of treatment products for nitrogen reduction and identifying imminent threats to public health and safety from uncontrolled discharges. The SSTS Program is also in the middle of a 10-year plan to upgrade and maintain Minnesota’s SSTSs. One of the main objectives of the SSTS Program is to strengthen local county programs to reduce the percentage of failing subsurface soil treatment systems (SSTS) from 39 percent to less than five percent by January 1, 2014.

Nutrient Management – The MDA Nutrient Management Programs focus on nonpoint source chemical fertilizer contamination of the state's rural and urban water resources by adhering to the Ground Water Protection Act (Minn. Stat. chapter 103H), which requires that MDA work to properly manage nutrients and to adequately protect groundwater from their impacts. Much of this effort is directed to development of Best Management Practices for nitrogen fertilizer use, and a Nitrogen Fertilizer Management Plan (NFMP) for the prevention, evaluation and mitigation of nonpoint source occurrences of nitrogen fertilizer in the waters of the state. Efforts include on-farm demonstrations, in partnership with University of Minnesota scientists and extension personnel to address research needs. Additionally, the program works cooperatively with area farmers, dealers and communities in finding solutions to complex water quality problems, for example an advisory committee meets quarterly to assess and review field scale drainage water quality demonstrations conducted at working farms; see http://www.mda.state.mn.us/protecting/bmps/drainagedemos.aspx

A cooperative effort between the MDA and MDH has established the Source Water Protection Web Mapping Application, providing assistance to municipal drinking water authorities and members of the public in identifying where source water protection areas are located and the probability of potential contamination impacts and sources; see http://www.mda.state.mn.us/protecting/waterprotection/waterprotectionmapping.aspx

A significant effort has been the establishment of the Nutrient Management Initiative (NMI) available to farmers in southern Minnesota. The NMI program provides a framework for farmers to evaluate their own nutrient management practices compared with nutrient rate guidance promoted by the USDA-NRCS. Results will assist the USDA-NRCS in assessing their nutrient management guidance on a regional scale. Farmers receive $1200 for providing data and completing the program requirements. Participants are required to work with a certified crop adviser, who assists with site design, and validates cropping information, and yield results. Funding for the program is through the Environmental Quality Incentives Program (EQIP) and administered by the Minnesota USDA-Natural Resources Conservation Service (NRCS). The Minnesota Department of Agriculture assists through promotion, data collection, and compilation of data for the program. An informational brochure is available at http://www.mn.nrcs.usda.gov/technical/ecs/nutrient/Initialive/NMIBrochure2009.pdf and a report of results for the 2009 growing season available at http://www.mda.state.mn.us/sitecore/content/Global/MDADocs/protecting/soilprotection/nmi2009results.aspx. More information is available at http://www.mda.state.mn.us/chemicals/fertilizers/nutrient-mgmt.aspx.

The MDA also administers the Agricultural Best Management Practices Loan Program, providing low interest loans to implement practices that improve and protect water quality. Loans are typically provided for: Feedlot improvements, manure storage basins, and spreading equipment; conservation tillage equipment; terraces, waterways, sediment basins; shore and river stabilization; and septic systems. More information is available at http://www.mda.state.mn.us/en/grants/loans/agbmploan.aspx and the most recent program status report is available at http://www.mda.state.mn.us/sitecore/content/Global/MDADocs/financing/loans/agbmploan/statusreport.aspx

Chloride

There are three key efforts being led by the MPCA in cooperation with other government entities to reduce, minimize and eliminate the impacts of chloride degradation on water quality. Two of these efforts involve the reduction of non-point sources of chlorides within watersheds and urban areas and the third involves the regulation of point source discharges from industrial and municipal discharges to surface waters. The primary focus of these efforts is to prevent chloride impacts to streams and lakes; however, most of these efforts will also help reduce impacts to groundwater which tends to accumulate chlorides from surface water sources over a longer period of time.

One of the main efforts is the Total Maximum Daily Load (TMDL) process, provided in federal law, which begins with a water quality assessment and listing of waters that do not meet water quality standards. As a part of this process, the MPCA has listed 19 stream reaches for chloride impairments, many of which were placed on the impairment inventory list within the last three to four years. In the TMDL process all the sources of pollutants within the watershed causing the impairment are identified and a restoration plan is developed and implemented.

The first chloride TMDL approved in Minnesota was for Shingle Creek in Hennepin County, placed on the impairment inventory list in 1998. The Shingle Creek TMDL identified the main source of chloride impairment as runoff containing deicing products. The TMDL report shows that the sources of chloride include: Road maintenance authorities - 82%, Private commercial applicators - 7 %, Salt storage facility runoff - 5 %, Groundwater - 5%, and Residential - 1%.

A reduction of approximately 71 percent in chloride levels is needed to achieve water quality standards and avoid future water quality impairments. Chloride reductions will mainly come through the implementation of best management practices (BMPs) by the road maintenance authorities and private commercial applicators.

In conjunction with TMDL efforts, the MPCA has developed a website called the Road Salt Education Program with links to BMPs, training and chloride data spreadsheets (see http://www.pca.state.mn.us/index.php/about-mpca/mpca-events-and-training/road-salt-education-program.html). This website describes many ongoing efforts to curb road salt pollution that includes: pollution prevention grants to develop education outreach programs to local governments and private applicators of road salt, development of BMPs for road salt application, develop a training program, certification and implementation of BMPs, Winter Maintenance Manual and Minnesota Snow and Ice Handbook, and a Chloride Feasibility Study for the TCMA, website. The project status for the 18 other chloride impaired streams shows there are three projects underway with the remaining projects recently listed; but not underway at this time.

The MPCA has also recently completed a Metropolitan Area Chloride Feasibility study to better understand chloride impacts to surface waters within the seven county TCMA and to address chloride impairments and other impacts to water resources. This project is proactive in that it involves a multi-agency team and local stakeholders to develop a chloride restoration and protection plan which will satisfy the TMDL process requirements for impaired waters, address waters that are not listed, and protect waters that are not yet impaired.

In addition to the above nonpoint source efforts to reduce and eliminate chloride impacts to the environment, the MPCA staff has recently incorporated increased monitoring and assigned effluent limits to point source discharges from industrial and municipal facilities that show a potential to exceed chloride water quality standards. More specifically, the MPCA has identified facilities that use treatment technologies that tend to concentrate salinity levels in their wastewater discharges. Salt water discharges from residential water softeners have also been identified as a potential contributor to this problem. Facilities with the potential to exceed water quality standards will be required to monitor and comply with surface water quality standards for their point source discharges to streams and rivers under their National Priority Discharge Elimination System (NPDES) permits.

In summary, the impacts of salts and chlorides to both groundwater and surface water has more recently been identified as a growing risk to water quality. The efforts cited above, to monitor and manage chloride sources entering surface waters, indicate this problem is just beginning to be managed and the outcomes of the TMDL process, chloride BMPs, and other rehabilitation efforts on our lakes and streams may not be known for many years.

Volatile Organic Compounds (VOCs)

Two main efforts have been instrumental in the prevention and reduction of volatile organic compound (VOC) degradation of Minnesota's groundwater resources that include the cleanup of soils and groundwater at VOC contaminant release sites and pollution prevention (P2) programs.

Cleanup (Remediation) – Over the past 20 years, MPCA's cleanup (Remediation) programs including the petroleum remediation, Superfund, Hazardous Waste, Closed Landfill, Spills, and voluntary investigation and cleanup (Brownfields) programs have addressed the contamination of groundwater from VOCs at thousands of chemical release sites. The main focus of remediation activities is the cleanup of both soils and groundwater so that the groundwater quality meets drinking water standards.

These remediation programs have worked on a cumulative total of 20,699 sites. There are 1,657 sites that remain open, where cleanup activities (remediation) have yet to be completed. The reduction in these groundwater contaminant sites has been a result of remediation efforts, preventative programs and a change in societal and business knowledge and ethics. The number of contaminant sites that are "open" compared to the cumulative number of sites on a per program basis are provided on a program by program basis in Table 2.

Many of the remaining cleanup sites have long term operation and maintenance activities such as the CLP - Closed Landfill Program where all 112 sites are under operation and maintenance. Overall, the remediation of these sites in tandem with pollution prevention and environmental regulation have prevented and reduced most controllable causes of VOC releases to the environment, however, VOC releases may continue to occur as a result of spills and other accidents.

Table 2: Number of remediation contaminant sites that are "open" compared to the cumulative number of sites on a per program basis.

Program	Open	Cumulative
Petroleum Remediation	1,108	16,971
Superfund Program	95	237
VIC (Brownfields)	381	3,026
RCRA (Haz. Waste sites)	62	356
CLP (Closed Landfills)	8	112
Total	**1,657**	**20,699**

Additional details of efforts to prevent and cleanup VOCs in the environment can be found on the MPCA website: http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup-programs-and-topics/topics/remediation-sites/remediation-sites.html.

Pollution Prevention – Pollution prevention is the best way to avoid the risk posed by VOCs to groundwater resources. Pollution prevention means eliminating or reducing at the source, the use, generation or release of toxic chemicals, hazardous substances and hazardous waste. Examples of pollution prevention include waste reduction and use of less persistent and less toxic chemicals. Some of the Best Management Practices (BMPs) to decrease the risk of contamination include: Proper storage of VOC-containing chemicals; proper disposal of VOC-containing waste; locating water supply wells upgradient of VOC sources; and locating industries in areas where aquifers are less sensitive.

The MPCA in partnership with the Minnesota Technical Assistance Program (MnTAP) and Retired Engineers Technical Assistance Program (ReTAP) provides technical assistance and financial assistance for businesses and institutions seeking ways to reduce waste to achieve pollution prevention goals. For 2008 and 2009, pollution prevention technical assistance efforts resulted in 6.8 million pounds of waste reduced, 1.3 million pounds of materials reused, 104 million gallons of water conserved, 15.5 million kWh and 780,000 therms of energy conserved for a savings of $8.7 million. By January 1, 2013, technical assistance at specific facilities is projected to reduce the amount of pollution generated by 10% from 2008 levels. Current reporting of pollution prevention efforts can be found on the MPCA webpage for Pollution Prevention activities: http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/preventing-waste-and-pollution.html.

Pesticides

The MDA has developed the Minnesota Pesticide Management Plan: A Plan for the Protection of Groundwater and Surface Water (the PMP; revised in 2007) as the primary tool for preventing, evaluating and mitigating pesticide impacts to water resources. The PMP established the delineation of Pesticide Management Areas (PMAs) based on similar hydrologic, geologic, and agricultural management characteristics occurring within a region/area of the state (Figure 4). The PMAs provide the MDA with a framework for outreach and education to agricultural stakeholders, further described in the PMP (Chapter 8: Prevention) at http://www.mda.state.mn.us/protecting/waterprotection/pmp.aspx.

The PMP establishes a BMP Education and Promotion Team made up of state and local pesticide and water quality specialists, along with others interested in developing and delivering consistent messages to pesticide users about BMPs and water quality protection.

In 2004, the MDA developed "core" BMPs for all agricultural herbicides, and separate BMPs specific to the use of the "common detection" herbicides acetochlor, alachlor, atrazine, metolachlor and metribuzin. The acetochlor BMPs were revised in 2009 due, in part, to impairment decisions for acetochlor in two southern Minnesota watersheds. One of the ways MDA is evaluating the adoption of BMPs through biennial surveys (see http://www.mda.state.mn.us/chemicals/pesticides/pesticideuse.aspx), while BMP effectiveness is being evaluated through in-field studies and other methods (see, for example, http://www.mda.state.mn.us/chemicals/pesticides/acetochlor1/acetochlor6.aspx).

The MDA also recently began a program of conducting special registration reviews of pesticides that might have specific concerns to use in Minnesota, including water quality protection. Atrazine is the first pesticide to undergo such a review, which included significant cooperation with the MPCA and MDH. Results of the atrazine special registration review are available at http://www.mda.state.mn.us/chemicals/pesticides/atrazine/atrazinereview.aspx. The current special registration review is for pesticides used to control Emerald Ash Borer.

Perfluorochemicals (PFCs)

In May, 2007, the MPCA Citizens' Board approved a Settlement Agreement and Consent Order negotiated between MPCA staff and 3M for the investigation and cleanup of PFCs at three 3M PFC disposal sites. The cleanup plans include: 1) institutional controls, 2) excavation of remaining source areas, 3) continued and/or enhanced ground-water extraction and treatment, and 4) long-term monitoring. Excavated wastes from these sites will be placed in a specially built long-term containment cell at the SKB Industrial Landfill in Rosemount, Minn. The Washington County Landfill will be re-excavated and the wastes placed into newly constructed, triple-lined cells on-site.

All of the households or communities with drinking water found to be above MDH health standards for PFCs have been provided with bottled water, carbon filtration, or municipal water hookups. 3M provided the city of Oakdale with large carbon filtration units which filter water from two of the city's affected wells at the treatment plant. 3M also provided funding for the city of Lake Elmo to extend clean city water to over 200 homes in the area affected by the contamination. Information on cleanup of the four sites is on the MPCA Web site at www.pca.state.mn.us/cleanup/pfc/pfcsites.html.

MDH's East Metro PFC Biomonitoring Study is measuring exposure to PFCs in adults living in selected areas of Washington County where the drinking water is contaminated with PFCs. Although public health actions to prevent or reduce people's exposure to PFCs are now in place, some PFCs stay in the body for years and can likely still be measured. Additional details and reports on PFCs in Minnesota's environment can be found on the MPCA websites at http://www.pca.state.mn.us/index.php/waste/waste-and-cleanup/cleanup-programs-and-topics/topics/perfluorochemicals-pfc/perfluorochemicals-pfcs.html .

Contaminants of Emerging Concern (CECs)

To date the efforts to prevent degradation of waters by CECs and Endocrine Active Compounds (EACs) have largely focused on research to define their presence and distribution in the environment with more recent efforts to evaluate their risk and toxicology. From a regulatory perspective, efforts to reduce the potential risk of pollutants typically follows the development of risk based toxicological limits for the chemicals of concern. However, the presence of CECs and more specifically EACs in our state's water resources has prompted Minnesota government agencies and the Minnesota state legislature to take actions to address this concern.

Currently, the MPCA ambient groundwater monitoring program is monitoring for CECs and EACs in the groundwater as part of its efforts to address the rising concerns associated with these chemicals in Minnesota's environment. This monitoring will significantly expand the existing knowledge of the occurrence of CECs in the groundwater. Specific long-term objectives for the MPCA's monitoring of EACs and other CECs in groundwater are to: 1) determine the occurrence and distribution of these contaminants in the groundwater system, 2) quantify any temporal trends in concentrations, and 3) use this information in conjunction with other data collected as part of ambient monitoring to evaluate the sources of any contamination found in the groundwater. The MDA shares these objectives as it coordinates with other state agencies its own pesticide-related CEC monitoring and response activities.

The Minnesota Department of Health (MDH) has a CEC program to identify contaminants in the environment for which current health-based standards do not exist or need to be updated to reflect new toxicity information. Through the CEC program, the MDH will investigate the potential for human exposure to these contaminants, and develop guidance values. MDH staff are currently developing contaminant selection and screening criteria.

Other state and county government agencies have established educational web pages to inform the public of the growing concern of specific CECs and EACs in the environment and the need to prevent or minimize their impacts to water resources.

Groundwater Summary

Significant progress has been made by MPCA and MDA in addressing sources of groundwater contamination, particularly through remediation, permitting and BMP activities. However, concerns still exist.

Some of the most common contaminants detected include nitrates and specific pesticides in rural settings, and volatile organic compounds, petroleum compounds and road salt in urban areas. In addition, new chemicals of emerging concern to groundwater quality, such as endocrine active compounds are being identified.

Continued effort is needed to fully realize the state's groundwater quality goals. In particular, ongoing monitoring of vulnerable aquifers is critical to identify and track trends, and evaluate the success of management efforts.

As noted in the MPCA's "2010 Groundwater Monitoring Status Report" and in MDA monitoring reports and program plans, a long term commitment to the collection and analysis of groundwater data is necessary to identify changes in water quality and quantity over time and provide information needed to effectively manage and protect this critical resource. While available trend data is currently limited, the necessary monitoring network is currently being enhanced and is on track to produce the information needed to fill this gap.

Surface Water Quality: Assessment & Analysis

Presented below is summary information on the quality of the state's surface water resources, including impaired waters, pollutant trends in streams, lake water quality, wetland quality and contaminants of emerging concern (CECs). More detailed information can be found in the 2010 Integrated Report to Congress, which summarizes the status of the state's waters (MPCA publication "2010 Minnesota Water Quality: Surface Water Section" (Abbreviated Narrative Report) http://www.pca.state.mn.us/water/index.html) in the MDA publication "2009 Water Quality Monitoring Report" (http://www.mda.state.mn.us/chemicals/pesticides/~/media/Files/chemicals/reports/2009waterqualitymonrpt.ashx) and other reports , documents and sites referenced in this section.

Current Status – Impaired Waters Listings

Impaired Waters – The Clean Water Act of 1972 requires states to adopt water quality standards to protect waters from pollution. These standards define how much of a pollutant can be in a water and still allow it to meet designated uses, such as drinking water, fishing, swimming, irrigation or industrial purposes. Impaired waters are those waters that do not meet water quality standards for one or more pollutants, thus they are "impaired" for their designated use(s).

The state has recently adopted a watershed approach to monitor and assess surface waters to identify impaired and "unimpaired" waters. This effort, led by the MPCA under the Clean Water Act requirement to monitor and assess the state's waters, is on track to monitor and assess the water quality of 100% of the state's major watersheds on a 10-year cycle.

The MPCA assesses waters and lists the impaired waters every two years in accordance with the Clean Water Act. Table 3 lists the various causes or stressors for stream impairments and the total number of stream miles impaired. Table 4 lists the causes of lake water quality impairments for lakes and the total acreage impaired. Table 5 lists the total acres of wetlands and the impairment causes. Data in the tables is based on the 2010 draft list of impaired waters; this information is drawn from the 2010 Integrated Report.

Table 3. Total miles of waters impaired by various cause/stressor categories – streams.

Cause/Stressor Name	Impaired Miles
Acetochlor	9
Ammonia (Un-ionized)	97
Aquatic Macroinvertebrate Bioassessments	553
Arsenic	147
Chloride	205
DDT	19
Dieldrin	19
Dioxin (including 2, 3, 7, 8-TCDD)	13
Escherichia coli	771
Fecal Coliform	3265
Fish Bioassessments	2068
Lack of Coldwater Assemblage	38
Mercury in Fish Tissue	4791
Mercury in Water Column	434
Nitrates	117
Oxygen, Dissolved	1820
PCB in Fish Tissue	1187
PCB in Water Column	43
Perfluorooctane Sulfonate (PFOS) in Fish Tissue	85
pH	126
Temperature	10
Toxaphene	13
Turbidity	5887

Table 4. Total acres of waters impaired by various cause/stressor categories – lakes.*

Cause/Stressor Name	Acres
Chloride	497
Mercury in Fish Tissue	3,452,498
Mercury in Water Column	6,968
Nutrient/Eutrophication Biological Indicators	541,373
PCB in Fish Tissue	1,627,560
Perflurorooctane Sulfonate (PFOS) in Fish Tissue	2,330

Based on ADB 2010 Cycle data from March 2, 2010, *data includes Lake Superior

Table 5. Total acres of waters impaired by various cause/stressor categories – wetlands.*

Cause/Stressor Category	Integrated Reporting Acres Impaired
Aquatic Macroinvertebrate Bioassessments	**323**
Aquatic Plant Bioassessments	**878**

*Summary acreage reflect data available in the Asessment Database on 1/4/10.

Lake and Stream Water Quality Trends

One of the goals of MDA and MDH water quality monitoring efforts is to identify and track trends in Minnesota waters. The following sections highlight available trend information for Minnesota's lakes and streams.

As a part of this assessment, it is important to note that trend analysis can be very challenging, in part due to the amount of data needed over multiple years to detect a trend. Work is currently underway (with considerable support from the Clean Water Fund created by the Clean Water, Land and Legacy Amendment) to significantly enhance the available trend information for Minnesota lakes, streams and wetlands. For example, in recent years state agencies and our partners have established permanent flow and chemistry monitoring sites at the outlets of the state's 81 major watersheds. In addition, the state is participating in 5-year rotating surveys of lakes, streams and wetlands as part of the Environmental Protection Agency's National Aquatic Resource Surveys (see http://www.epa.gov/owow/monitoring/pdf/narsprogress.pdf). Even with this enhanced monitoring, time and ongoing support is needed to amass the datasets needed to augment the currently available trend information highlighted in the following sections.

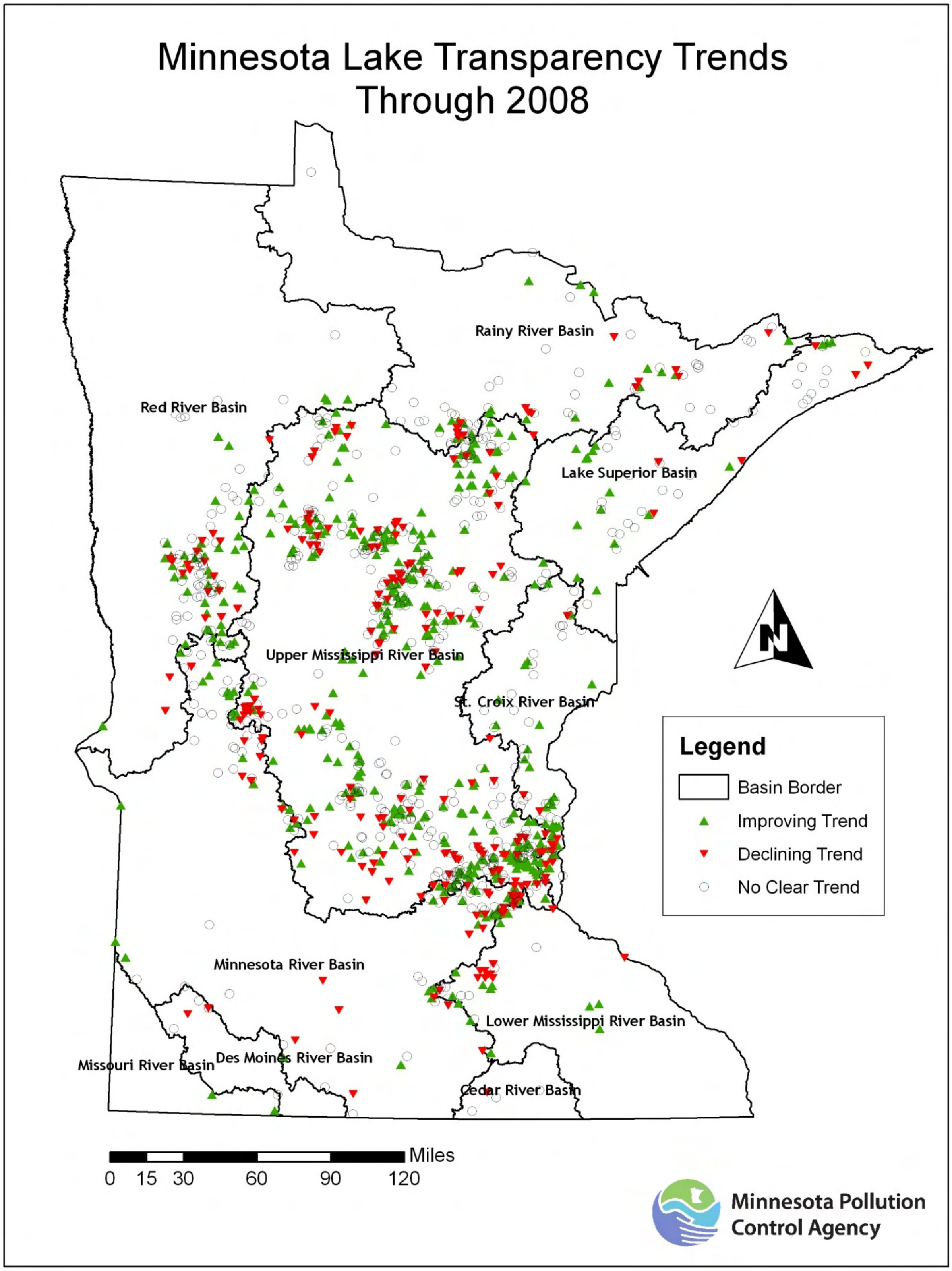
Lake Water Quality – Detecting changes (trends) in water quality over time is a primary goal for many monitoring programs. Detecting trends requires many measurements each summer and several years' worth of data. Secchi transparency is a preferred parameter for monitoring lake water quality trends for many reasons: it is relatively low-cost, it is easily incorporated into volunteer monitoring programs, and it allows for the collection of a large number of samples in a given sampling period on many lakes. Most importantly, it is a good indicator of lake water quality, particularly as it relates to recreational use. In 2008, data was analyzed to determine whether the available Secchi data for lakes in Minnesota exhibited increasing or decreasing trends. Only lakes with more than eight years of data were included in the trend analysis.

There were 1,201 lakes in Minnesota that met the minimum requirements for trend analysis in 2008. Table 6 shows the number of lakes which have either an improving, declining or no clear trend in water Secchi transparency. Of the 1,201 assessed lakes, 455 of them exhibited a statistically significant improvement in transparency over time. In contrast, only 231 lakes exhibited a statistically significant decline in transparency. 515 of the assessed lakes exhibited no clear water quality trend. See http://www.pca.state.mn.us/water/clmpfactsheets.html for lake and county-specific trend information. Figure 6 provides a geographic depiction of the trends in lake water quality across the state. .

Table 6. Trends in Minnesota lake water quality.

Description	Number of Lakes
Assessed for Trends	1201
Improving	455
Declining	231
No Clear Trend	515

Figure 6. Minnesota lake transparency trends through 2008



In 2009, six different lakes were sampled twice for pesticides by MPCA under a cooperative effort with MDA and as part of the DNR's Sentinel Lakes Program. The goal was to evaluate seasonal changes in lakes to guide future lake sample efforts.

Table 7 shows summary statistics for pesticide compounds detected in 2009 lake sampling efforts. All pesticide detections in lakes in 2009 were well below applicable water quality standards. Atrazine and acetochlor were the only two pesticide parent compounds detected. As with previous sampling, pesticide degradate compounds were detected in higher frequencies and concentrations than the parent compounds.

There was a large difference between the average total pesticide concentrations in lakes that were located in areas dominated by agricultural land use as opposed to those located in areas with less agricultural land use. Additional information about 2009 MDA lake sampling results can be found online at www.mda.state.mn.us/monitoring.

Table 7. Summary statistics for pesticides detected in MDA lake sampling 2009.

Pesticide Compound	Median (µg/L)	Maximum (µg/L)	Detection Frequency %
Acetochlor	nd*	0.07	25% of 12 samples
Atrazine	nd	0.08	42% of 12 samples
Deethylatrazine	nd	0.06	25% of 12 samples
Acetochlor ESA	nd	0.59	33% of 12 samples
Acetochlor OSA	nd	0.78	33% of 12 samples
Alachlor ESA	nd	0.64	33% of 12 samples
Alachlor OSA	nd	0.09	17% of 12 samples
Metolachlor ESA	nd	0.79	58% of 12 samples
Metolachlor OSA	nd	0.28	33% of 12 samples

* "nd" indicates no detection of the pesticides

Stream Water Quality – Some of the best available information on pollutant trends in rivers comes from Minnesota Milestone sites, citizen-collected stream transparency data, and from MDA pesticide monitoring sites.

MPCA MINNESOTA MILESTONE MONITORING: Minnesota Milestone sites are a series of 80 monitoring sites across the state with high quality, long-term data, in some cases going back to the 1950s. Table 8 illustrates the statistical trends for the Milestone sites which show significant reductions for contaminants often associated with human inputs: biological oxygen demand, total suspended solids, phosphorus, ammonia and fecal coliform bacteria. These results reflect the considerable progress made during that time in controlling municipal and industrial point sources of pollution. Nitrite/Nitrate nitrogen levels, on the other hand, showed increases at many of the sites, perhaps reflecting continuing non point source problems. State trend maps for Nitrite/Nitrate and Total Phosphorus in rivers are provided in Figures 7 and 8.

Table 8. Pollutant trends in rivers and streams – Minnesota Milestone sites.

	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
Decreasing pollutant trend	89%	41%	78%	1%	83%	82%
Increasing pollutant trend	1%	4%	1%	75%	4%	0%
No trend	10%	54%	21%	23%	13%	18%

Citizen Stream Monitoring: Trend analysis of stream water clarity data (Table 9) has been done using transparency-tube measurements collected by volunteers through the MPCA's Citizen Stream Monitoring Program (CSMP). For streams with sufficient data in 2009, statistical analysis was performed using a linear-regression model. Of the 529 assessed stream sites, 134 of them exhibited a statistically significant improvement in transparency over time. In contrast, 69 exhibited a statistically significant decline in transparency. No clear WQ trend was exhibited in 326 of the assessed stream sites. See http://www.pca.state.mn.us/water/csmp-reports.html for state-wide and site-specific CSMP annual reports.

Table 9. Trends in Minnesota stream water clarity.

Description	Number of Streams
Assessed for Trends	529
Improving	134
Declining	69
No Clear Trend	326

Figure 7. Nitrite/Nitrate nitrogen stream trends at Minnesota Milestone sites.

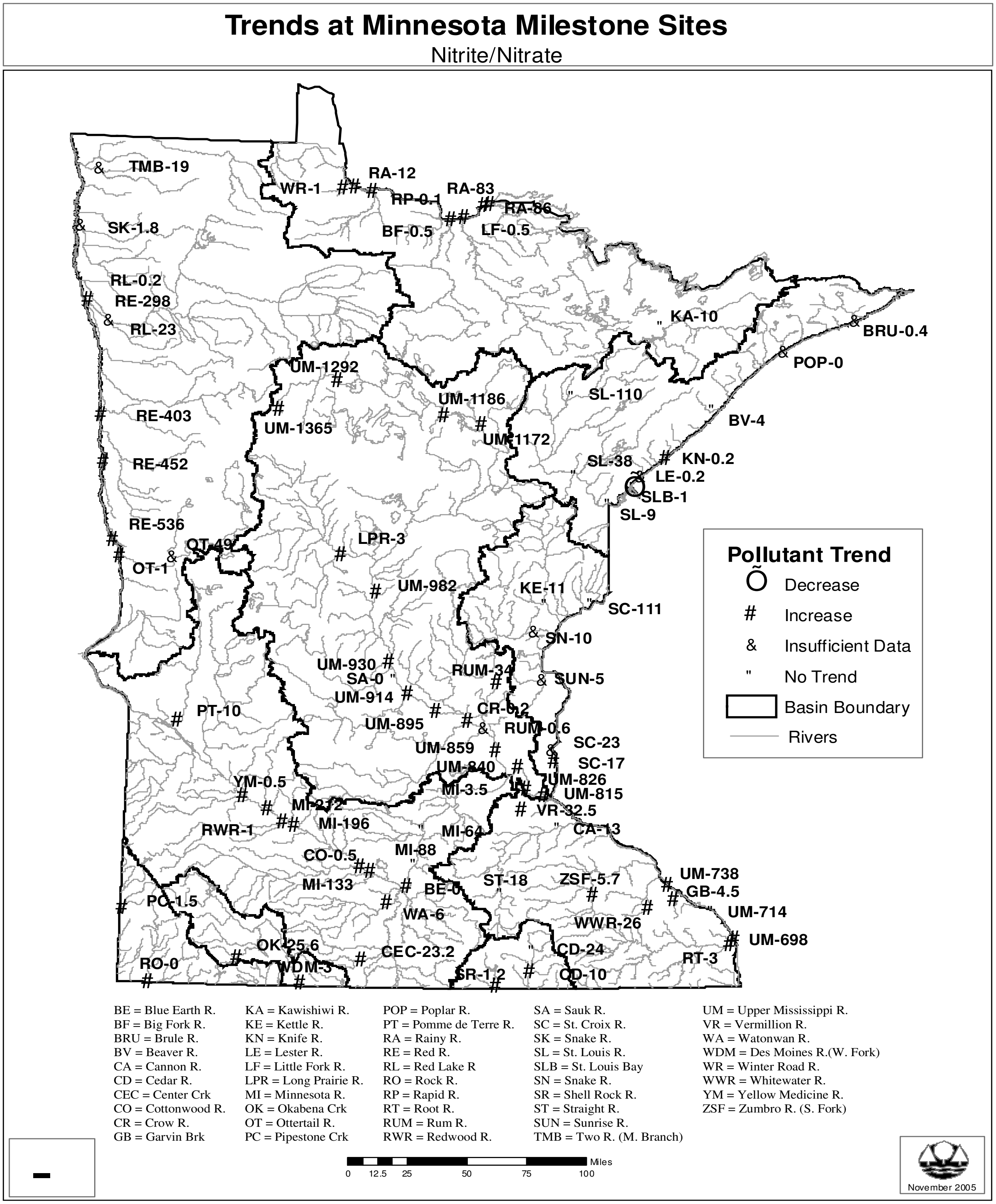
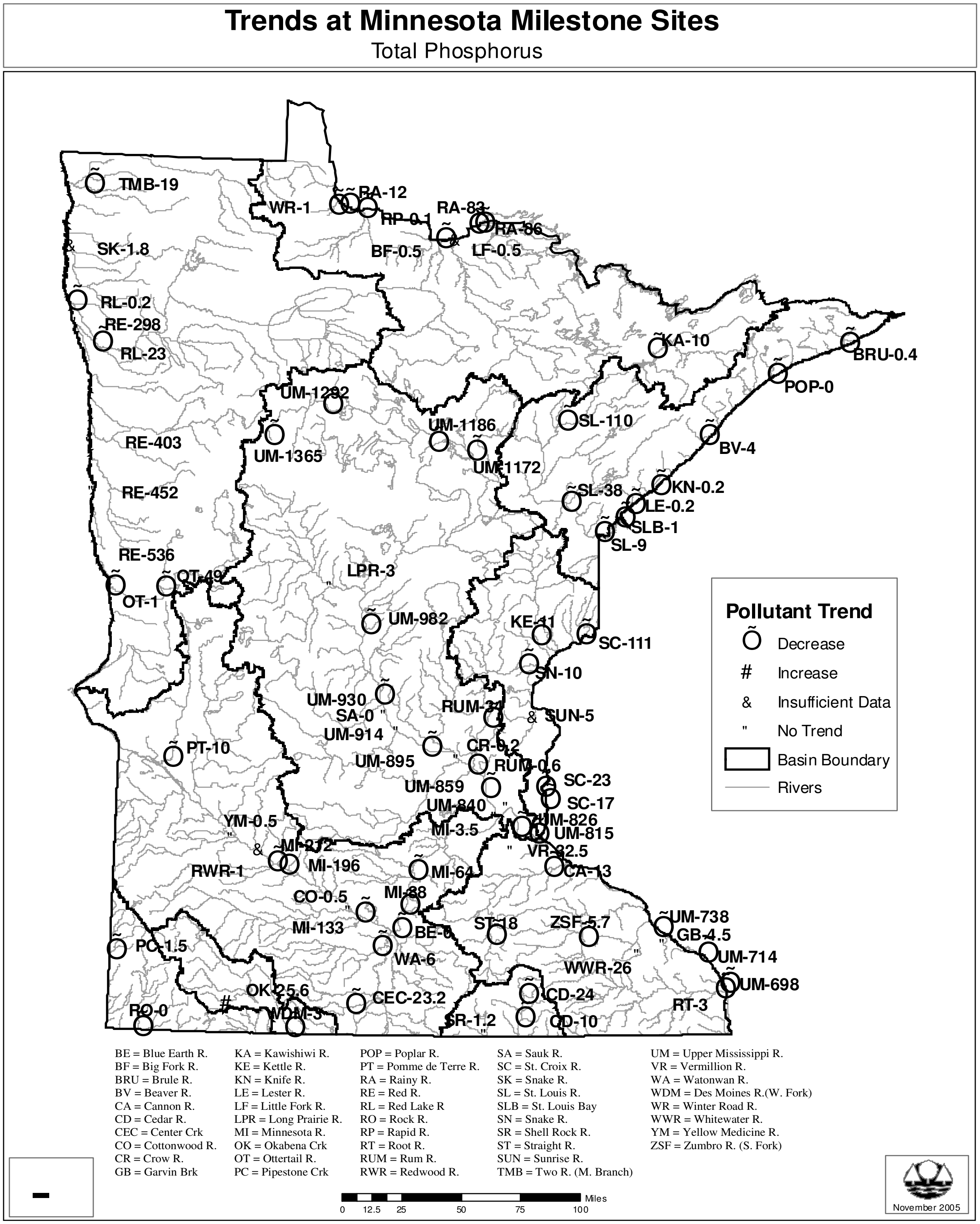


Figure 8. Total phosphorus stream trends at Minnesota Milestone sites.



MDA PESTICIDE MONITORING AND ACETOCHLOR IMPAIRMENTS: MDA surface water monitoring for pesticides extends back to 1991. Current monitoring is done within a framework of Pesticide Monitoring Regions (PMRs) shown in Figure 9. In 2006 the MDA began monitoring surface water utilizing a tiered structure defined and described in the MDA Surface Water Monitoring Design Document (www.mda.state.mn.us/monitoring).

Seven of the 369 pesticide samples collected from rivers and streams in 2009 were measured at concentrations greater than ("exceedances") the established aquatic life standards or reference values. And while in previous years (2001 and 2005) there have been exceedances leading to water quality impairment decisions (see below), there were no exceedances in 2009 when concentrations were properly time-weighted to the applicable standard.

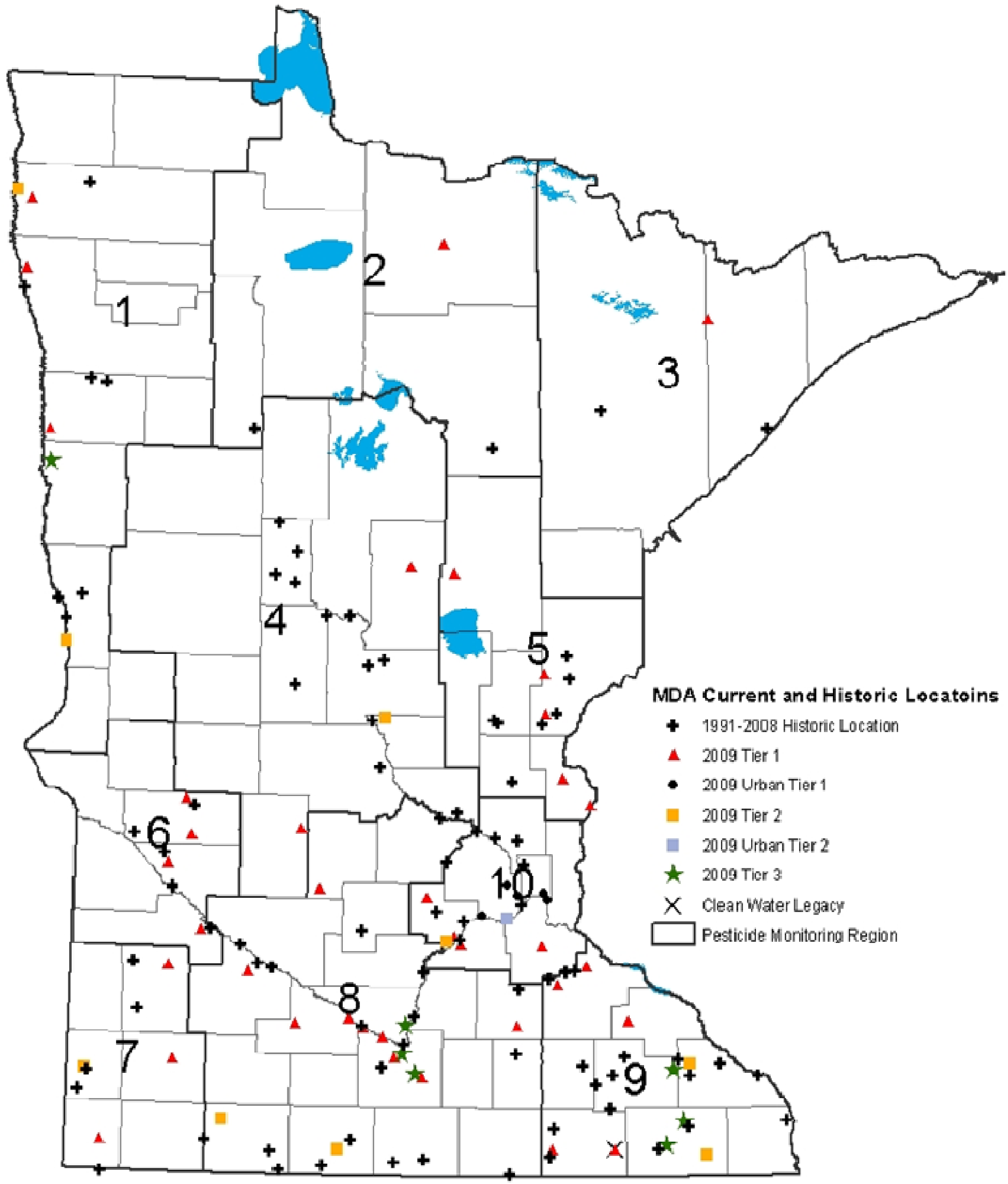
Because pesticides, especially agricultural and home and garden pesticides, are typically applied to coincide with the seasonal need to control weeds, insects and other pests or plant diseases, the presence of pesticides in streams and rivers is often linked to application timing, and subsequent rainfall and runoff events. Consequently, trends in water quality - especially individual streams and rivers - are difficult to establish. Nevertheless, the MDA analyzes data from Tier 3 sampling locations in an effort to track certain statistics associated surface water pesticides of concern or potential concern. Table 10 shows statistics (2005 – 2009) for select Tier 3 sampling locations where corn herbicides acetochlor, atrazine and metolachlor are frequently detected. Results for all MDA surface water sampling sites are available at http://www.mda.state.mn.us/chemicals/pesticides/maace.aspx

Table 10. Surface water pesticide concentration results at select MDA Tier 3 sampling locations.

River	Acetochlor (µg/L) 4-day toxicity standard = 3.6 µg/L			Atrazine (µg/L) 4-day toxicity standard = 10 µg/L			Metolachlor (µg/L) 4-day toxicity standard = 23 µg/L		
Beauford Ditch	**Median**	**90th %-tile**	**Maximum**	**Median**	**90th %-tile**	**Maximum**	**Median**	**90th %-tile**	**Maximum**
2005	P*	3.88	12.1	P	0.43	2.85	P	0.74	3.70
2006	0.06	0.21	1.58	nd**	P	P	P	0.14	0.17
2007	0.04	0.14	0.19	0.04	0.20	0.22	P	0.15	0.42
2008	P	0.70	1.46	P	P	P	P	0.28	1.99
2009	P	0.16	0.43	P	P	0.08	0.12	0.34	76.0
Le Sueur									
2005	P	0.42	5.30	0.07	0.28	0.72	0.07	0.37	0.98
2006	0.13	0.58	1.24	0.05	0.17	0.29	P	0.08	0.24
2007	P	1.74	1.50	0.08	0.27	0.47	P	1.60	0.57
2008	P	0.91	2.05	P	0.16	0.66	0.10	0.29	1.54
2009	0.06	0.40	0.47	P	0.20	0.29	0.08	0.28	9.44
Middle Branch Whitewater									
2005	nd	P	2.20	0.09	0.33	2.00	P	0.28	3.70
2006	nd	P	P	0.08	0.14	0.16	P	P	P
2007	nd	P	P	0.07	0.11	0.35	P	0.08	0.39
2008	nd	0.10	0.53	0.07	1.14	3.64	P	1.53	3.32
2009	nd	0.74	1.88	0.08	0.34	0.69	nd	P	0.45

* "P" indicates qualitative laboratory confirmation of the pesticide's presence, though below acceptable quantitative reporting limits. ** "nd" indicates no detection of the pesticides

Figure 9. Current and historic surface water sampling locations.



Two Minnesota streams, the Le Sueur River and the Little Beauford Ditch, violated MPCA's 4-day toxicity chronic water quality standard of 3.6 µg/L. The Little Beauford Ditch is a subwatershed of the Le Sueur River and is located in Blue Earth County south of the city of Mankato. The documented violations occurred in 2001 for the Le Sueur River and 2005 for the Little Beauford Ditch, and are likely associated with runoff from storm events that occurred early in the growing season soon after acetochlor was applied to crop fields. There have been no subsequent violations of pesticide standards in either of these streams. These streams were included on the Minnesota 2008 Total Maximum Daily Load (TMDL) of impaired waters list. Further information about the impairments is available at http://www.mda.state.mn.us/chemicals/pesticides/acetochlor1.aspx

Wetlands Water Quality Trends

Wetland quality trends in Minnesota are less understood than trens in lake and stream quality. Minnesota initiated the Minnesota Wetland Status and Trends Monitoring Program (MWSTMP) to assess the status and trends in wetland area (quantity) and condition (quality). That effort began in 2006 and is being conducted on a three year cycle.

The first three-year cycle of the MWSTMP estimated 10.6 million acres of wetland occur in Minnesota. As a percentage of state area, wetlands comprised 19.6 percent and an estimated 4.95 percent of Minnesota was covered by deepwater habitats. Forested wetlands were the most common wetland class at 4,392,198 acres; emergent wetlands were the second most common wetland class covering an estimated 3,170,665 acres. Shrub-scrub wetlands were the third most common wetland class occupying an estimated 2,348,689 acres. Aquatic bed, unconsolidated bottom and cultivated wetlands totaled an estimated 694,633 acres.

Minnesota is well positioned to evaluate the overall state-wide quality of Minnesota's wetlands using surveys every three years to determine if wetland programs are meeting the goal of no net-loss of wetland quality and to assist the MDNR and the BWSR in their evaluation of wetland quantity. Additional details for the WSTMP's first three year cycle and the impaired wetland listing are contained in the MPCA publication "2010 Minnesota Water Quality: Surface Water Section" http://www.pca.state.mn.us/water/index.html.Water quality data from the first three-year monitoring cycle are currently being analyzed, and a report is expected by the end of 2010. More information about the MWSTMP is available at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/minnesota-comprehensive-wetland-assessment-monitoring-and-mapping.html

Contaminants of Emerging Concern (CECs)

Endocrine Active Chemicals (EACs), Pharmaceuticals, Antibiotics and Other CECs – In fall of 2009 the MPCA, in collaboration with other agencies, measured the levels of EACs, pharmaceuticals and antibiotic compounds near 25 wastewater plant discharges across Minnesota. Preliminary results show that pharmaceuticals are present in Minnesota wastewaters and streams. Pharmaceuticals detected include anticonvulsant, antihistamine, antibiotics, heart arrhythmia medication, caffeine, codeine, cotinine (nicotine metabolite) and caffeine metabolite. The concentrations were generally low (less than 1 microgram per liter) and most were below laboratory reporting levels.

In addition to this monitoring at wastewater plants, the MPCA is continuing the statewide lake study by focusing on contributions of CECs and EACs from possible sources to lakes. The MPCA is also sampling 150 sites for pharmaceuticals, personal care products, and other CECs in collaboration with the EPA Flowing Waters study (the national stream survey) during the summer of 2010. The results from these studies will be available in 2011.

The MDA's pesticide monitoring efforts include assessing water resources for CECs such as recently registered pesticide active ingredients, specific pesticide degradates, or other compounds associated with pesticide formulations and updated toxicity evaluations.

Perfluorochemicals (PFCs) – The MPCA, MDA and MDH jointly reviewed known and potential sources of PFCs from industrial, agricultural and other human activities. Subsequent MPCA studies detected perfluorooctane sulfonate (PFOS) at elevated concentrations in fish taken from the Mississippi River near the 3M Cottage Grove plant and downstream, and in some Twin Cities Metro Area lakes with and without known connections to 3M's manufacturing or waste disposal. Mississippi River Pool 2, which received 3M Cottage Grove effluent during the years of PFOS and PFOA manufacturing, is listed as an impaired water due to PFOS. This is based on fish tissue PFOS concentrations that prompted the MDH to issue a one-meal per month fish consumption advisory for certain species in Pool 2. Preliminary work in advance of a PFOS TMDL for Pool 2, including additional monitoring to better understand all the sources of PFOS to Pool 2, is underway.

Surface Water Quality: Reducing, Preventing, Minimizing & Eliminating Degradation

A majority of the efforts to reduce and prevent pollutant impacts to surface waters are directed at the sources of pollutants within the watershed areas that may degrade the water resource. To this end, the MPCA is adopting a watershed approach for protection of waters of the state that evaluates pollutant impacts from a watershed perspective. The goal of the watershed approach is to identify impaired waters and those waters in need of additional protection to protect, restore and preserve the quality of Minnesota's surface waters. For additional detail on MPCA's watershed approach, see: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/basins-and-watersheds/watershed-approach.html.

The MDA also considers the watershed approach for water quality protection, and has been guided for pesticides by the Minnesota Pesticide Management Plan: A Plan for the Protection of Groundwater and Surface Water (the PMP; most recently revised in 2007; http://www.mda.state.mn.us/protecting/waterprotection/pmp.aspx) and for nitrate by the Nitrogen Fertilizer Management Plan (http://www.mda.state.mn.us/chemicals/fertilizers/nitrogen-task-force-recommend/nitrogen-task-force-exec-summ.aspx). The PMP established the delineation of Pesticide Monitoring Regions (PMRs) and Pesticide Management Areas (PMAs) as indicated earlier in this report. The PMRs and PMAs are generally identical and are based on similar hydrologic, geologic, and agricultural management characteristics occurring within the region/area. The PMAs provide the MDA with a framework for outreach and education to agricultural stakeholders, further described in the

Pesticide Management Plan (Chapter 8: Prevention) at
http://www.mda.state.mn.us/protecting/waterprotection/pmp.aspx

The watershed approach involves multiple program efforts focused on water quality protection and restoration. Summaries of some of the program efforts and activities that reduce, prevent, minimize and eliminate the degradation of water resources are described below.

Wastewater Discharges – The MPCA regulates the discharge of treated wastewater to surface waters of the state (primarily rivers and streams) through NPDES/SDS permits from both municipal and industrial facilities. Minnesota has been successful in controlling end-of-pipe discharges from wastewater treatment plants to our state's surface waters. While only 20 percent of the state's sewered population was served by facilities capable of at least secondary treatment in 1952, fully 99.9 percent are served at present. Rates of regulatory compliance for municipal and industrial facilities are at a high level, with more than 95 percent of major water quality permittees meeting their effluent limits.

Improvements to increase biological nutrient removal at wastewater treatment plants are beginning to have an effect in improving the overall quality of discharges to Minnesota's surface waters. Although exceptions exist the general trend in total loading of all pollutants examined has been downward during the five most recent years of record, 2004-2008.

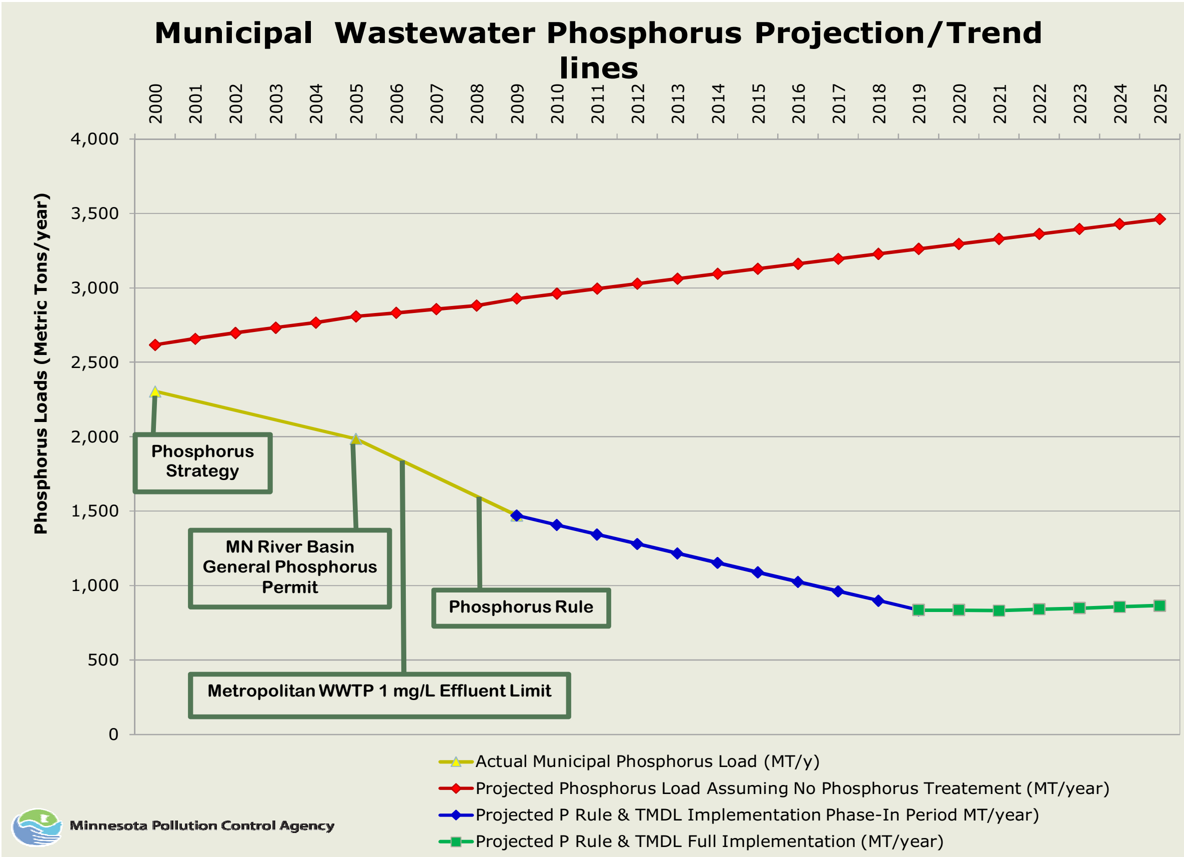
As a specific example, phosphorus data at the Metropolitan Council Environmental Services Metropolitan Wastewater Treatment Plant (Metro Plant), the largest treatment plant in Minnesota, show that biological phosphorus removal has significantly improved the plant's overall performance. Due to the large volume of waste treated by the Metro Plant, improvements like this have contributed to verifiable reductions in reported water pollutant loadings over the past several years. During the period 2003-2005, phosphorus loading from the Metro Plant was reduced by 66 percent and total loading was reduced by 72 percent. From 2006-2007, phosphorus loading fell from 154,000 kilograms to 133,500 kilograms. From 2007-2008, phosphorus loading fell again by nearly 13,000 kilograms to 120,900 kilograms.

Additional phosphorus loading reductions have resulted from permit revisions and TMDL implementation for municipal wastewater discharges as shown in Figure 10. The red line shows phosphorus effluent discharges assuming pre-2000 practices while the yellow line represents actual wastewater loads based on actual discharge data reported for 2000, 2005 and 2009. The blue line and green lines represent projected phosphorus loads considering the phase-in of permit phosphorus load limits and TMDL Implementation.

Reductions of other pollutants common to wastewater plant effluent (total suspended solids, biochemical oxygen demand, total phosphorus, ammonia, and nitrate) occurred from major dischargers between 2007 and 2008, as described in a report to the legislature (PCA Annual Pollution Report, 2010). This suggests recent improvements to treatment plant technology and operation continue to have a measurable positive effect on Minnesota's water resources, at least as far as point source discharges are concerned.

The MPCA Annual Pollution Report also notes that point source contributions of nitrate and phosphorus to waters of the state are still small compared to nonpoint contributions from sources such as agriculture and urban runoff. Point sources tend to have the greatest impact on receiving waters during periods of low precipitation and stream flow, while nonpoint sources are most significant during periods of high precipitation and stream flow. However, it is difficult to measure directly the effects of nonpoint

Figure 10. Phosphorus loading reductions for municipal wastewater discharges.



pollution on Minnesota's lakes, rivers and groundwater. Continued collection of trend data, along with watershed monitoring and TMDL studies, will help better understand the contributions of these sources.

Recent program- specific efforts to reduce wastewater treatment discharges include conducting training and certification programs for wastewater treatment plant operators, pretreatment rule making, inspection and enforcement activities. Additional details on these activities can be found in the 2010 integrated Report ("2010 Minnesota Water Quality: Surface Water Section" http://www.pca.state.mn.us/water/index.html).

Animal Feedlots – Animal manure contains significant quantities of nitrogen which if improperly managed can lead to nitrate contamination of waters of the state. The animal feedlot program regulates the land application and storage of manure in accordance with Minnesota Rules Chapter 7020 for over 25,000 registered feedlots in Minnesota. The feedlot program requires that the land application of manure and its storage in manure storage basins is conducted in a manner that prevents nitrate contamination of waters of the state. Manure management plans, facility inspections, permitting, technical assistance and record keeping are all used to manage nitrogen impacts to water quality.

One of the main goals of the feedlot program is to ensure that manure does not contribute to the impairment or degradation of state waters. Efforts to achieve this goal include inspection and compliance monitoring activities which focus on: production areas located in sensitive areas, manure land application sites, and earthen basins in karst areas. The inspections and compliance rates are tracked and measured against program metrics to achieve the program goals

Subsurface Sewage Treatment Systems (SSTS) – Of the approximate 450,000 septic systems across the state, slightly more than 100,000 of them are estimated to be failing and could be sources of pollution to our water resources. The wastewater in SSTSs contains bacteria, viruses, parasites, nutrients and some chemicals. If not adequately treated, there is a risk of some of these contaminants traveling to the groundwater or any nearby surface waters leading to degradation in water quality. Therefore, SSTSs must be properly sited, designed, built and maintained to minimize the potential for disease transmission and contamination of groundwater and surface waters.

The SSTS program oversees the treatment of sewage discharge to subsurface treatment systems in accordance with state statute and rules (Chapter 7080). The SSTS program requires the proper location, design, installation, use and maintenance of SSTS systems to protect our state's water resources from the discharge of treated sewage to the groundwater.

The SSTS program includes a number of different efforts to prevent and minimize impacts to water quality degradation such as: incorporating nitrogen BMPs into SSTS rules, requiring registration of treatment products for nitrogen reduction and identifying imminent threats to public health and safety from uncontrolled discharges. The SSTS program is also in the middle of a 10-year plan to upgrade and maintain Minnesota's SSTSs. One of the main objectives of the SSTS Program is to strengthen local county programs to reduce the percentage of failing subsurface soil treatment systems (SSTS) from 39 percent to less than five percent by January 1, 2014.

Storm Water – The MPCA is the delegated National Pollutant Discharge Elimination System (NPDES) authority to implement the storm water regulatory program in Minnesota. The MPCA issues general and individual NPDES permits for municipal, construction, and industrial storm water discharges. These permits require permittees to control discharges of polluted storm water runoff by implementing best management practices (BMPs) which are incorporated in their Storm Water Pollution Prevention Program or Plans (SWPPPs).

Specific efforts to reduce the impacts of storm water runoff from municipal, construction, and industrial sites are conducted by the MPCA Storm Water Program in cooperation with other public and private organizations. Some of these efforts include: Storm Water Pollution Prevention Workshops, technical assistance, the Minnesota Storm Water Manual, Implementation of Storm water Pollution Prevention Plans (SWPPs), and informational websites that contain guidance, fact sheets, and rules for storm water management at http://www.pca.state.mn.us/water/stormwater/index.html.

Clean Water Partnerships (CWPs) **-**The CWP and Section 319 programs address nonpoint sources of pollution. Nonpoint pollution comes from many individual sources, such as storm sewers, construction sites, animal feedlots, paved surfaces, failing septic systems and over-fertilized lawns. When taken together, these sources contribute huge quantities of phosphorus, bacteria, sediments, nitrates and other pollutants to the environment. They also represent the largest combined threat to the state's water resources.

The CWP and Section 319 programs help support leadership efforts of local units of government and citizens to address nonpoint sources of pollution. The programs provide financial and technical assistance to study water bodies with pollution problems, develop action plans to address the problems, and plan implementation to fix the problems. Additional information can be found on the MPCA's web page at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/water-nonpoint-source-issues/clean-water-partnership/more-about-the-clean-water-partnership-program.html.

TMDLs – For each pollutant that causes a water body to fail to meet applicable water quality standards, the Clean Water Act requires states to conduct a Total Maximum Daily Load (TMDL) Study. An impaired water body may have several TMDL studies, each one determining reductions for a different pollutant. After a TMDL study is completed, a detailed implementation plan is developed to meet the pollutant load reduction specified in the TMDL to restore water quality. Depending on the severity and scale of the impairment, restoration may require many years and millions of dollars.

Minnesota has completed TMDLs on 1,163 impairments – 998 for Hg and 172 for conventional pollutants (Figure 11) – out of the more than 3,000 as of the draft 2010 inventory. The state is currently on schedule to complete TMDL studies by their target dates. There are approximately 100 TMDL studies underway, addressing 500 impairments. To date, 12 water body impairments have been fully restored to again meet water quality standards.

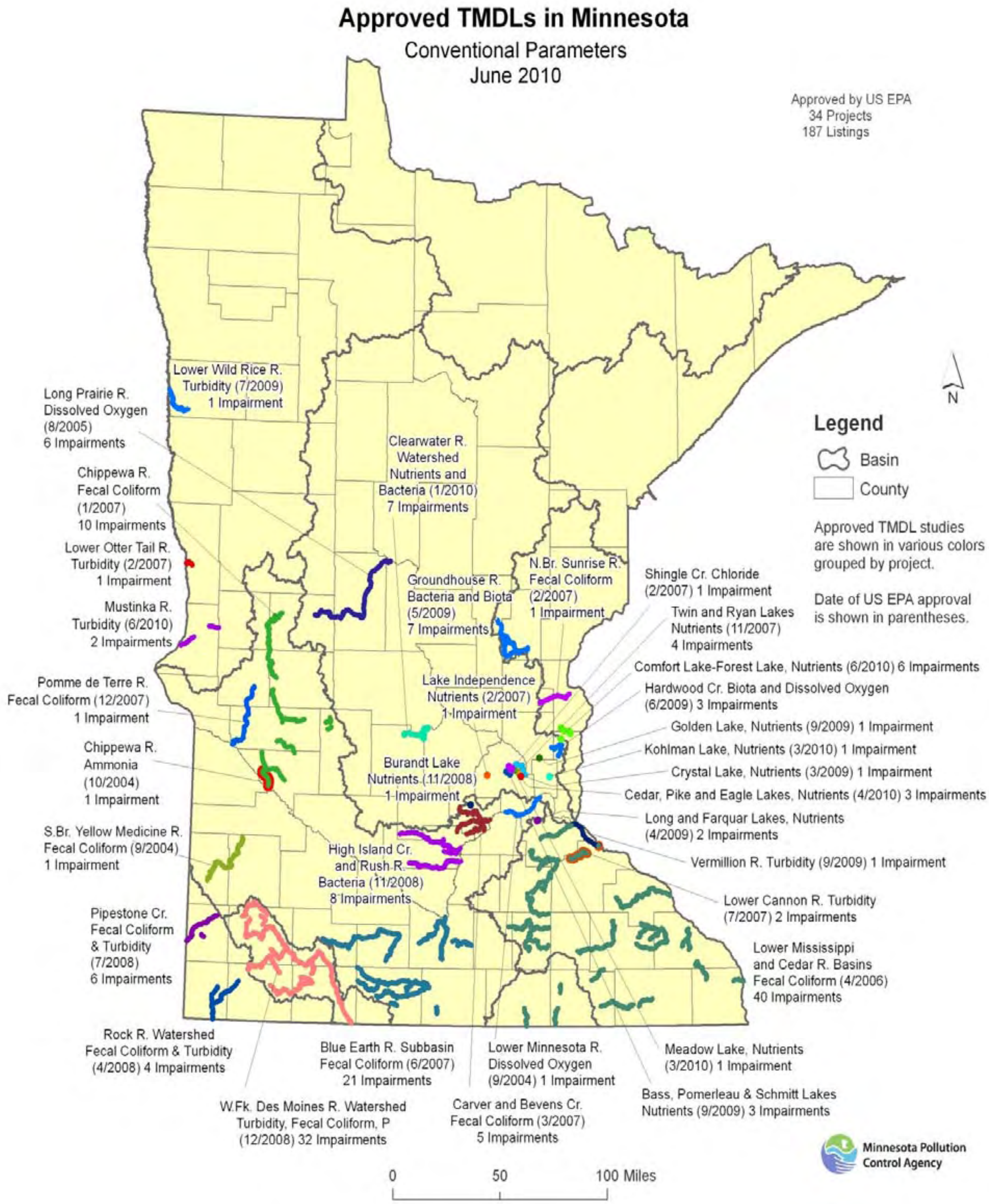
Agricultural Best Management Practices Loans – The MDA Agricultural Best Management Practices Loan Program provides low interest loans to implement practices that improve and protect water quality from nutrients and sediments associated with field and feedlot runoff. Loans are typically provided for: feedlot improvements, manure storage basins, and spreading equipment; conservation tillage equipment; terraces, waterways, sediment basins; shore and river stabilization; and septic systems. A recent status report is available at http://www.mda.state.mn.us/sitecore/content/Global/MDADocs/financing/loans/agbmploan/statusreport.aspx

Pesticides and Fertilizers– The foundation of the MDA's programs to reduce, prevent minimize and eliminate degradation of water resources from pesticides and fertilizers begins with the registration of products and, for pesticides, EPA's risk assessments and development of product labels. Pesticide regulation also includes the certification and licensure of certain commercial and private applicators, and education and regulatory oversight of label use provisions (e.g., restrictions on use rate per acre and according to soil type; application setbacks from water bodies; and other water resource-related use restrictions or hazard statements) through outreach and inspections. Fertilizer programs focus on nonpoint source contamination from fertilizers that is typically the result of combined activities of many landowners within a localized area, and typically cannot be attributed to any single source.

The MDA surface water programs for prevention, evaluation and mitigation of pesticide and fertilizer impacts adhere to guidance documents and plans (i.e., the Pesticide Management Plan [PMP at http://www.mda.state.mn.us/protecting/waterprotection/pmp.aspx], the Nitrogen Fertilizer Management Plan (NFMP at http://www.mda.state.mn.us/protecting/bmps/nitrogenbmps.aspx) or other efforts that are implemented through monitoring, assessment and multi-stakeholder committees that review the activities of MDA and cooperators. These plans, along with cooperator assistance, guide the MDA in evaluating Best Management Practices established to prevent and minimize agricultural chemical impacts to water resources. In addition, groups external to the MDA play a role in advancing key issues related to environmental protection and farming profitability. Information about the Pesticide Management Plan Committee is available at http://www.mda.state.mn.us/protecting/waterprotection/pmpcommittee.aspx, along with links to the biennial PMP Status Reports required under statute. The PMP Status Reports provide additional detail about MDA prevention, evaluation and mitigation efforts to protect Minnesota's water resources from pesticide impacts. Information about nutrient-related research and outreach conducted via the Agricultural Fertilizer Research & Education Council is available at http://www.mda.state.mn.us/afrec

All surface water pesticide and nutrient monitoring data is referred to the MPCA for further evaluation.

Figure 11. Approved TMDLs in Minnesota.



Other examples of MDA programs and efforts related to protecting water resources from pesticide and fertilizer impacts include:

- Education and promotion of pesticide BMPs (http://www.mda.state.mn.us/protecting/bmps/herbicidebmps/promotingbmps.aspx);
- Protection of public drinking water supplies from fertilizers and pesticides (http://www.mda.state.mn.us/protecting/waterprotection/drinkingwater.aspx);
- Guidance to homeowners on testing domestic wells for pesticides (http://www.mda.state.mn.us/protecting/waterprotection/pesticides.aspx);
- A Nutrient Management Initiative that, with MDA cooperation, provides a framework for farmers to evaluate their own nutrient management practices compared with nutrient rate guidance promoted by the USDA-NRCS (http://www.mda.state.mn.us/protecting/soilprotection/nmi.aspx);
- General pesticide management education and outreach (http://www.mda.state.mn.us/chemicals/pesticides/outreach.aspx); and
- General guidance on nutrient management (http://www.mda.state.mn.us/chemicals/fertilizers/nutrient-mgmt.aspx)

Once pesticides are observed in water resources, the MDA's PMP provides guidance for evaluating monitoring results and addressing any impacts through voluntary or regulatory actions supported by the Pesticide Control Law (Minn. Stat. chapter 18B0), and the Clean Water Act as administered by the MPCA (Minn. Rules chapter 7050).

As part of addressing nutrient impacts to surface water, Minnesota's Phosphorus Lawn Fertilizer Law was enacted to reduce over-enrichment of rivers, lakes, and wetlands with the nutrient phosphorus. Excessive phosphorus in surface water leads to an overabundance of algae and other aquatic plants.

The law was enacted over a period of years starting in 2002. Restrictions on phosphorus fertilizer use on lawns and turf started in 2004 in the seven county Twin Cities metro area and in Minnesota's other 80 counties in 2005. For more information on the phosphorus law, including access to a 41-page 2007 report on the law's effectiveness, see
http://www.mda.state.mn.us/protecting/waterprotection/phoslaw.aspx

Additionally, the 2007 legislature amended Minnesota Fertilizer Law to better protect water resources from point-sources of nitrogen. Permits and safeguards are required for agricultural commodity producers who store, on their own property, for their own use, more than 6,000 gallons of liquid commercial fertilizer. Product storage must be permitted by the MDA and secondary containment installed. Farmers who store bulk liquid fertilizer are also required to maintain an Incident Response Plan. http://www.mda.state.mn.us/en/chemicals/fertilizers/on-farm-bulk-liquid-fert-storage.aspx.

Surface Water Summary

As a result of the program efforts described above, significant improvements in state surfacewater quality – and reduction of point and nonpoint sources of pollution – have occurred over the past several decades.

There are many examples of these successes. On the Mississippi River below the Twin Cities, both the elimination of floating mats of sludge and the return of the mayfly are evidence of cleaner water conditions that followed massive treatment facility construction and storm water separation. Parks are being developed up and down the river's shores and recreational boat use has increased significantly. In the St. Louis River Bay, while sediment and fish tissue contamination problems remain, facility construction and improvements by the Western Lake Superior Sanitary District has led to noticeably cleaner water and return of a walleye fishery. And because atrazine use rates per acre have fallen – in part as result of cooperative state-federal label restrictions, best management practices and state-based enforcement of label-required application setbacks from surface waters – there are no impairment decisions for the widely used corn herbicide.

Even with these and other improvements, problems do remain. Continued action is needed to realize Minnesota's water quality goals. Ongoing monitoring is required to identify and investigate problems, including the presence and extent of CECs, and to provide the trend data that is critical to evaluating progress and refining management actions. The state must also stay on track to complete TMDL studies in a timely manner, which is a critical element of addressing water quality problems. Ongoing development of protection strategies is also needed to avoid new problems from occurring. Finally, implementation of all of the tools available for reducing and preventing pollution, from regulatory permits to voluntary BMPs, is key to achieving water quality standards and ensuring that the designated uses of Minnesota's surface waters are restored and maintained.

Conclusion

In accordance with 2008 legislation that modified state agency reporting requirements for water assessments and reports, this report summarizes relevant water quality monitoring data for both groundwater and surface water in Minnesota from the MPCA and MDA.

The MPCA and MDA collect water quality information in response to both broad and specific statutory mandates to explore water quality issues of current and emerging concern, and in accordance with formal interagency agreements, and through continuous cooperation and open communication.

Significant progress has been made by MPCA, MDA and stakeholders in addressing sources of groundwater contamination, particularly through remediation, permitting and BMP activities. However, concerns still exist, and continued effort is needed to fully realize the state's groundwater quality goals.

Improvements in state surface water quality have also been significant, along with voluntary and regulatory reduction of point and nonpoint sources of pollution through MDA and MPCA programs and stakeholder support. Coupled with these gains are opportunities for continued improvements, and additional actions are needed to realize Minnesota's surface water quality goals.

For both groundwater and surface water resources, ongoing monitoring is required to characterize vulnerable aquifers and landscape settings. Additionally, MDA and MPCA must continue to identify and investigate contaminant problems, including the presence and extent of emerging contaminants. Ongoing monitoring provides the trend data that is critical to evaluating progress and refining management actions. Protection strategies – whether regulatory or voluntary –must be developed that avoid the occurrence of new problems, and all strategies should be periodically re-evaluated and refined in order to adapt to changing situations in chemical and land use.

Appendix B – *2010 Groundwater Monitoring Status Report*

2010 Groundwater Monitoring Status Report

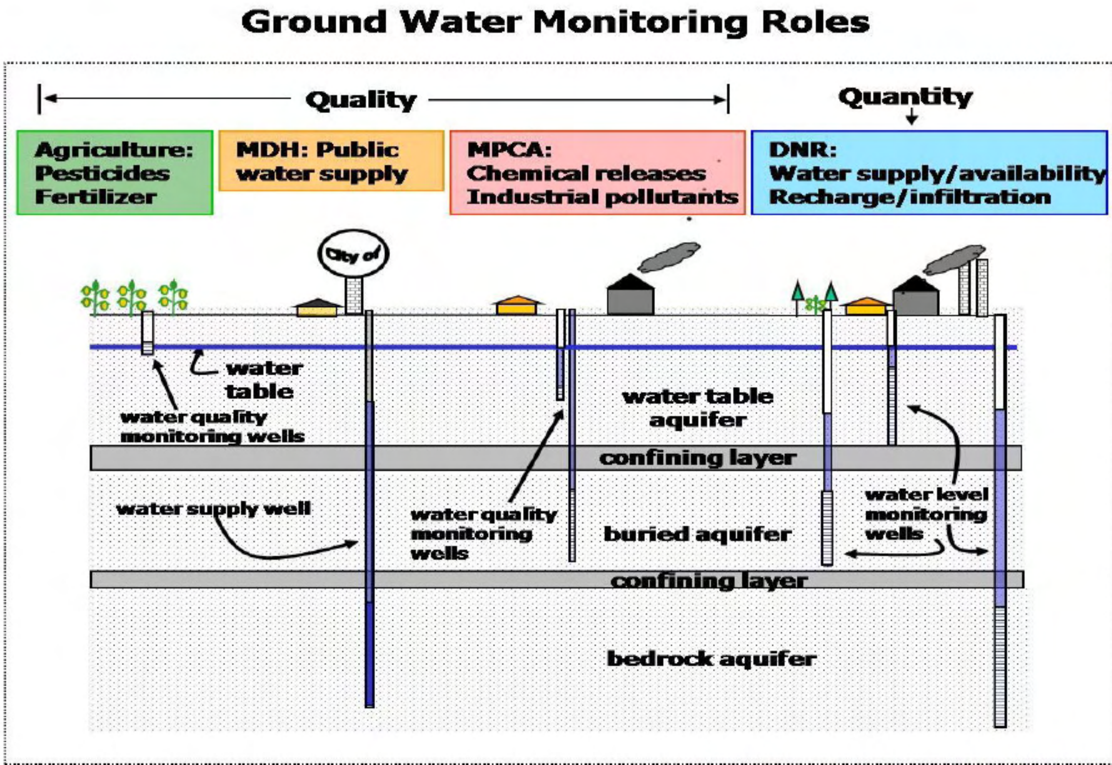
1. Introduction

The 1989 Groundwater Protection Act (GWPA) (Minnesota Statutes, Chapter 103H.175) requires the Minnesota Pollution Control Agency (MPCA), in cooperation with other agencies participating in the monitoring of water resources, to provide a draft report on the status of groundwater monitoring to the Environmental Quality Board (EQB) for review in each even-numbered year. This report is written to provide an update of groundwater monitoring activities in Minnesota to fulfill the MPCA's 2010 GWPA reporting requirements. For additional information on the background and history of groundwater monitoring in Minnesota, see *Minnesota's Groundwater Condition: A Statewide* View (O'Dell 2007).

2. Agency Roles in Groundwater Monitoring and Assessment

Minnesota employs a multi-agency approach to monitoring groundwater that requires a wide range of technical expertise to evaluate and assess groundwater resources. Please see the attached table for descriptions of the roles the various agencies play in groundwater monitoring, protection, and evaluation. It takes the concerted effort of all the state agencies, along with local and federal partners, to build a comprehensive picture of the status of the state's groundwater resources.

The MPCA, Minnesota Department of Agriculture (MDA), and Minnesota Department of Health (MDH) each have important statutory responsibilities in protecting the quality of Minnesota's groundwater. The MPCA and MDA conduct statewide ambient groundwater quality monitoring. The MDH conducts groundwater monitoring for the purpose of regulating public and private water supply wells and to evaluate the risk of contaminants in groundwater to human health (O'Dell 2007). In addition to these agencies, the Minnesota Department of Natural Resources (DNR) monitors groundwater quantity conditions across the state through a network of groundwater monitoring wells. The groundwater monitoring roles conducted by these agencies are shown in the figure below.



Credit: Laurel Reeves, DNR Waters

A 2004 Memorandum of Agreement (MOA) between the MPCA, MDA, and MDH clarifies the agencies' roles in operating a statewide integrated groundwater-quality monitoring system, provided in Appendix A.

3. Water-Quality Monitoring and Assessment

Groundwater quality monitoring in Minnesota was conducted at many different levels during 2008-2009 including national, statewide, multi-county, and site-specific efforts. National groundwater-quality monitoring was conducted by the U.S. Geological Survey (USGS) as part of the National Water Quality Assessment (NAWQA). The USGS studies evaluated chlorides in groundwater in the northern U.S. and mapped aquifer levels in the Twin Cities area. Statewide groundwater-quality monitoring sampled a greater number of wells compared to national efforts with a bulk of the monitoring conducted by the MPCA, MDA, and MDH. Reports for two multi-county assessments of groundwater-quality conditions were completed including a citizen volunteer monitoring of nitrate concentrations in southeastern Minnesota and a reconnaissance of perfluorochemicals (PFCs) in the state's ambient groundwater. A considerable amount of groundwater monitoring was conducted at contaminant release sites including: petroleum release sites, Superfund sites, brownfield clean-up sites, solid waste landfills, hazardous waste sites, agricultural cleanup sites, and other facilities. The following sections provide more detail about these monitoring activities.

3.1 National Water-Quality Monitoring

As noted in the 2008 Groundwater Monitoring Report (MPCA 2008), the USGS has conducted several regional groundwater studies that included Minnesota. These studies have assessed groundwater quality as influenced by different land use settings for the presence of organic wastewater compounds (OWCs), the occurrence of arsenic, the presence of uranium and radon in glacial and bedrock aquifers, and to calculate groundwater recharge rates.

More recent work by the USGS assessed chloride concentrations in shallow glacial aquifer systems in the northern United States within urban, agricultural and forested land use settings (Mullaney et al 2009). The highest chloride concentrations in groundwater were measured in urban areas followed by agricultural and forested areas.

The chloride report noted the use of salt for road deicing has increased since the 1950s in the United States. These increases may be related to increases in road area and consequent deicing, salt storage areas, wastewater and septic-system discharges, recycling of chloride from drinking water, and landfill leachate. This report notes that human land use practices are likely increasing salt concentrations in our shallow groundwater resources. Similar results are noted in studies conducted by the University of Minnesota and MPCA which are presented in the Regional Water-Quality Monitoring section of this report.

The USGS also conducted a study of groundwater levels in three principal aquifers within the Twin Cities Metropolitan Area (TCMA) in cooperation with the DNR, MPCA, and Metropolitan Council (Sanocki et al 2009). Water concentrations were measured once in March and again in August of 2008 in the Prairie du Chien-Jordan, Franconia (Tunnel City Group)-Ironton-Galesville (Wonewoc Sandstone), and Mount Simon-Hinckley aquifers. The study noted large seasonal fluctuations in water levels between the sampling events and provides important information for tracking water levels within the TCMA in response to increasing groundwater withdrawals; and informing groundwater modeling efforts.

3.2.2 Statewide Water-Quality Monitoring

The MPCA and MDA continued statewide ambient groundwater quality monitoring during 2008-2009. This monitoring focused on aquifers that are vulnerable to anthropogenic (manmade) contamination from the land surface. Monitoring groundwater in vulnerable aquifers increases the likelihood that human impacts on groundwater quality will be detected within a reasonable time frame. The MPCA ambient monitoring efforts were conducted in non-agricultural areas of the state with a majority of samples collected in quaternary (glacial) sand and gravel aquifers. The MDA monitoring focused on agricultural regions in quaternary sand and gravel aquifers, with additional samples collected from springs in the southeastern part of the state where little or no quaternary deposits are present. The locations for ambient monitoring wells for both of these programs are overlain on Minnesota's vulnerable aquifers in the figure below.

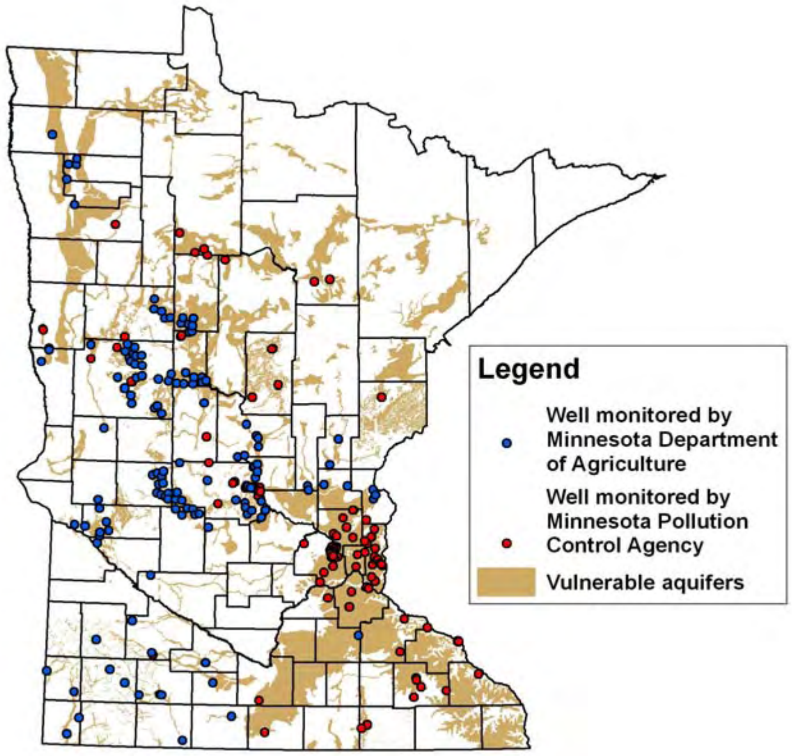


Figure 1. Ambient Monitoring Well Locations in Minnesota's Vulnerable Aquifers.

MDH water-quality monitoring efforts continued to focus on assessing public water supplies, which often utilize groundwater. The MDH sampled the quality of finished drinking water in cooperation with the state's public water supply systems to determine contaminant concentrations as part of the Safe Drinking Water Act regulations.

Minnesota was selected as one of five pilot sites to test the concepts for a proposed National Framework for Groundwater Monitoring Network (NFGWNM) (ACWI 2009). The proposed NFGWMN will use selected wells from state monitoring networks to be included in a long-term national-scale assessment of groundwater quantity and quality conditions. Data will be made available from the various state networks through a web-based data portal. The DNR and MPCA are working cooperatively with staff from the USGS, EPA, and other organizations to evaluate monitoring networks, field practices, and data management systems to identify any monitoring gaps, changes required to conform to the proposed NFGWMN criteria, and develop a prototype web-based portal for data sharing. The project area for the Minnesota pilot study is the Cambrian-Ordovician aquifer system located in the southeastern part of the state. In Minnesota, the Cambrian Ordovician aquifer system consists of the Galena limestone, Platteville limestone, St. Peter Sandstone, Prairie du Chien Dolomite, Jordan Sandstone, Tunnel City (Franconia) Sandstone, Wonewoc (Ironton-Galesville) Sandstone, and Mount Simon-Hinckley Sandstone. A final report on this effort is expected to be available by March 2011.

3.2.1 MPCA

Within the last several years, the MPCA has redesigned its statewide ambient water quality monitoring network to better represent ambient groundwater conditions within different land use settings. Most monitoring wells originally sampled by the MPCA's network were installed for the purposes of remedial investigations; those wells installed "upgradient" of the suspected contamination were also used for ambient monitoring to minimize network installation costs. Using remediation wells resulted in a bias towards detecting gasoline-related volatile organic compounds in surficial aquifers and likely was not representative of ambient groundwater conditions. The redesigned network will focus on monitoring groundwater quality within vulnerable, shallow sand and gravel aquifers to provide an early warning of groundwater contamination, and to better understand how shallow groundwater quality varies with land use, and to track changes in water quality over time. The network will be located within non-agricultural parts of the state and focus on quantifying the impacts from different urban land use settings, as shown on the figure below. Groundwater will be tested for nutrients, inorganic compounds, volatile organic compounds and contaminants of emerging concern that include endocrine disrupting compounds (EDCs). Assessing EDCs in the groundwater is part of the MPCA's larger efforts to determine the occurrence, distribution, sources, and fate of these contaminants in the hydrologic system (Draft MPCA Ambient Monitoring Plan 2010).

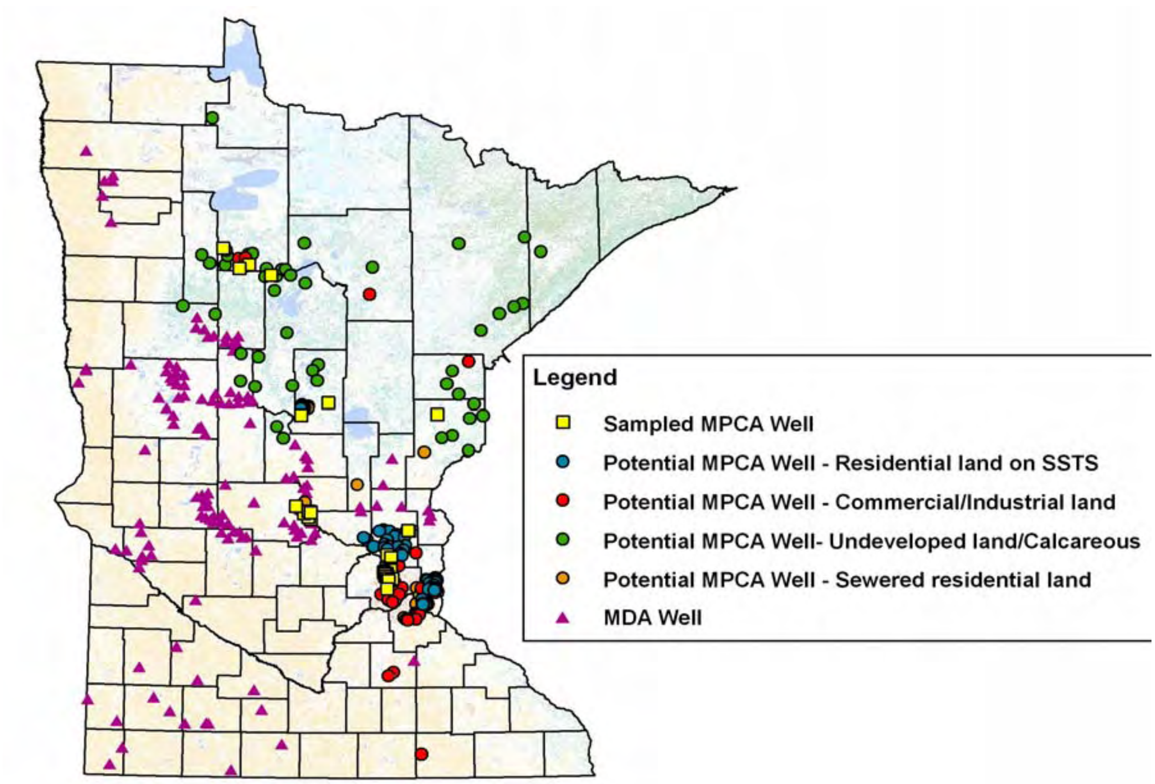


Figure 2. Statewide Ambient Groundwater Monitoring Well Networks for the MPCA and MDA.

In addition to monitoring ambient groundwater conditions, the MPCA continues to collect groundwater quality information at contaminant spill and release sites, permitted landfills and land treatment facilities. The MPCA remediation programs alone have investigated a cumulative total of 20,699 sites with the main focus of protecting groundwater resources. Approximately 1,660 of these sites have ongoing corrective actions, many of which include groundwater monitoring. Petroleum product spill sites and voluntary investigation and cleanup sites (brownfields) make up the majority of these sites, followed by Superfund, RCRA and closed landfills. The most common contaminants detected at remediation sites are volatile organic compounds and major and trace inorganic elements.

3.2.2 MDA

The MDA began monitoring groundwater in November of 1985 and redesigned its network in 1998. New wells were installed in 1999, and the MDA began sampling these wells in 2000, shown as triangles in the map above. Wells were first installed in the vulnerable aquifers located in the central sand plains (pesticide management region 4 (PMR 4) for the purpose of tracking trends over time. Monitoring of other PMRs of the state began in 2004 that included sampling of naturally occurring springs in the southeast portion of the state PMR 9. In 2009 natural spring monitoring was augmented with the sampling of domestic drinking water wells. Groundwater in the north central and northeastern part of the state are not currently monitored due to very limited agricultural production in these heavily forested regions.

MDA collected samples from 169 wells and springs in 2009. Of the total sites, 143 were monitoring or observation wells, 14 were private drinking water wells, and 12 consisted of naturally occurring springs emerging from karst bedrock formations in southeastern Minnesota. All of the locations are considered sensitive to contamination from activities at the surface (MDA 2010).

The MDA also manages a remediation program which collects a large volume of groundwater quality information from contaminant spill and release sites. Over 500 sites have been investigated and one of the main priorities of these investigations is to protect groundwater resources. Soil corrective actions are completed at most sites, and groundwater monitoring is completed at many of these sites. Typical sites include agricultural chemical storage and distribution cooperatives in rural Minnesota, agricultural chemical manufacturing facilities and wood treating facilities. Groundwater monitoring also is conducted at sites managed by the MDA, including the former Kettle River Creosoting Company site in Sandstone, Minnesota. Common constituents that are monitored at MDA remediation sites include fertilizers, herbicides and insecticides and wood treatment compounds.

3.2.3 MDH

The MDH continues to facilitate the monitoring of community public water supplies across the state as required by the Safe Drinking Water Act. A majority of the nearly 1,000 community water supply systems across the state obtain their drinking water supplies from groundwater. Including private well systems, the MDH estimates the total number of

Minnesotans reliant on groundwater resources for drinking water and other purposes is 3.84 million or 73 percent of the state's population (MDH Memo 2009).

Community public water supply systems are routinely tested for a number of different contaminants, which include: pesticides and industrial compounds, bacterial contamination, nitrate/nitrite, radioactive elements (radium), disinfection by-products, arsenic, lead, copper and other inorganic chemicals. The MDH reviews these test results to determine if they meet applicable federal or state drinking water standards. In the event of an exceedance, the people who use the water are notified and appropriate steps are taken to correct the problem.

Private drinking water wells are not tested as part of the effort described above; however, the MDH reviews nitrate, coliform bacteria, and arsenic data collected by well drillers from newly installed drinking water wells to determine the potability of the water. Approximately 20 percent of Minnesotans are served by private water systems (almost entirely wells). State regulations, administered by the MDH, now require licensed water well contractors (and anyone constructing a new well for his or her personal use) to have the water from each new drinking water well tested once for arsenic.

The MDH continues to administer the state's wellhead protection program which is designed to protect public water supplies from sources of groundwater contamination. There are roughly 8,300 public water supply systems in the state that mostly use groundwater. Wellhead protection planning is required to protect the groundwater resources and potable water from contamination sources. For many of the larger community water supply systems, extensive groundwater protection plans are required and reviewed by the MDH.

3.2.4 DNR

The DNR continued to maintain a groundwater level monitoring network across the state. There are approximately 750 wells in this statewide network, which also is being evaluated to determine its adequacy. Data collected from the network is used to assess groundwater resources, determine long-term trends in water levels, interpret impacts of pumping and climate, plan for water conservation, and evaluate water conflicts. Water level readings are measured monthly in cooperation with soil and water conservation districts or other local units of government. Site specific monitoring is required of 123 permittees. An ongoing water supply planning effort is guiding establishment or improvement of monitoring plans for all public water suppliers. More than 650 communities in the state have public water supply systems, and 320 of these are currently involved in the planning effort.

The DNR is also developing county geologic atlases in cooperation with the Minnesota Geologic Survey (MGS). As a part of that effort, groundwater sampling is done at selected wells to support groundwater sensitivity mapping done as part of the county geologic atlas series of reports. These atlases were completed in cooperation with the MGS. Approximately 80 to 100 wells were sampled in each investigated county to determine major ion and trace element concentrations and tritium values. Stable isotopes of oxygen, hydrogen, and carbon-14 age dating analysis also were conducted in a few wells which were suspected of having very old water.

As noted in the 2008 report, data was published from Pope and Crow Wing counties in 2006 and 2007, which was followed by publication of the Traverse/Grant Regional Hydrogeologic Assessment in 2008. Data from Todd county is scheduled to be published in 2010. Data collection for Carlton County is underway. Data collection for McLeod, Carver, Benton, and Chisago Counties will be conducted in 2010.

The DNR also has completed a plan to improve groundwater level monitoring in the greater Twin Cities Metropolitan Area. This monitoring is necessary to address the ever increasing demands on groundwater resources in this area. The report titled "Plan to Develop a Groundwater Level Monitoring Network for the 11-County Metropolitan Area" (MnDNR 2009) is based on the NFGWM and identifies the long-term needs for monitoring to understand aquifers and groundwater movement in the region. This network will inform groundwater protection activities, help reduce water quality degradation, and ensure that water use does not harm ecosystems.

The DNR in conjunction with the MGS is conducting an aquifer investigation of the Mt. Simon aquifer to better understand the physical and recharge characteristics of this important aquifer. The investigation will map and monitor water levels of the aquifer in south-central and east-central Minnesota and augment production of county geologic atlases for this area. Monitoring wells will be installed in a number of locations to assess the physical and recharge characteristics of this important aquifer. The wells also will be sampled for chemical constituents that will help determine the residence time or age of the groundwater in the aquifer. The wells will also be instrumented with equipment to continuously record groundwater concentrations. The information generated by this project will be useful to water management scientists, planners, drillers, consultants, industrial users, and municipal officials for protection and use of this aquifer (DNR Memo 2010).

3.2.5 Metropolitan Council

The Metropolitan Council began a regional water supply planning effort in 2005. Five years of community outreach, data collection, and technical analysis culminated in the development and approval of the seven-county Twin Cities Metropolitan Area Master Water Supply Plan. The framework in the Plan guides long-term water supply planning at the local and regional level. The plan uses an adaptive approach to water supply management, guided by management tools and based on the best available information generated through resource monitoring and predictive analyses. Ongoing data collection and analyses are used to refine the understanding of water availability and offer a robust range of options for meeting the projected water demand.

A key component of this planning effort is a regional groundwater flow model, which simulates all major aquifers underlying the Twin Cities Metropolitan Area. The Metropolitan Council constructed this model (Metro Model II) with the cooperation of a technical workgroup and other stakeholders. The Metro II Model simulates all major aquifers underlying the TCMA, including the glacial drift or recent alluvium, St. Peter, Prairie du Chien Group, Jordan, St. Lawrence, Upper Franconia, Ironton-Galesville, Eau Claire, and Mount Simon-Hinckley. The model is designed to determine: 1) the maximum pumping capacity of a proposed wellfield, 2) the drawdown from a proposed wellfield and if any existing wells may be impacted, 3) future groundwater concentrations, 4) the effect of pumpage on ecological resources such as trout streams and calcareous fens, and 5) the effect of land use on recharge and groundwater concentrations. The Metropolitan Council currently is collecting additional aquifer hydraulic conductivity data that can improve the Metro II Model's predictive capabilities and will be useful for water planning efforts in Metro Area communities.

Public outreach tools, such as the online Conservation Toolbox and water supply map service, also are critical components of the plan. Current data collection efforts are targeted at updating these tools and include characterizing ground and surface water interaction across the region, creating a geodatabase of reported aquifer hydraulic properties, and developing effective resource monitoring and water conservation strategies.

3.3 Regional Water-Quality Monitoring

3.3.1 Nitrates

Nitrates, the most common form of groundwater contamination in Minnesota, continue to be widely detected in the state's groundwater. Nitrate monitoring was included in the ambient groundwater monitoring networks of the MDA and MPCA, USGS NAWQA, and the southeastern Minnesota citizen Volunteer Nitrate Monitoring Network. The MPCA, MDA, and USGS networks collected nitrate concentration data which can be used to identify temporal trends. Nitrate concentration data was collected by the MPCA annually in approximately 98 wells from 2008-2009, and in 31 of these wells since 2004. The MDA sampled approximately 85 wells on a quarterly basis in the central sand plains which have been in place since 2000, and the USGS has monitored selected wells for nitrates since 1995 as part of the NAWQA.

The final report for the Volunteer Nitrate Monitoring Network was issued by the Southeast Minnesota Water Resources Board (SEMWRB 2009). The network was developed by the SEMWRB, MDA, MDH, and MPCA to assess the practicality of establishing a cost-effective, locally driven means of obtaining long-term data on nitrate concentrations in private drinking water supplies. Nitrate concentrations were tested in approximately 600 private drinking water wells across nine counties in southeastern Minnesota. The wells were monitored to determine the impact well construction and local land use have on drinking water quality, and to describe the regional distribution of nitrate concentrations and any temporal trends.

A review of the nitrate data, on a county-by-county basis, shows about 12% of the wells had nitrate concentrations equal to or above the 10 milligram per liter (mg/L) drinking water standard, 27% between 1 to 10 mg/L, and 61% of samples below 1 mg/L. The data also suggest there may be a geographic pattern, with the eastern counties showing greater percentages of wells with higher nitrate levels (Appendix 8.d, SEMWRB Final Report). Results from the third round of sampling are shown on the figure below (Appendix 8.b, Final Report).

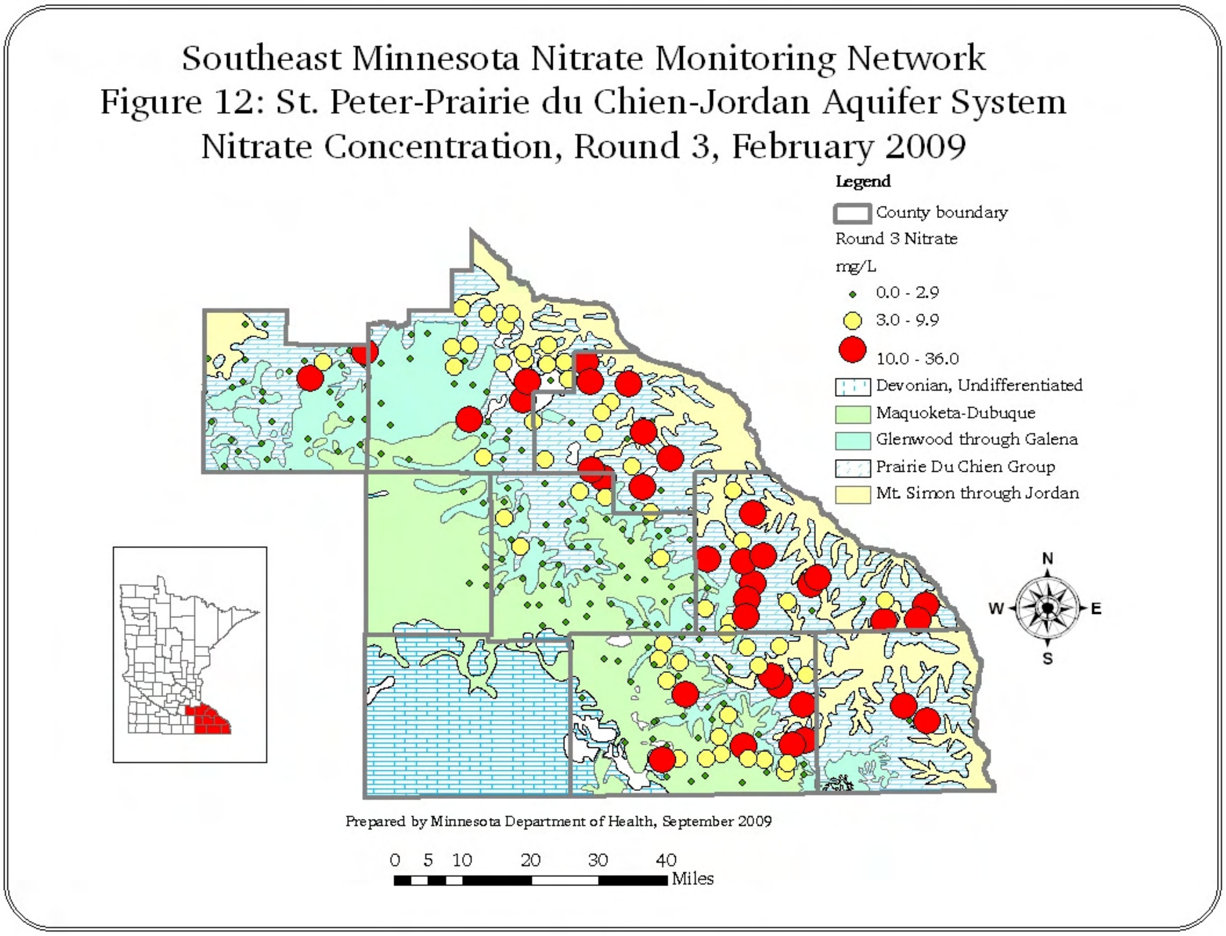


Figure 3. Southeastern Minnesota Volunteer Nitrate Study.

3.3.2 Chloride

The presence of elevated chloride concentrations in some of Minnesota's urban streams and lakes has generated several studies of the distribution of chloride in the groundwater underlying urban settings. There are few natural salt-containing minerals in the sediments and rocks underlying the Twin Cities Metropolitan Area, so any detected chloride in Minnesota's water resources likely is of anthropogenic (man-made) origin (Novotny et al 2008). Chloride is highly mobile in the environment, and numerous studies have documented increased concentrations in streams, lakes, and groundwater in a variety of environmental settings (Novotny et al 2007 and Wenck et al 2006).

A review of chloride concentrations and sources in the surficial sand and gravel aquifers of Minnesota was conducted by the MPCA. Concentrations were most increased in urban settings with lesser effects in agricultural and forested parts of the state. The highest concentrations occurred in urban areas. Road de-icing chemicals were identified as the primary source of chloride within urban areas, based on interpretations of chloride/bromide ratios.

The University of Minnesota prepared several reports that address salt impacts on water quality that focus primarily on the Twin Cities Metropolitan Area (Sander et al 2007, Novotny et al 2008). They have identified the presence of higher chloride concentrations in shallow wells near major roadways. Higher chloride concentrations in shallow groundwater monitoring wells compared to deeper wells in the region further suggests an anthropogenic chloride source. Increased chloride concentrations also have been observed in shallow public water-supply wells near Toronto, Canada (Bester et al 2006) and Chicago, Illinois (Kelly 2008) over the last 30 years.

4.2.3 PFCs

In 2004, perfluorochemicals (PFCs) were detected in drinking water supplies in groundwater in several eastern Twin Cities suburbs; most of the contamination was traced to four dumps or landfills. In 2004, MPCA began sampling monitoring wells at disposal sites and nearby private wells. The MDH sampled city wells in Washington County to identify drinking-water supplies with PFCs. Sampling soon expanded to a large part of the east metro. More than 1,600 private wells were sampled, along with more than 50 community wells. Both private and community wells were affected, including a number of private wells in Lake Elmo, Cottage Grove, Grey Cloud Island Township, and several of the city of Oakdale's wells. Based on PFC concentrations found in some wells, MDH advised 83 households not to drink their water. The MDH, MPCA, and 3M have worked with affected parties to provide safe drinking water by supplying alternative sources of water or assisting with water filtration to remove PFCs. Results over the past several years indicate the groundwater plumes emanating from the waste sites are stable, i.e. the areas of contamination are not expanding and concentrations are not increasing. The MDH and MPCA continue to test wells in the area to monitor any changes in concentrations or movement of the PFC groundwater plumes.

Testing of drinking water supplies outside of the eastern Twin Cities generally shows very low to undetectable concentrations of PFCs, with the exception of low level detections of PFBA (perfluorobutanoic acid). PFBA was detected in several wells at concentrations below health concern levels established by the MDH. Long-term sampling of city and private wells is underway to assure that actions can be taken to protect public health if concentrations increase. Testing of additional drinking water sources throughout Minnesota will inform efforts to evaluate potential exposure to PFCs through drinking water (MPCA 2008).

3.3.4 Contaminants of Emerging Concern

The USGS has been at the forefront in identifying chemicals of emerging concern (CECs) in the United States (Barnes et al 2008, Lee et al 2004). In testimony before Congress, the USGS noted that CECs include many chemicals used in our homes, businesses, and industries, such as pharmaceuticals, detergents, fragrances, fire retardants, disinfectants, plastics, hormones and insect repellants. Many of these chemicals are used in relatively small quantities and were not expected to be of environmental concern; however, in recent years advances in laboratory technology have allowed scientists to detect CECs in the environment at very low concentrations, usually at less than one part per billion. Despite these extremely low concentrations, investigation is warranted because the limited data suggest some CECs may have adverse effects at these concentrations (Richardson 2007).

The continual introduction of CECs into the environment may have undesirable effects on humans and animals. The introduction of antibiotics and other pharmaceuticals into the environment may result in strains of bacteria that are resistant to antibiotics treatment (Daughton and Ternes, 1999). Another concern is the potential to adversely affect fish reproduction due to endocrine disruption.

CECs were identified in Minnesota's groundwater at low levels in a national reconnaissance conducted by the USGS. The USGS tested for the occurrence of pharmaceuticals and organic wastewater compounds (OWCs) from a network of 47 wells across 18 states. CECs were detected at 81% of the wells sampled. The most frequent detections were for DEET (an insect repellant-in 35% of the samples), bisphenol A (a plasticizer– in 30% of the samples), tri (2-chloroethyl) phosphate (a fire retardant- in 30% of the samples), sulfamethoxazole (an antibiotic-in 23% of samples), and 4-octylphenol monoethoxylate (a detergent metabolite-in 19% of the samples) (Barnes et al 2008).

In a Minnesota study, the USGS tested for the presence and distribution of OWCs in wastewater, surface, ground and drinking waters. Samples were tested for pharmaceuticals; antibiotics; household, industrial, and agricultural use compounds; sterols and hormones. Groundwater sampling was limited to 11 wells located near potential OWC sources. A total of 31 OWCs were detected in the groundwater samples. The greatest number of OWCs were detected in two wells adjacent to a waste dump. For all of the samples tested the most frequent detections were for cholesterol (commonly associated with animal fecal matter), caffeine, DEET insect repellant, bromoform (by-product of waste and water disinfection), *beta*-sitosterol (plant sterol and a know endocrine disruptor), AHTN (synthetic musk fragrance widely used in personal care products); bisphenol-A (plastic in polycarbonate resin, a known endocrine disruptor); and cotinine (a nicotine metabolite) (Lee, K.E., et al, 2004).

The MPCA is currently monitoring for endocrine disrupting compounds and other CECs in the groundwater as part of its efforts to address the rising concerns associated with these chemicals in Minnesota's environment. This monitoring will expand the existing knowledge of the occurrence of CECs in the groundwater.

Specific long-term objectives for the MPCA's monitoring of EDCs and other CECs in groundwater are to: 1) determine the occurrence and distribution of these contaminants in the groundwater system, 2) quantify any temporal trends in concentrations, and 3) use this information in conjunction with other data collected as part of ambient monitoring to evaluate the sources of contamination in the groundwater (Draft MPCA Ambient Monitoring Plan 2010).

One short-term objective of this monitoring is to define the magnitude of EDCs and CECs in groundwater within urbanized parts of the state. Other areas may be targeted which have the potential for CEC contamination, in subsequent sampling events, such as areas receiving livestock manure applications (Nichols et al 1998, Peterson et al 2000). The current goal is to sample 40 wells each year. Monitoring will first concentrate on shallow wells in the surficial quaternary sand and gravel aquifers, which are more susceptible to contamination.

All groundwater quality sampling will be performed by the MPCA in cooperation with the USGS. All water sampling and analyses will be performed according to USGS procedures, and all water samples will be analyzed to determine the concentrations of approximately 120 emerging contaminants including hormones, alkylphenol detergents, plasticizers, fire retardants, pharmaceuticals, antibiotics, and personal care products. Many of these compounds are known or suspected EDCs. Additional details of this work are presented in the Draft MPCA Ambient Groundwater Quality Monitoring Network Improvements and Implementation Plan (MPCA 2010).

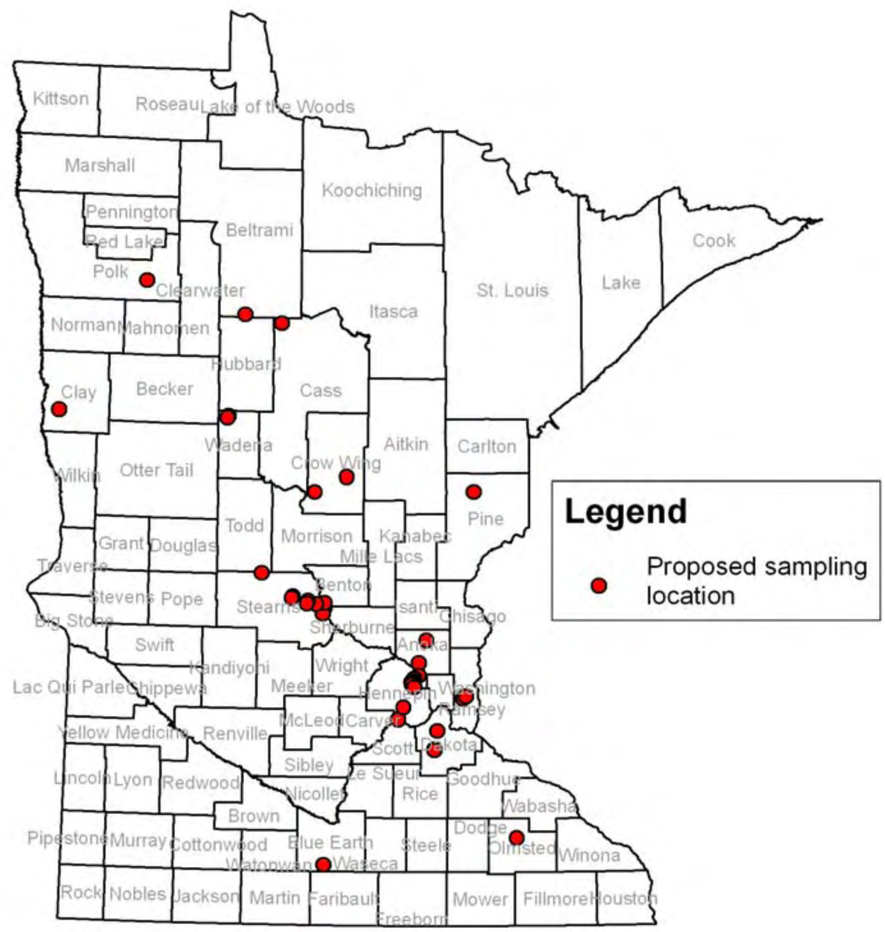


Figure 4. Proposed Sampling Locations for EDCs and CECs in FY2010.

4.0 <u>Groundwater Data Access and Management</u>

Data from the MPCA's ambient groundwater monitoring network, previous monitoring efforts, and the open, closed, and demolition landfills are available on the MPCA's website through the Environmental Data Access (EDA) system. The EDA system was developed to improve access to environmental data and is available at the following web address (URL): http://10.4.5.106/water/groundwater/gwmap/gwdata.html.

Groundwater quality data collected by other program areas including feedlots, National Pollutant Discharge Elimination System/(NPDES) permitting, petroleum remediation, Resource Conservation and Recovery Act cleanup, Superfund, and Voluntary Investigation and Cleanup programs is not available in EDA; however, information on how to access water-quality data from these programs is available through the MPCA's Groundwater Catalog, http://www.pca.state.mn.us/index.php/topics/environmental-data/eda-environmental-data-access/eda-groundwater-searches/eda-groundwater-catalog.html.

The MPCA is transitioning its data management for water-quality data, which includes the Agency's ambient groundwater quality monitoring data to a new database (EQuIS) with enhanced functionality. The new data management system will allow the MPCA to improve the current limitations of STORET and design a system that is tailored to meet Minnesota's needs. EQuIS was procured by the MPCA in January 2010 and is being prepared to receive the agency's water-quality data. Migration of data from the current local STORET database into EQuIS is expected to begin in May 2010 and is projected to be completed by Fall 2010. EQuIS will allow for better compatibility with the MDA and other state agency databases.

5.0 Needs and Conclusions

The need for monitoring groundwater quality and quantity continues. A long term commitment to the collection and analysis of groundwater data is necessary to identify changes in water quality and quantity over time and provide information needed to effectively manage and protect this critical resource. Groundwater movement is generally slow and often requires years of monitoring to assess the trends and impacts of human activities on this resource.

To date, groundwater monitoring efforts in Minnesota have identified that groundwater quality generally is good and in compliance with drinking water standards. However, human-caused impacts to groundwater quality are apparent in many areas of the state. Areas of impacted groundwater correlate well with land use practices known to cause the observed quality impacts (O'Dell 2007). As noted in the studies cited in this report, groundwater monitoring continues to verify the presence of elevated concentrations of nitrates, low concentrations of pesticides and their degradation by-products, and chlorides in more sensitive aquifers within the state (see figure 1.). The more recent detections of CECs and PFCs in our groundwater supplies require additional monitoring efforts to evaluate their impacts on groundwater resources (see figure 4.).

It should be recognized that a number of state and local agencies have increased their activities associated with groundwater monitoring, planning and aquifer resource evaluation within the last several years, as described in the plans and reports listed below:

- DNR's Plan to Develop a Groundwater Level Monitoring Network for the 11-County Metropolitan Area,
- Metropolitan Council's seven-county Twin Cities Metropolitan Area Master Water Supply Plan and regional groundwater model,

- MDA additional analytical equipment, increased monitoring capacity, and expanded pesticide analyte list,
- Minnesota's involvement as a pilot state for a proposed National Groundwater Monitoring Network,
- Environmental Quality Board's water availability report "Managing for Water Sustainability, (EQB 2008),
- Freshwater Society's report "Water is Life – Protecting A Critical Resource For Future Generations (FWS 2008),
- MPCA's redesigned ambient groundwater monitoring network,
- MDA-MDH partnership to monitor Community Water Supplies for pesticides and pesticide degradates,
- Research conducted by the USGS NAWQA in this region,
- Incorporation of groundwater considerations in county water plans,
- Improved groundwater data management by the MPCA by using the EQuIS database,
- Studies by the Minnesota Geological Survey of Minnesota's aquifer resources,
- MDA cooperation with MPCA, MDH, and the Southeast Minnesota Water Resources Board to obtain pesticide data in conjunction with long-term nitrate data collection, and
- University of Minnesota's water sustainability planning.

Long term monitoring networks coupled with the ability to share groundwater data with state and local agencies responsible for groundwater resources are necessary to determine if the quality and quantity of Minnesota's groundwater resources are at risk and inform management decisions. In addition, investments are needed to understand and protect groundwater systems so that future generations also will have an abundant source of clean water (DNR 2009).

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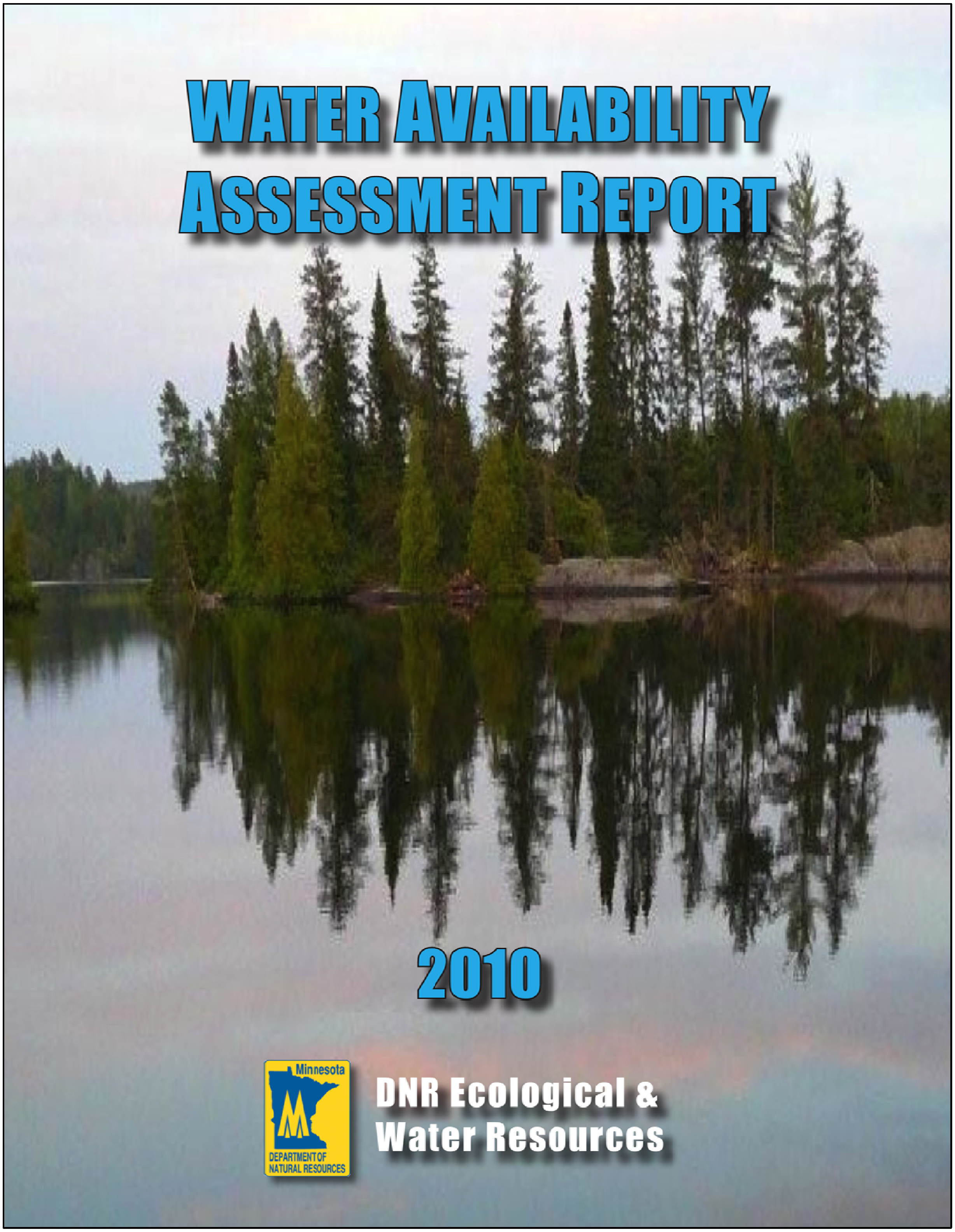
Appendix C – *2010 Water Availability Assessment Report*



The cost of preparing this report was $9360.

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Water Availability Assessment Report 2010

by DNR Ecological & Water Resources
Hydrogeologists and Hydrologists

St. Paul, Minnesota

August 2010

Minnesota
Department of Natural Resources
Ecological & Water Resources

"Healthy Watersheds across Minnesota"

Introduction

The availability of water to meet the state's needs is determined by three basic factors; climate and global weather patterns, human changes to flow pathways and water use, and human changes to water quality[1]. In Minnesota, we have little ability to affect climate and global weather patterns, but we have great ability to affect how we change flow pathways and water use, and our land use choices that can affect water quality.

In order to address the long-term sustainability and availability of our water and natural resources, the Department of Natural Resources (DNR) must necessarily engage in long-term thinking and planning efforts. Minnesota Statutes, 103G.265 requires the DNR to provide for an assurance of water supply as follows: "The commissioner shall develop and manage water resources to assure an adequate supply to meet long-range seasonal requirements for domestic, municipal, industrial, agricultural, fish and wildlife, recreational, power, navigation, and quality control purposes from waters of the state."

The greatest threat to having sufficient water to assure our many and varied needs comes from how we have manipulated the landscape without due consideration of its impacts on our water quantity, water quality and the ecosystem. The ecosystem functions of natural plant communities that slow water down and remove nutrients and other compounds can reduce the problems we create if we better plan for and make landscape management choices that retain these essential functions. Looking forward, we must become much wiser about how we are managing the lands and waters of Minnesota if we hope to have the desired availability and quality of water to provide the quality of life we desire.

This report provides a review of the current state of our water resources relative to the quantities and trends of our water supplies. The necessary background for reading and understanding this report lies in a DNR Information Paper entitled "Minnesota's Water Supply: Natural Conditions and Human Impacts". Its reference is found in the Appendix to this report and is available on our web page in the following location: mndnr.gov/waters

Minnesota's Water Budget and Human Impacts

The following charts, maps, diagrams and narratives provide information to evaluate the trends of our climate, surface waters, groundwater systems and water use over the last ten years as well as in relation to long-term historic trends.

[1] Waters that become impaired by contaminants are still available for use, however the cost of removing contaminants may be so expensive that they become undesirable and not considered as waters that are available for use.

The Ten Year Water Availability Trends for Planning Purposes

The following information is provided for general trend evaluation purposes. The reader must recognize that the historical period of record for each of the indicator resources examined is not the same and the average conditions for each of these resources is a reflection of these dissimilar time periods. However, for examining general trends and changes over time these data provide a reasonable assessment of the resources.

A ten year average for water levels, flows and precipitation from 2000-2010 was calculated using data from indicator sites in the state's monitoring networks. These indicator locations are those presented in the DNR's monthly Hydrologic Conditions Report (web link) and represent a cross section of monitoring sites throughout the state. At a minimum these sites have at least 20 years data.

Precipitation (2000-2009)

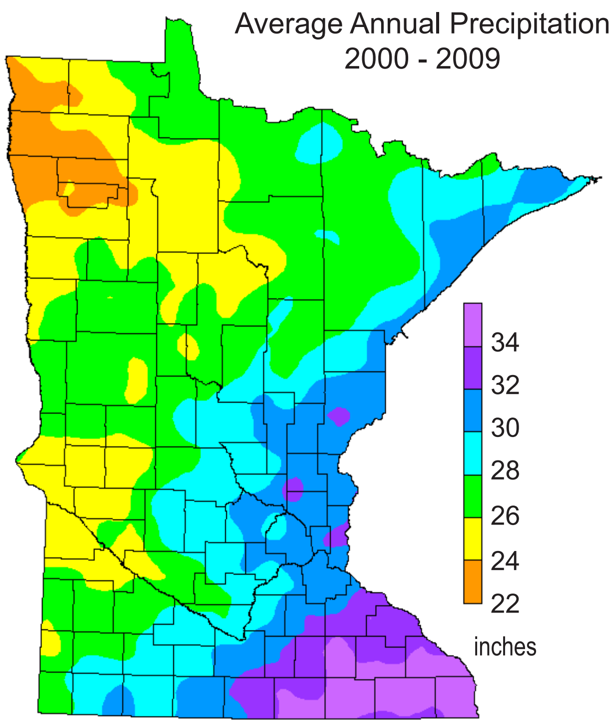
Caution must be used when making generalized statements concerning climate trends for a state the size of Minnesota. Large spatial variations can and do occur from one end of the state to another. Nonetheless, it can be informative to look at the state climate data set as a collective. The figure titled "Minnesota State-Averaged Annual Precipitation" offers a precipitation time-series using data from across Minnesota. Items of note from this graphic:

- Precipitation trends in Minnesota reached a plateau during the past decade, halting the upward push evident during the end of the 20th century. However, the 2000-2009 decadal precipitation average remained high relative to the full period of record.

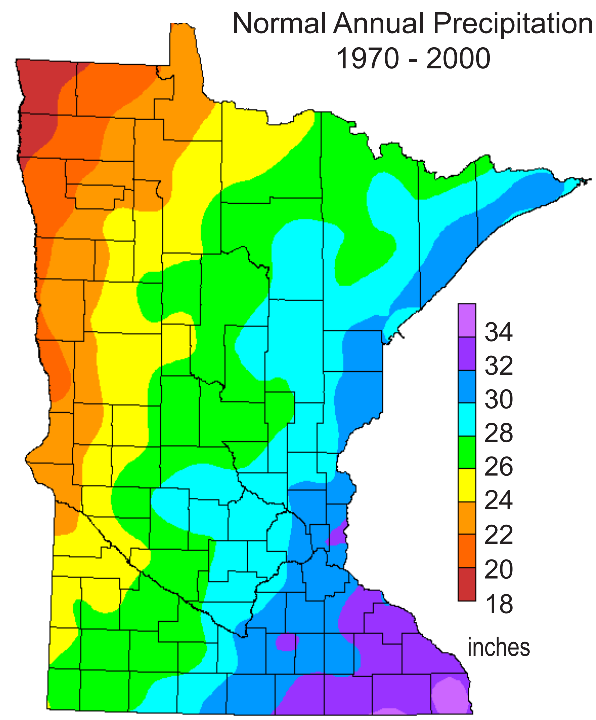
- The past decade produced two years that ranked in the drier range of the historical distribution (2003, 2006). This comes on the heels of the 1990s when dry years were nonexistent and drought was seldom an issue.

Although the annual precipitation trend leveled off during the first decade of the 21st century, this was NOT the case for seasonal precipitation. As shown in the graphic titled "Minnesota State-Averaged Seasonal Precipitation", summer precipitation totals showed an appreciable dip over the past 10 years. The summer dryness was offset by increases in autumn precipitation, and to a lesser extent, spring precipitation.

The decadal precipitation departure from normal and precipitation ranking maps demonstrate the ongoing precipitation anomaly impacting hydrology and agriculture in west central and northwestern Minnesota. This extraordinary wet spell dates back to 1991 and is responsible for high water level problems experienced in the those counties as well as the Devils Lake crisis in neighboring North Dakota. The suggestion of relative dryness depicted in north central and northeastern Minnesota may have impacted forest health issues such as drought-stress and pest infestations.



State Climatology Office - DNR Waters, July 1, 2010



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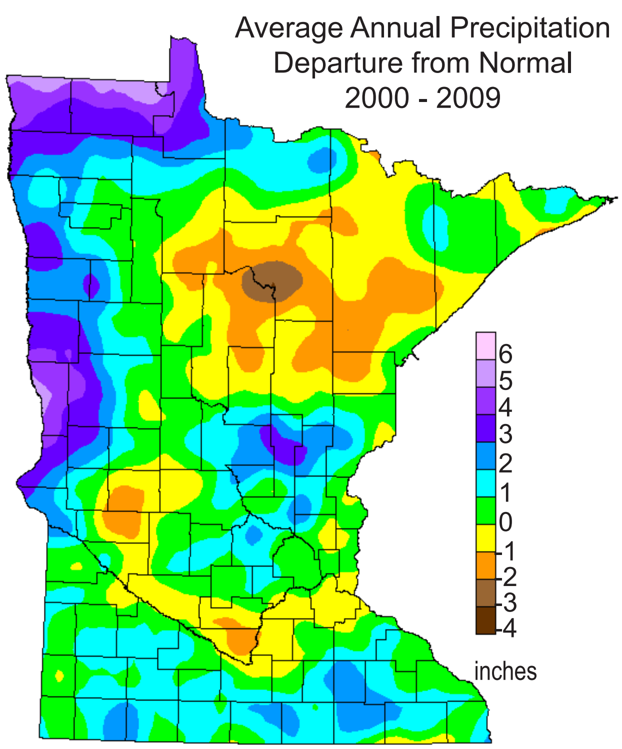

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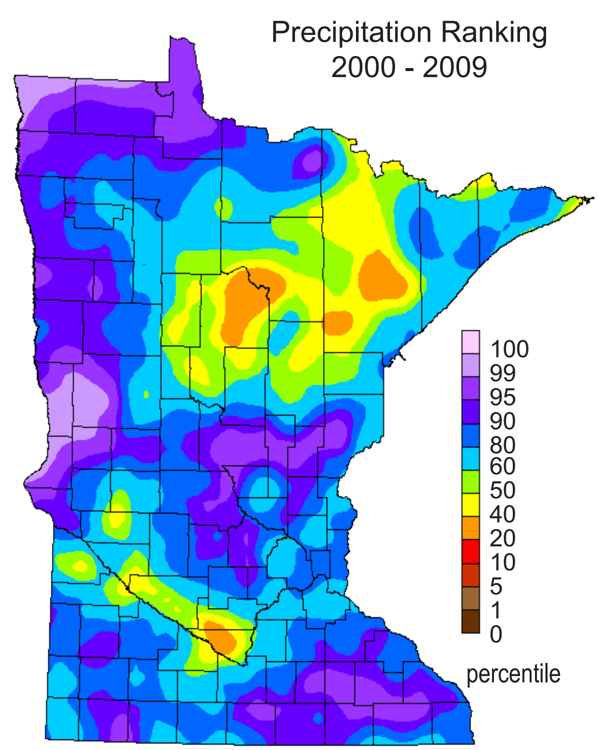

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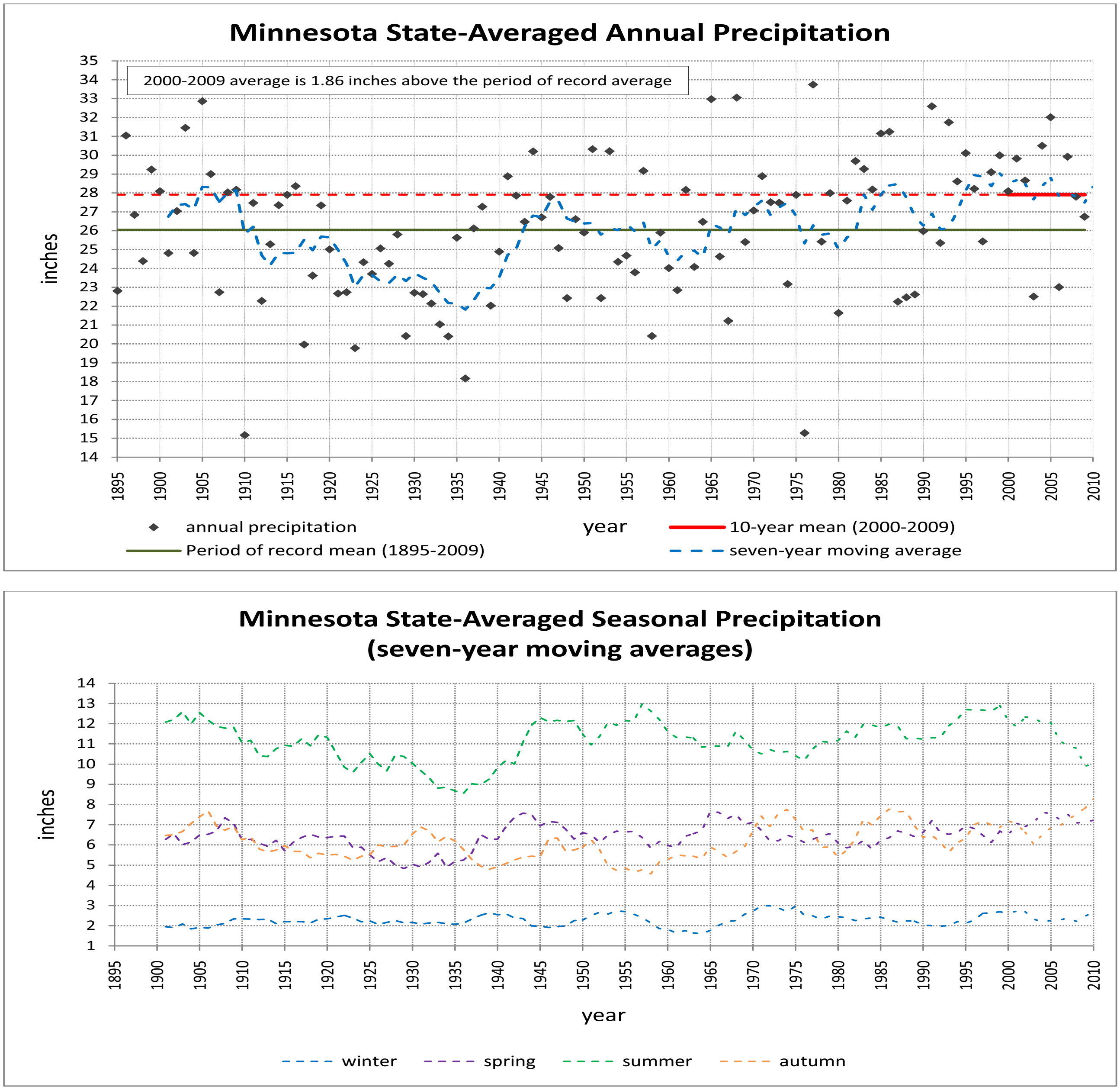
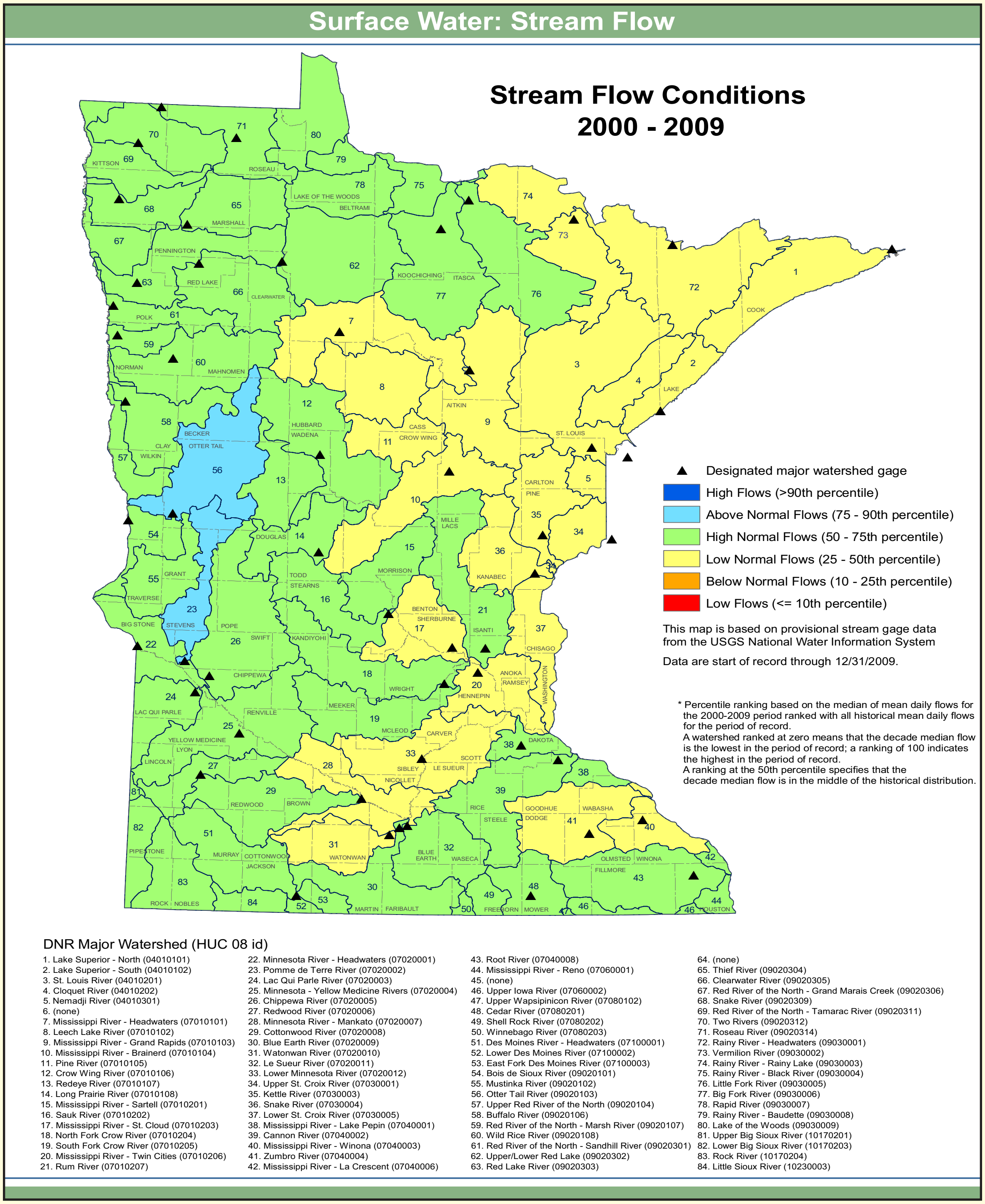
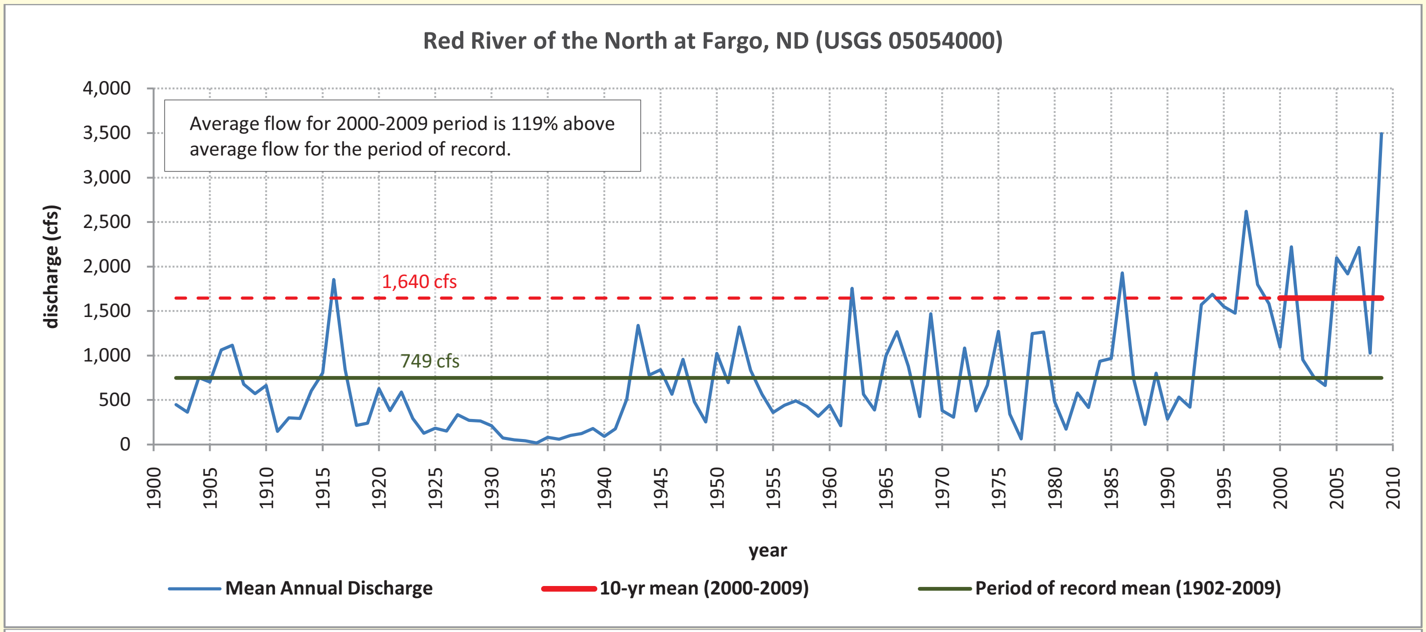

Minnesota State-Averaged Annual Precipitation
2000-2009 average is 1.86 inches above the period of record average
inches
year
annual precipitation
Period of record mean (1895-2009)
10-year mean (2000-2009)
seven-year moving average
Minnesota State-Averaged Seasonal Precipitation
(seven-year moving averages)
inches
year
winter
spring
summer
autumn

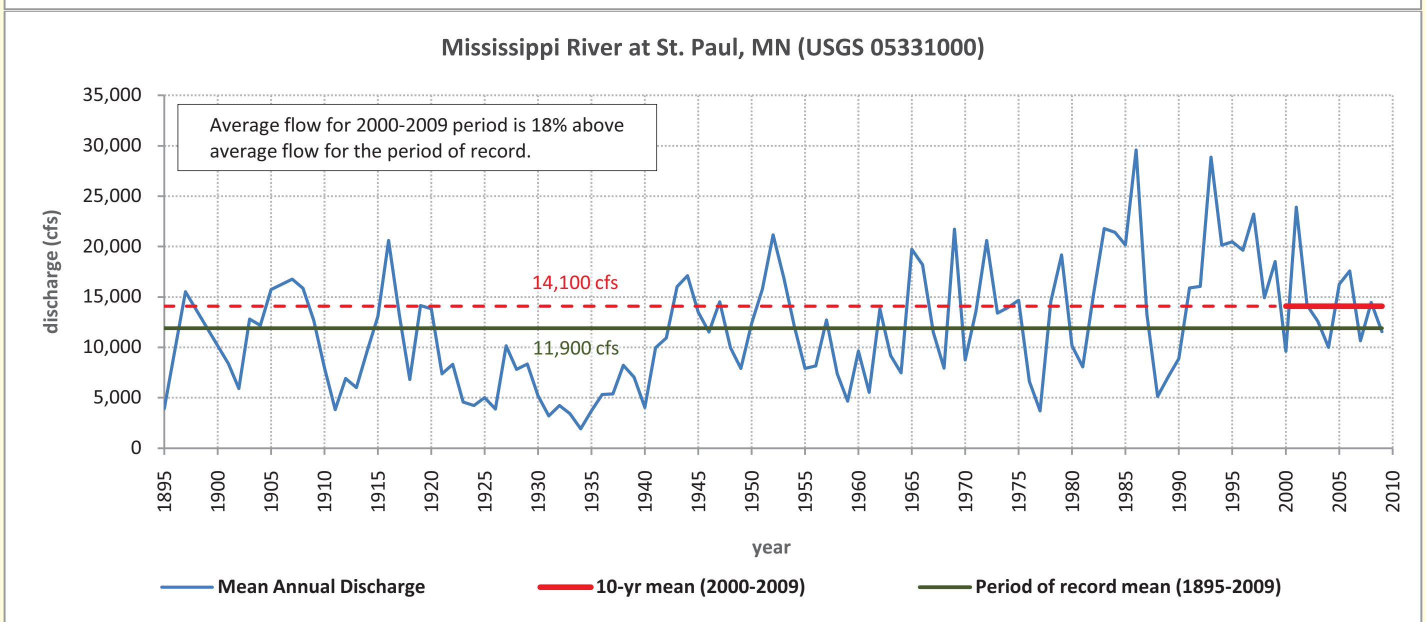
Stream Flows (2000-2009)

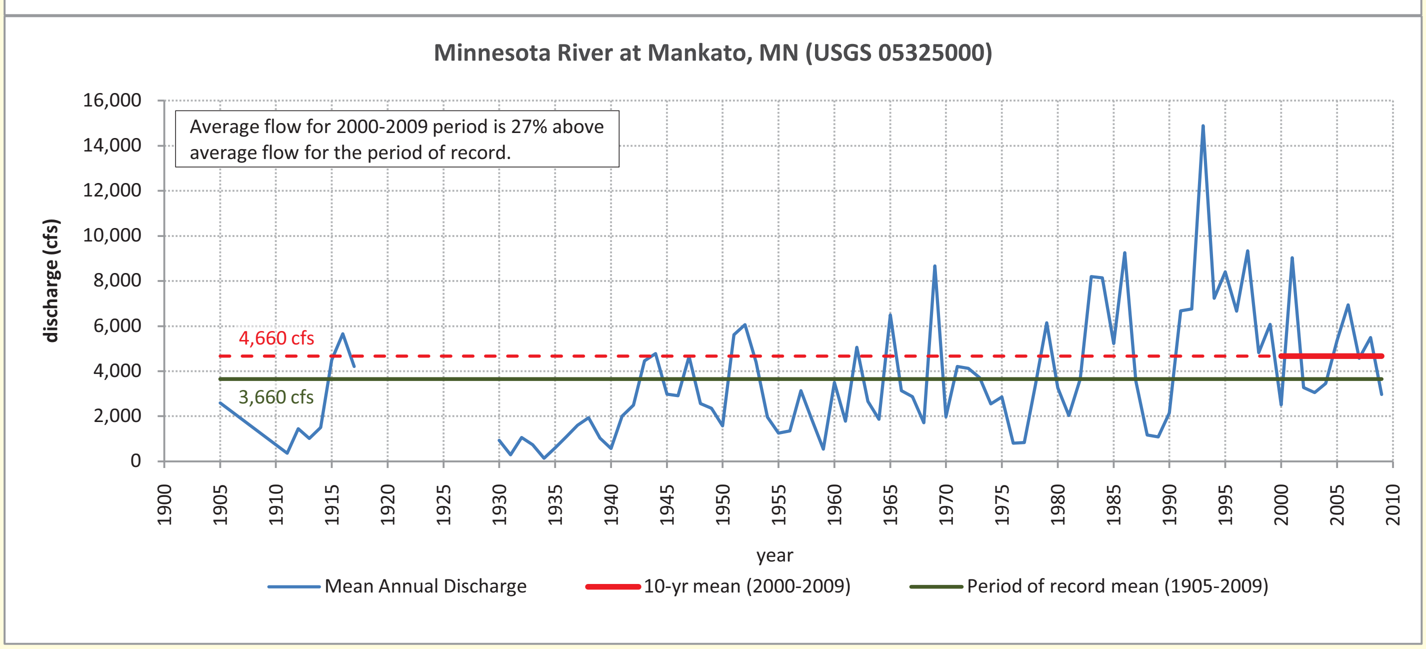
For much of Minnesota, stream flows at indicator gages for each major watershed were in the normal range with the eastern and northeastern watersheds low normal (25-50th percentile) and western watersheds high normal (50-75th percentile). The exceptions to this include the Pomme de Terre River (Major Watershed 23) and Otter Tail River (Major Watershed 56). These watersheds rank above normal (75-90th percentile).

Three gages on major rivers with long-term records were also selected to compare average mean daily flow from the ten-year period 2000-2009 to the average mean daily flow for the entire period of record. The Mississippi River at St. Paul and the Minnesota River at Mankato show slightly higher average flows for the ten-year period. The mean annual flow for these locations masks seasonal variations in flow during the past decade where severe drought was followed by extremely wet periods. The mean annual flow ends up being fairly close to the period of record mean as opposed to other years when persistent trends in flow (dry in the 1930s, wet years in 1986 and 1993) show a greater deviation from the long term mean. The Red River of the North at Fargo, however, showed a much different pattern in the last decade. Mean annual flow was significantly higher over the last ten years when compared to the full period of record. This condition was seen all across the Red River Basin in eastern North Dakota and northwestern Minnesota and began this wetter trend beginning in the early 1990s. In the last decade, even the driest years at Fargo are still above or at the period of record mean flow.



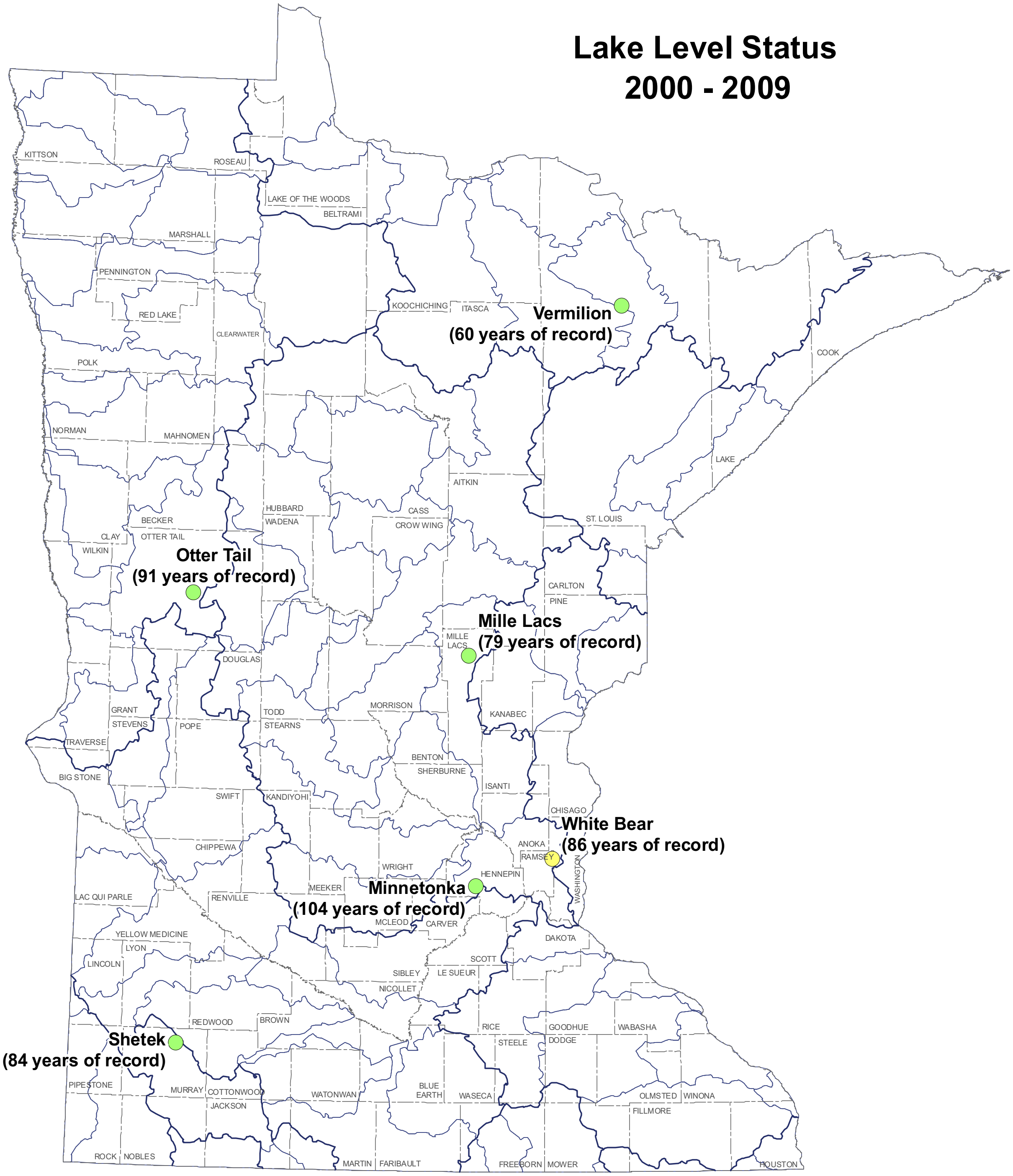

Red River of the North at Fargo, ND (USGS 05054000)
Average flow for 2000-2009 period is 119% above average flow for the period of record.
1,640 cfs
749 cfs
discharge (cfs)
year
Mean Annual Discharge
10-yr mean (2000-2009)
Period of record mean (1902-2009)


Mississippi River at St. Paul, MN (USGS 05331000)
Average flow for 2000-2009 period is 18% above average flow for the period of record.
14,100 cfs
11,900 cfs
discharge (cfs)
year
Mean Annual Discharge
10-yr mean (2000-2009)
Period of record mean (1895-2009)


Minnesota River at Mankato, MN (USGS 05325000)
Average flow for 2000-2009 period is 27% above average flow for the period of record.
4,660 cfs
3,660 cfs
discharge (cfs)
year
Mean Annual Discharge
10-yr mean (2000-2009)
Period of record mean (1905-2009)

Surface Water: Lake Levels

Lake Level Status 2000 - 2009



Percentile *

- High Water Levels (>90th percentile)
- Above Normal Water Levels (75 - 90th percentile)
- High Normal Water Levels (50 - 75th percentile)
- Low Normal Water Levels (25 - 50th percentile)
- Below Normal Water Levels (10 - 25th percentile)
- Low Water Levels (<= 10th percentile)
- Level 2 Hydrologic Unit
- DNR Major Watershed

* Percentile ranking based on the median of lake levels for the 2000-2009 period ranked with all historical reported levels. A lake ranked at zero means that the decade median is the lowest in the period of record; a ranking of 100 indicates the highest in the period of record. A ranking at the 50th percentile specifies that the decade median lake level is in the middle of the historical distribution.

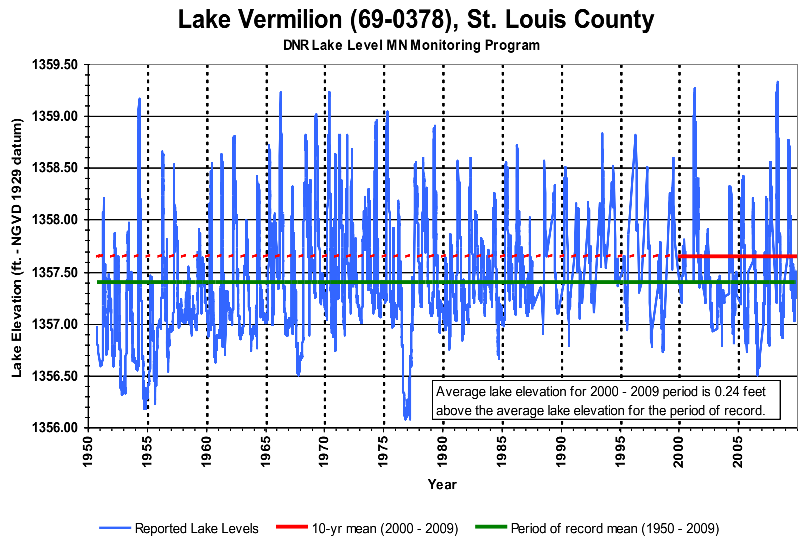
Source data from: MN DNR Waters Lake Level Minnesota Monitoring Program

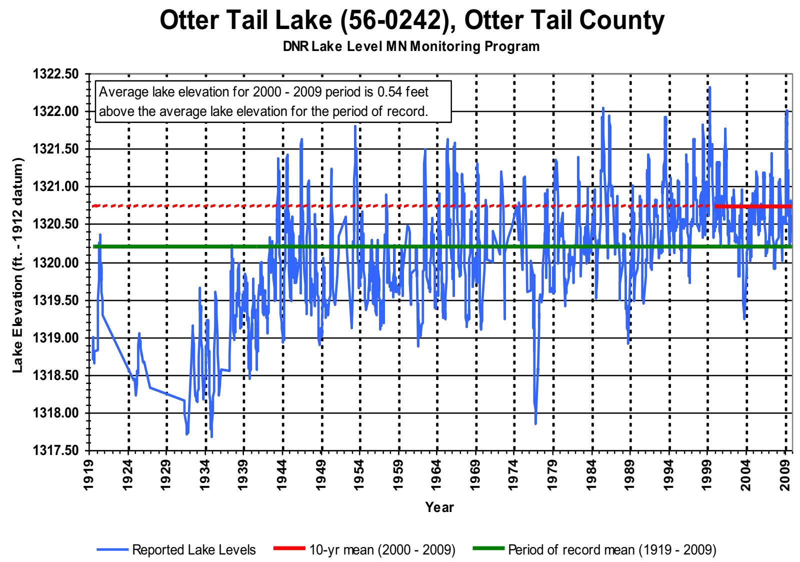
Lake Levels (2000-2009)

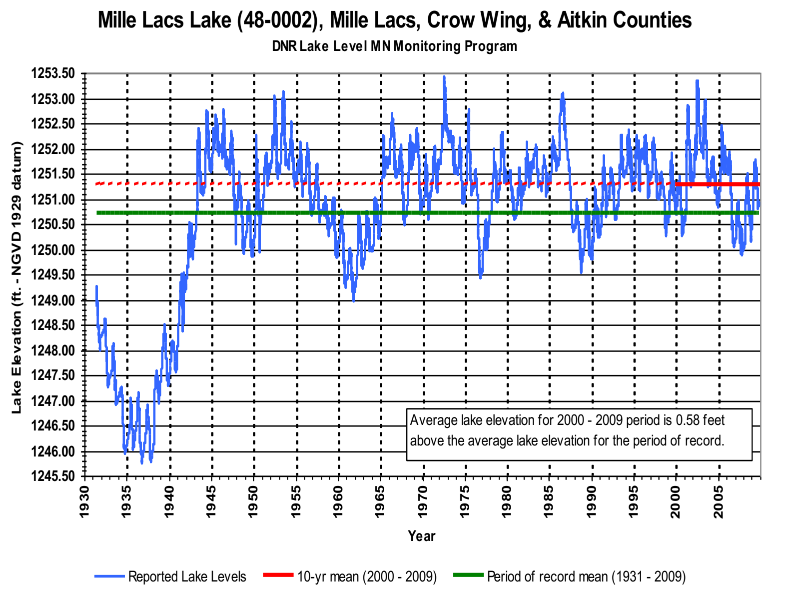
On **Lake Vermilion**, Minnesota's fifth largest lake, the last half of the 2000 - 2009 decade has seen large annual lake level fluctuations between spring and fall, a common pattern in a majority of the years of lake records. Years of little annual lake fluctuation, such as 2000 and 2003, are relatively uncommon.

Otter Tail Lake, the largest lake in Otter Tail County, is part of the Otter Tail River chain of lakes. Although the lake has a maximum depth of 120 feet, over 50% of the lake is less than 15 feet in depth. In response to the high precipitation as seen in the climate maps, the lake experienced very high and sustained levels in 2009, well above the 10-year and total record averages. This is also reflected in the stream flow map.

Although most changes in water level in **Lake Mille Lacs** are influenced by usual weather patterns, the lake is also affected by a 1953 fixed-crest spillway and fluctuations caused by seiches, which are large waves or storm surges. For this decade, the maximum level was in 2002 affected by seiche action, and the lowest levels were during the droughts of 2007 and 2008. The dry 1930's era broke all records for low levels.







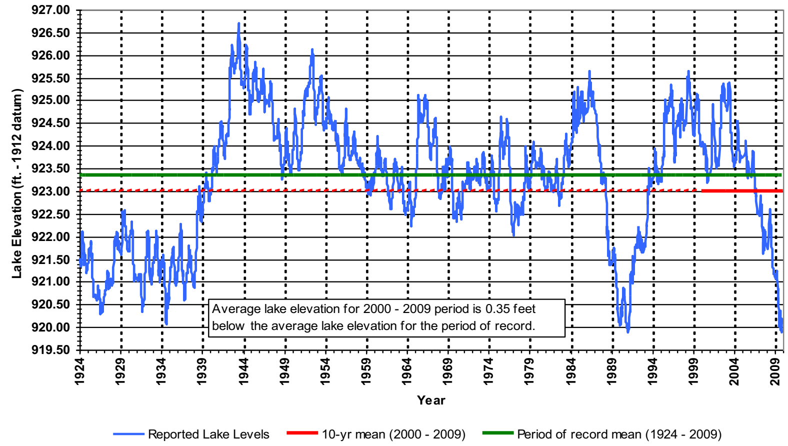
After high lake levels in the first few years of this decade, **White Bear Lake** has dropped almost 5.5 feet from Spring 2003 to Fall 2009. This area has experienced abnormally dry to severe drought conditions off and on during those seven years, according to the National Drought Mitigation Center. The decline resulted in the 10-year mean falling below the total record average. This is similar to the time when the lake dropped 5.6 feet from Spring 1986 to Fall 1990. Note that it took three years until 1993 for the lake to rise over 3 feet to a more average level. Over the long term, White Bear Lake levels are controlled principally by the region's groundwater level fluctuations, and in the short term by precipitation and runoff from a small watershed.

Lake levels and discharge have been controlled on **Lake Minnetonka** since 1897. In order to reduce flooding on downstream waters, water is stored from April to mid-June, and then released at a controlled uniform rate during summer and fall. The dam closes when the lake level is at 928.6 feet and below, as it did during the droughts of 2008 and 2009. Lake levels are affected by precipitation and runoff entering the lake, as seen by the last half of this decade during the dry seasons, as well as evaporation and controlled discharge leaving the lake.

With an average maximum depth of 10 feet, **Lake Shetek** is one of the largest lakes in southwestern Minnesota and the headwaters of the Des Moines River. The last half of this decade has shown a normal pattern around the average, with more extreme high bounces in the first part of the decade.

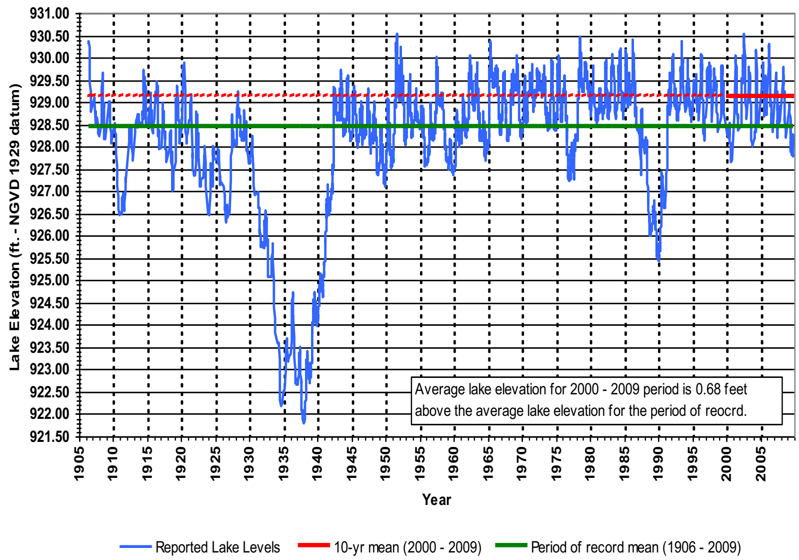
White Bear Lake (82-0167), Washington County

DNR Lake Level MN Monitoring Program



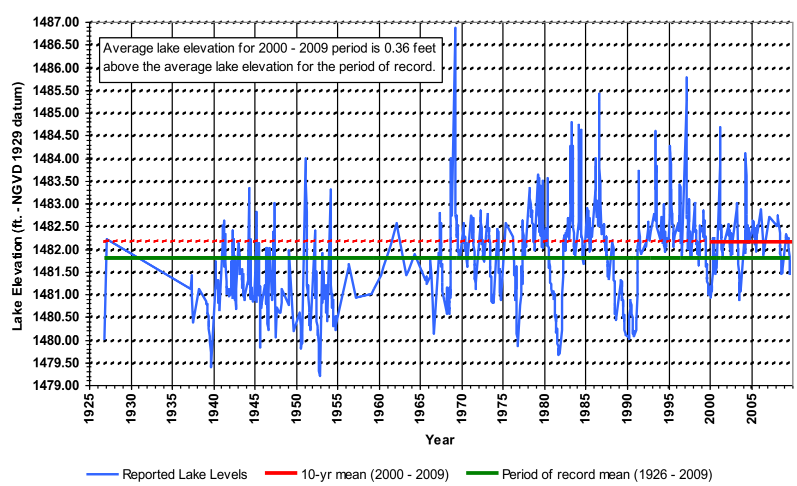
Lake Minnetonka (27-0133), Hennepin County

DNR Lake Level MN Monitoring Program

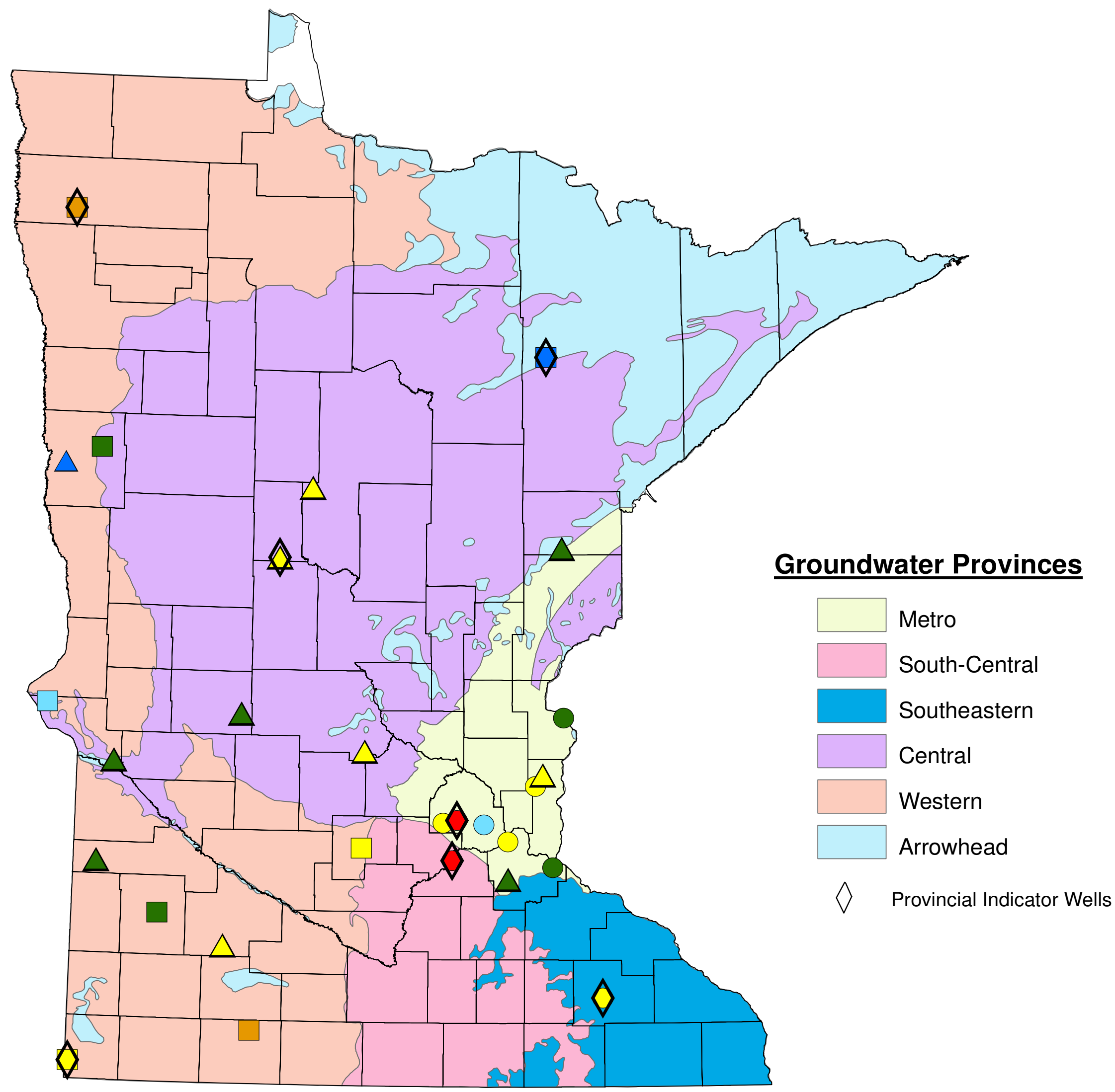


Lake Shetek (51-0046), Murray County

DNR Lake Level MN Monitoring Program



Groundwater



Aquifer

△ Water Table
□ Buried Artesian
○ Bedrock

Water Level

- High Water Levels (> 90% percentile)
- Above Normal Water Levels (75% - 90% percentile)
- Normal Water Levels (50% - 75% percentile)
- Normal Water Levels (25% - 50% percentile)
- Below Normal Water Levels (10% - 25% percentile)
- Low Water Levels (< 10% percentile)

* Percentile ranking based on last reported reading for the current month compared to all historical reported levels for that month. A water level ranked at zero means that the present reported level is the lowest in the period of record; a ranking of 100 indicates the highest in the period of record. A ranking at the 50th percentile (median) specifies that the present-month reported water level level is in the middle of the historical distribution.

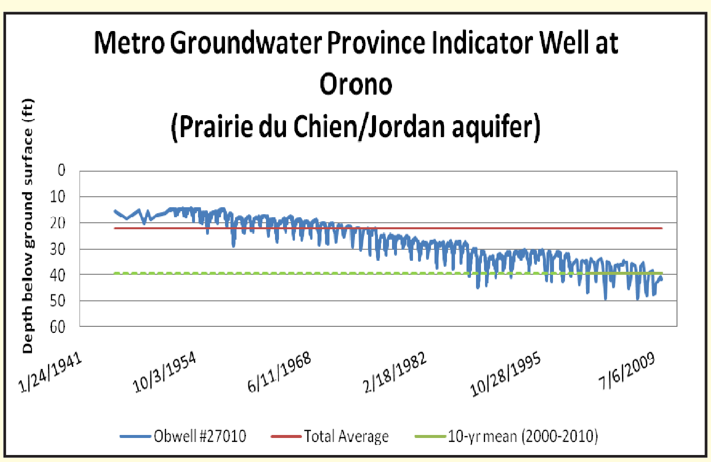
Source data from: MN DNR Ground Water Level Monitoring Program

Groundwater Levels (2000-2009)

The ten year average water level was compared to the entire length of record for the well. A high value indicates that the average water level compared to the highest 90% of water levels measured in the well. A low value indicated that the average water level compared to the lowest 10% of water levels measured in the well. A map showing the wells and their water levels is presented in Figure X. Most of the wells show that the ten year average falls within normal water levels for the well which are levels between 25% and 75% of all of the water levels measured in the well.

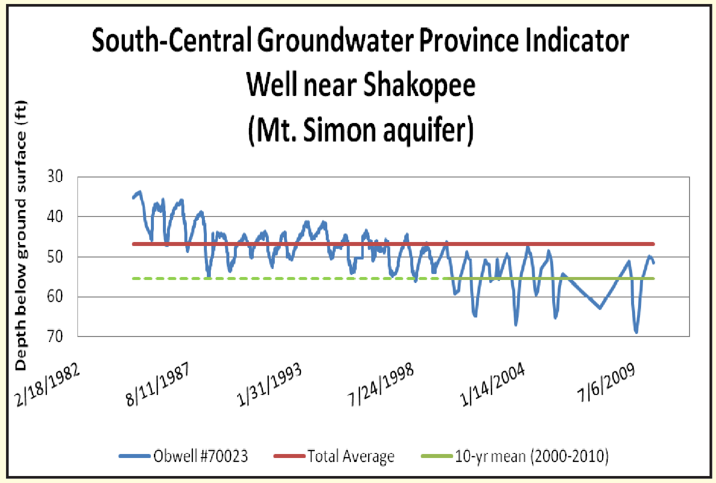
Seven of the wells were selected as representatives of the six groundwater provinces in the state and hydrographs were produced for each well. The groundwater provinces are defined by the bedrock and glacial geology which control the availability of groundwater in each of the areas. These provinces are presented on the Figure below.

Province 1 – Metro Province
Water levels in the Prairie du Chien/Jordan aquifer, a major water supply aquifer showed an overall downward trend in water levels. The hydrograph also shows the cyclical change between the high summer water use and lower winter water use. In the past ten years, the swing between the high water levels of winter and the low water levels of summer has increased and appears to be greater than any time except for the 1988 drought.



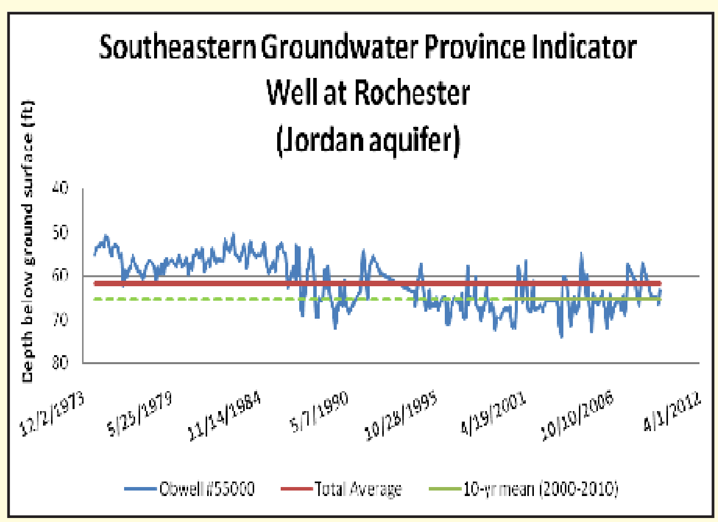
Province 1 – Metro Province

Province 2 – South-Central Province
The indicator well in the Mount Simon, typically the deepest aquifer in the state and a water supply aquifer for a number of communities shows a continued decline in the water levels. The size of the seasonal cyclic changes in water levels continues to increase between summer and winter water levels.



Province 2 – South-Central Province

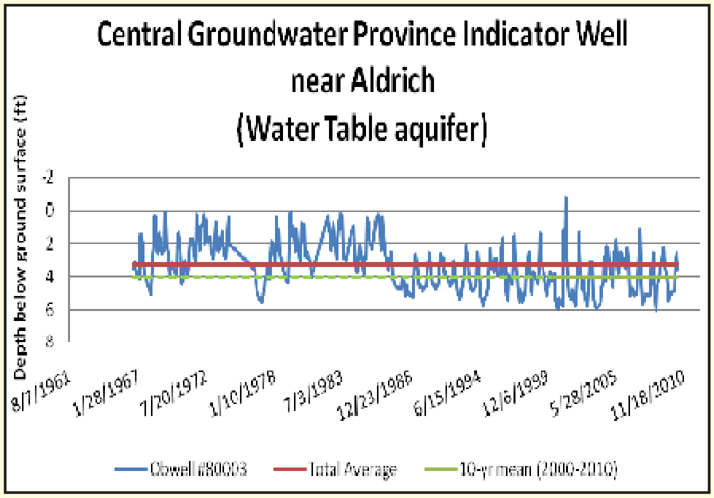
Province 3 - Southeastern Province
The indicator well in the Jordan aquifer also shows a slight downward trend in water levels since measurements began in the 1970s, although the water levels appear to have leveled in the past ten years. The past ten years also show winter/summer water level cycles similar in size to those in previous years.



Province 3 – Southeastern Province

Province 4 - Central Province

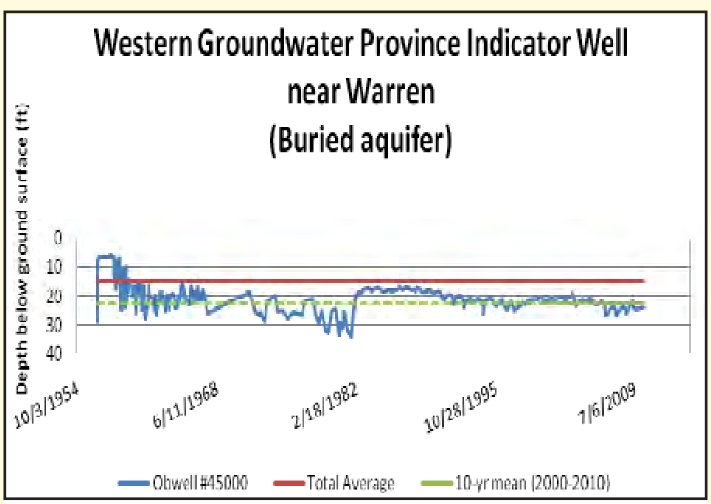
The water table aquifer in the Central Province is a major water supply for this part of the state. This area has a large number of irrigation systems which also use this aquifer. The water level in this aquifer has decreased since measurement began in the 1960s but appears to have leveled off in the past 20 years. However, the changes between winter and summer water levels have increased over the past ten years.



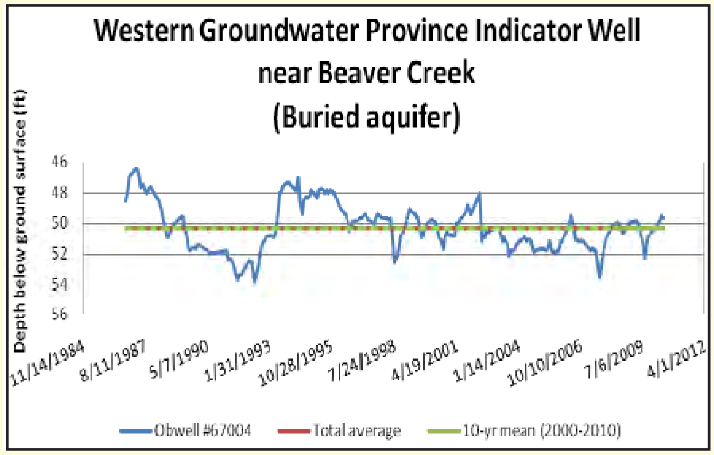
Province 4 – Central Province

Province 5 - Western Province

Two wells in the Western groundwater province were selected to provide a representative presentation of the province because of its size. These two wells are both buried aquifer wells. The northern of the two wells shows a downward trend in water level from the 1950s through the early 1980s when the water levels rose and stabilized. The past ten years has seen a slow downward trend in water levels, but not to the extent of what was seen in the past. The southern well shows a small downward trend in water levels. The past ten years does not appear to show any change in general water levels and there is no regularity in size or timing of the changes between summer and winter water levels.



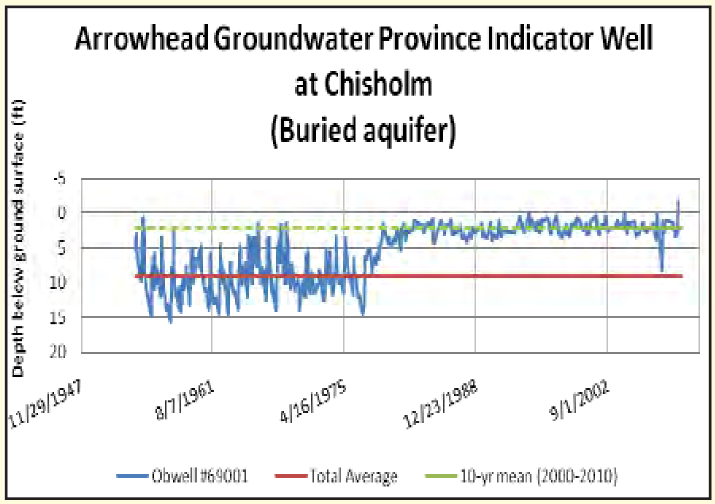
Province 5 - Western Province



Province 5 - Western Province

Province 6 - Arrowhead Province

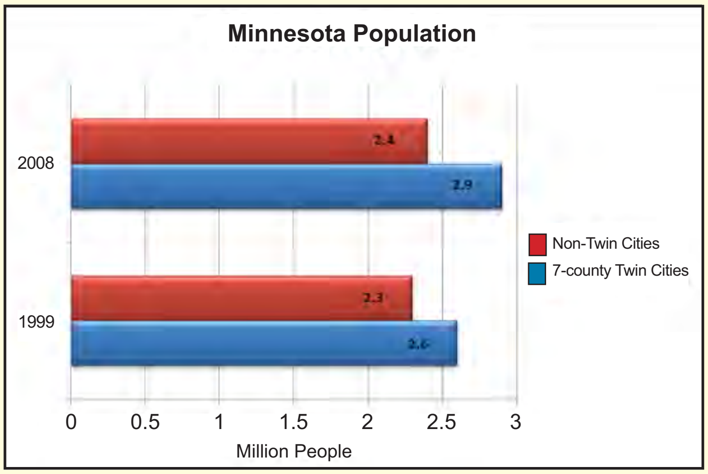
This well is a buried aquifer well on the border of the Arrowhead and Central Provinces. The well had large cyclical changes until about 1977 when the water level rose and leveled. In the past ten years, there has been little change in the general water levels or the seasonal changes measured in the well.



Province 6 – Arrowhead Province

Water Use

Minnesota DNR regulates water use to protect the long-term viability of the water resource for people and the environment. Water use permits are required from appropriators of more than 10,000 gallons per day or one million gallons per year. On an annual basis, monthly water use data is collected from these permit holders. This information is analyzed and compared with data from stream flow measurements, lake water levels, groundwater levels, and precipitation to give Minnesotans a picture of what is going on with the water resources of this state.

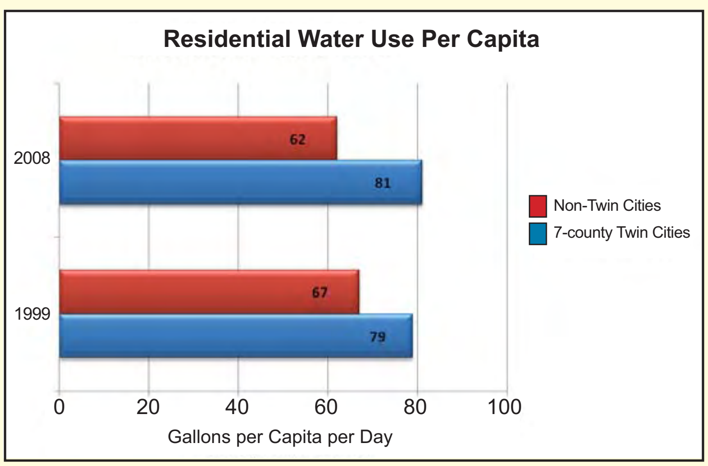


Minnesota Population. *Source: Estimates from the Minnesota State Demographic Center*

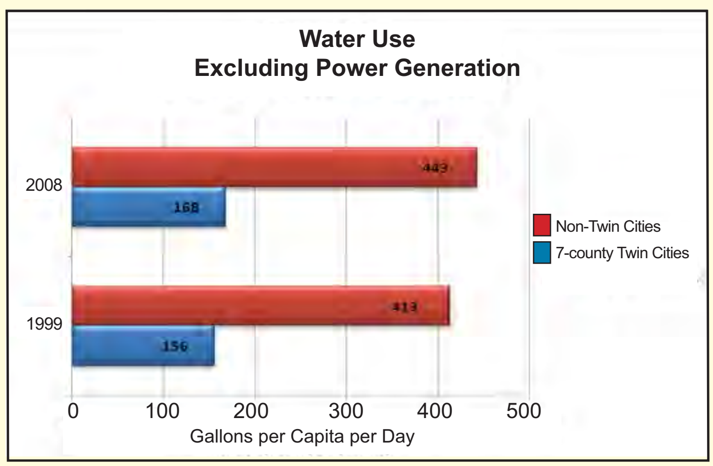
Overall, Minnesota saw water use increase by 77.6 billion gallons per year from 1999 through 2008 (excluding water used for power generation). Residential water use accounted for about 4.8 BGY, or 6%, of the increase.

The 3 figures on this page illustrate population and water use comparisons between the 7-county metro area and greater Minnesota. Minnesota's population increased slightly during the 10-year period from 1999 through 2008, mainly in the Twin-Cities area. Public water suppliers report the volume of water used in their communities for household purposes (residential water use). Comparisons of these volumes to reported population served are shown in Figure "Residential Water Use Per Capita". Residential per capita water use* increased in the 7-county Twin-Cities area and decreased slightly outside of Twin Cities area. When all water uses ("all uses" includes industrial processing, irrigation, public water supply, and other uses except power generation) are distributed across Minnesota's population, the per-capita water use increased by 6% from 1999 to 2008.

* Residential water use volume does not include separate water uses below the regulatory threshold of 10,000 gallons per day or one million gallons per year such as is typical for private residential wells.



Minnesota Residential Water Use. *Source: Supplemental Inventory forms required by public water suppliers which tally total water use by customer category and population served. Output is the averaging of all suppliers (large & small). Note the quality of this information varies. Values are from averaging all reported information.*



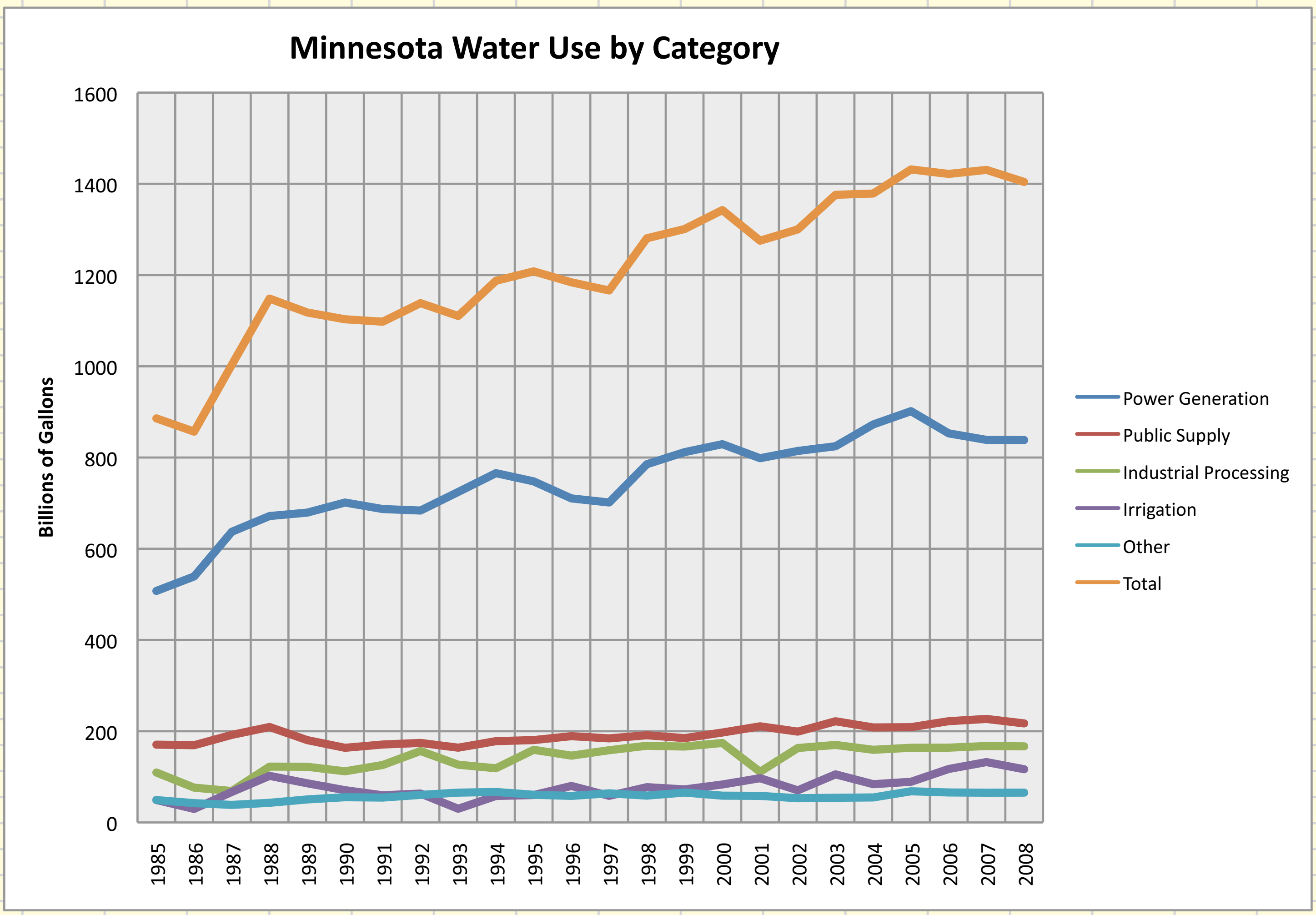
Water Use Excluding Power Generation. *Source: DNR Water Appropriation Permit Program water use reports maintained in the State Water Use Data System (SWUDS).*

Overall water use has risen from about 850 billion gallons per year in the mid 1980s when electronic water use data tracking began to about 1400 billion gallons per year in 2008. Over the 1999-2008 period water use increased by 103 billion gallons per year. The largest portion of water use is for power generation from surface water sources. This use is mostly non-consumptive, meaning that the water is returned to its source immediately after use. Public Water Supply and Industrial processing account for 68% of the non-power generation water use. Irrigation water use has increased over time with more acres regularly irrigated. Annual precipitation drives changes to irrigation demand on a yearly basis. Industrial processing water demand changes with the financial climate and the need to move water in the iron-mining areas of Minnesota.

Minnesota Reported Water Use in Billion Gallons

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Power Generation	508	539	637	672	679	701	687	684	725	766	748	710
Public Supply	171	169	192	209	180	164	171	174	164	178	181	189
Industrial Processing	109	76	69	122	122	112	126	157	127	119	159	146
Irrigation	49	30	67	102	86	71	59	63	30	58	60	80
Other	49	42	38	43	50	55	55	60	65	67	61	58
Total	886	857	1003	1148	1118	1103	1098	1138	1110	1187	1208	1184

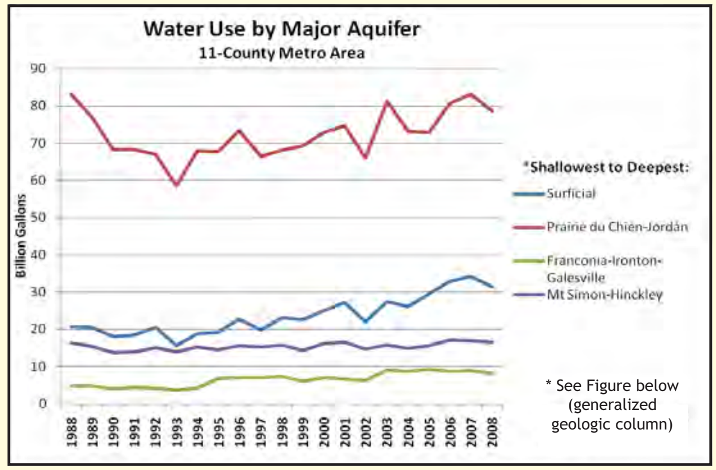
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Power Generation	701	785	812	829	798	814	825	873	902	853	839	838
Public Supply	184	191	185	197	211	199	222	208	209	222	227	217
Industrial Processing	158	168	166	174	111	163	170	159	164	164	168	167
Irrigation	58	77	72	83	97	70	105	84	89	117	132	117
Other	64	59	66	59	58	53	54	55	68	66	65	65
Total	1166	1281	1301	1342	1275	1300	1376	1379	1432	1422	1431	1404



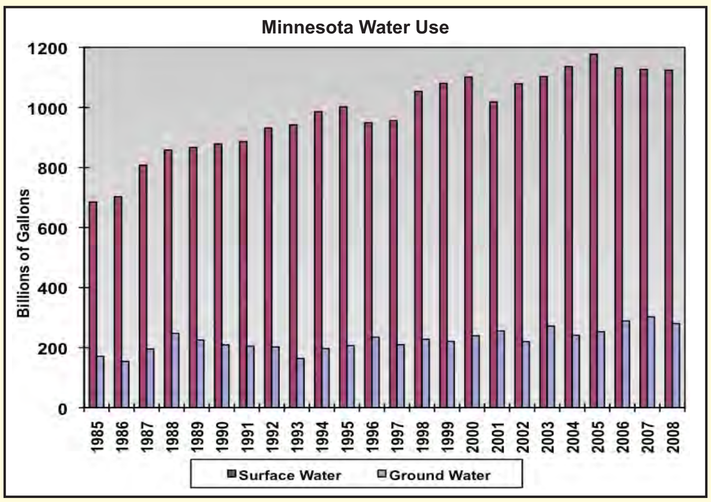
Minnesota Water Use by Category 1985-2008. Source: DNR Water Appropriation Permit Program water use reports maintained in the State Water Use Data System (SWUDS)

Surface water use has risen from 700 billion gallons per year in 1985 to 1100 billion gallons per year in 2008. Groundwater use has risen from 170 billion gallons in 1985 to 280 billion gallons in 2008.

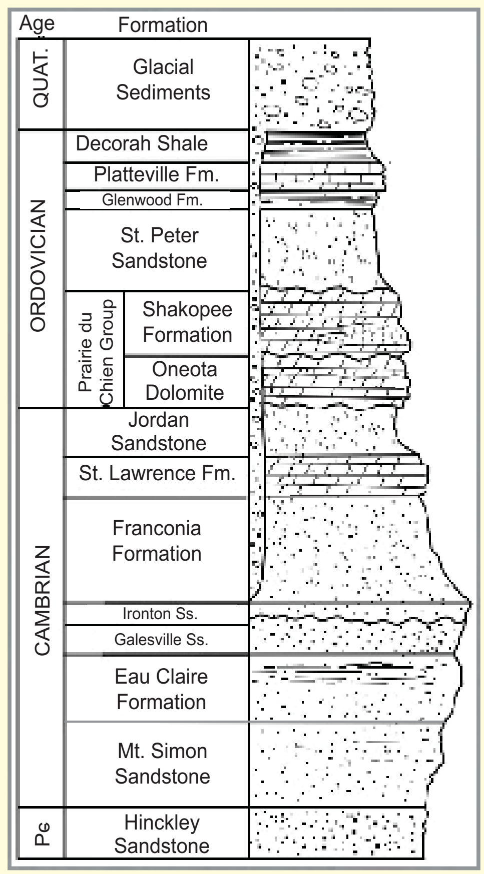
In the 11-county metro area, 4 principle aquifers account for 98% of groundwater use. The Prairie du Chien-Jordan aquifer is used for an average of 61% of the groundwater demand over the last 20 years. The surficial aquifers averaged 20% of the total groundwater use. The remaining water used came from the Franconia-Ironton-Galesville and Mt Simon-Hinckley aquifers. The largest increase in use over the 20-year time period was from the Prairie du Chien-Jordan and surficial aquifers.



Water Use by Major Aquifer. *Source: DNR Water Appropriation Permit Program water use reports maintained in the State Water Use Data System (SWUDS). Multi-aquifer wells were evaluated and water use assigned to individual major aquifer by the method described in US Geological Survey Water-Resources Investigations Report 83-4033. Two percent of known water use was either from an unknown aquifer source or other minor sources omitted from the graphic.*



Minnesota Water Use: Surface Water and Ground Water.
Source: DNR Water Appropriation Permit Program water use reports maintained in the State Water Use Data System (SWUDS).



Example of a generalized geologic column for the 7-county metropolitan area.

Water Resource Summary

- Over all the average precipitation was higher over the last ten years when compared to the historical average and markedly higher in areas of the northwest part of the state.

- Generally, indicator lakes and rivers responded to climatic conditions and reflect those conditions over the past ten years.

- Stream flows were higher than the historical average in the western half of the state and slightly below average in the east.

- Indicator lakes across the state were slightly higher than the historical average with the exception of White Bear Lake, a groundwater influenced lake.

- Generally groundwater levels in water table and buried artesian indicator wells are in the normal range when compared to historical average.

- Seasonal fluctuations in some indicator wells were greater in recent years when compared to historical fluctuations indicating seasonal use of the resource is increasing.

- Deeper aquifers in metropolitan areas used for water supply continue to decline over time.

- In some areas the reliability of deep aquifers for water supply in the future may be limited if the declining trend continues.

Previous Reports & Strategies for Water Management

The concerns, strategies and conclusions found in "Minnesota's Water Supply: Natural Conditions and Human Impacts" remain relevant today and are incorporated into this report by reference. The DNR has also laid out strategies to provide for the long-term protection of our surface and groundwater resources that can be found in our report found at:
http://files.dnr.state.mn.us/publications/waters/long-term_protection_surface_ground_water_201001.pdf.

The two reports referenced above and the table below were shaped and guided by present and past inter-agency input processes and reports, and through years of ongoing coordination and discussions with our many partners in water supply management. More recent reports, such as the Metropolitan Council's Master Water Supply Plan, EQB reports on Water Sustainability, and past reports on water availability required under Minnesota Statutes 103A.43 have continued to shape the direction DNR has taken with its responsibilities.

Previously Identified Strategies

Minnesota's Water Supply: Natural Conditions and Human Impacts (September 2000)	Long-term Protection of the State's Surface Water and Groundwater Resources (January 2010)
Water Supply Assessment	Enhance Data Collection and Sharing and Simplify Access to Data
	Answer Key Questions and Meet Key Information Needs
Partnership in Study and Protection	Deliver Up-To-Date Protection Tools and Recommended Best Management Practices
	Adopt Long-term Focus for Monitoring and Prevention Activities
Conservation and Restoration	Approach Groundwater and Surface Water Management and Protection as a Comprehensive System
	Provide Adequate Financial Resources
Regulation and shared responsibility	Encourage and Influence Local Engagement in Management, Prevention, and Demonstration Efforts

Conclusions and Recommendations

An increasing number of places in Minnesota are experiencing water supply problems related to inadequate supplies, unacceptable quality or both. Our past management systems were designed around managing the impacts of an individual project to prevent it from creating unacceptable impacts to our natural resource systems. We have been largely successful in this endeavor. The challenge for all levels of government, as we move forward, will be adapting to understand and manage the impacts from the collective actions of all land use and water supply management decisions on the public, economic and environmental health.

In some places we are seeing water availability problems. We are using water faster than it can be replenished by diverting water from natural discharge zones or lowering water levels in aquifers. In some areas our land use choices are contaminating our water supplies, and we have so greatly changed the natural landscape that the ecosystem that remains is no longer able to provide its essential cleansing and recharge functions.

Minnesota's climate, on average, provides us with an ample supply of water. We are improving our networks for understanding precipitation patterns, lake levels, and stream flow that enable us to manage surface water systems. We know far less about our groundwater system, and since approximately 75% of Minnesotans depend on groundwater systems and dependence is increasing, we will need to know more about these systems in the future. Additionally, we will need to have a better understanding of the surface and groundwater relationships to the health of our ecosystems. To begin to eliminate current problems and avoid future water availability problems, we must improve our understanding and the quality of management decisions in the following areas:

1) We need to significantly increase our understanding of how water moves into, through and out of the earth beneath us.

2) We need to learn to reduce our withdrawal of water and promote the understanding that water captured by pumping has been diverted from discharge areas (springs, streams, lakes and wetlands) and taken from storage as evidenced by declining groundwater levels. We need to learn how much humans can take away from discharge areas without impairing ecosystem function and we also need to learn how to manage pumping water levels to reduce competition and conflict among water users.

3) We will need to manage land uses to ensure that water recharging our groundwater systems has had sufficient time or treatment to remove contaminants before entering subsurface flow pathways.

4) And finally, we will need to learn more about how our surface waters are dependent on groundwater systems for supply throughout the year so we can prevent undesirable impacts in lakes and wetlands, rivers and streams, and in natural and rare plant communities that all provide important functions toward the quality of life we have enjoyed in Minnesota.

In summary, industry, agriculture, housing, manufacturing, power generation, and well-managed public water supply systems are all necessary elements to nurture and sustain communities. To maintain all the natural resource features that contribute to Minnesota's attractive quality of life, including fish and wildlife habitat and recreational opportunities, each growth and development decision needs to include consideration of its effect on the water supply and associated water resources. Careful consideration of the effect each use may have on the available water supply is essential for the sustainability of the water supply and the water supply's ability to be recharged for future growth, development, and enjoyment.

In order to ensure the future of our water supply, thoughtful water supply management, including conservation, restoration, study, and protection must be practiced. Only in this manner will Minnesotans continue to wisely control their water resource destiny.

Appendix D – *Metropolitan Area Water Supply Planning: Report to the Legislature as part of the 2010 Minnesota State Water Plan*

Metropolitan Area Water Supply Planning
Report to the Legislature, as part of the 2010 Minnesota State Water Plan

Introduction
Minnesota Statutes, Section 473.1565, directs the Metropolitan Council (Council) to "carry out planning activities addressing the water supply needs of the metropolitan area," including the development of a Twin Cities Metropolitan Area Master Water Supply Plan (Master Plan). The legislation directs that the plan:

- Provide guidance for water supply development.
- Emphasize conservation, interjurisdictional cooperation, and long-term sustainability.
- Address reliability, security and cost effectiveness of metro area water supplies.

The Master Plan was completed in March 2010. In addition, the law required that the Council "…***submit reports to the legislature regarding its findings, recommendations, and continuing planning activities under subdivision 1. These reports shall be included in the "Minnesota Water Plan" required in section 103B.151…".*** This report fulfills that requirement by describing efforts conducted to date, including an overview and conclusions of the Master Plan and ongoing planning efforts.

The analysis conducted as part of the planning effort to date indicates that, overall, the region's water resources are adequate to meet projected demands for the foreseeable future. However, local issues *are* predicted to continue to arise if traditional sources are developed to meet those demands. The issues include impacts to surface waters, unacceptable groundwater declines and the potential for interference with private wells.

The Master Plan sets forth a dynamic process for collecting new information, updating analytical tools, and improving guidance to address anticipated water resource issues and ensure supplies are developed sustainably. The plan adopted the following definition of water sustainability: ***"…water use is sustainable when the use does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs."*** **(Minnesota Session Law 2009 c172)**

Planning Activities

Stakeholder Input
As prescribed in Minnesota Statutes 473.1565, the Metropolitan Area Water Supply Advisory Committee – whose members represent state agencies, counties, local governments and the Council – was established to assist the Council in its planning activities. The guidance provided by this group was critical to the development of the plan and will continue to be so in the future. The advisory committee is set to sunset at the end of 2012.

From the beginning of the planning process, the Council recognized that an inclusive and transparent process involving water resource and supply managers is critical for this to be a successful and useful effort. Through a series of workshops, the Council sought direction from a wide range of stakeholders whose input played an important role in shaping the plan's content and structure. As the need to develop technical information and tools emerged in 2007, the Council convened a technical advisory group to ensure the accuracy of data and the usability of its analysis. With their roles in water management, the Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Health (MDH) played an integral part in the development of this plan.

The central issue that emerged from the stakeholder input was the need to link water supply to overall planning, and that evaluating resources in the context of planned growth is necessary if the region is to satisfactorily address potential limitations. As planning continues, so will the collaborative process that has been established between stakeholders and the Metropolitan Area Water Supply Advisory Committee.

Phase I

The planning activities were organized into two phases. During the first phase, culminating in a report to the 2007 Minnesota Legislature (January 2007), the Council conducted a preliminary evaluation of water supply availability, examined the water supply decision-making and approval process, and explored the need for a regional role in water supply safety, security and reliability.

As a first step in the development of a sound regional base of technical information, the Council collected water supply system and resource monitoring location information from throughout the region. The Council also performed an initial analysis comparing regional water demand projections and water resource availability. The goal was to identify communities where water supplies might be inadequate to serve projected growth. This was the foundation for a more robust analysis in the second phase.

With guidance from the Water Supply Advisory Committee (Minnesota Statutes 473.1565) and input from stakeholders, the Council evaluated the current water supply decision-making and approval process and agency roles during Phase I. The DNR, MDH, and the Council each play a unique role in the water supply decision-making and approval process in the region. While coordination exists among these agencies, opportunities were identified for improving coordination and streamlining the process. Consequently, the MDH and DNR have been increasing the routine communication and coordination between them. The most significant change to improve the process, however, was identified to be an adequate evaluation of water supply availability as part of planning for growth. Roads, parks and sewer service capacities are evaluated as part of regional planning, but historically there has been little or no water supply availability assessment prior to growth. It is this gap that the Master Plan addresses.

The Council also evaluated a range of safety, security and reliability issues during the first phase of the planning effort. Contamination (both intentional and accidental, in both the distribution system and the source-water area), loss of power, and natural disasters were identified as the most significant short-term risks to the region’s water supplies. The evaluation concluded that federal and state regulations and programs are already in place requiring communities to identify and establish protocols for protecting the safety, security and reliability of their water supplies. However, as part of ongoing planning activities, the Council will continue to look for areas where there is a benefit to a regional approach water supply protection.

Phase II

Building on the work done in Phase I, the second phase of work focused on refining the water resource availability assessment. Phase II culminated in the Metropolitan Area Master Water Supply Plan

(March 2010). Phase II analyses focused on the following stakeholder-identified issues, which have limited water supply availability in the past and may occur in the future:

- Impact to surface water features
- Significant aquifer drawdown
- Well interference
- Impact to trout streams or calcareous fens
- Aquifer vulnerability
- Presence of special well construction areas

The water resource availability assessment evaluated the potential for these issues to occur based on projected demands. It relied on the best available, regionally consistent data collected by the Council and by others through various programs and studies conducted over the years. These data sets included water supply system infrastructure information, geologic data, surface water flows, water well information, studies of groundwater and surface water interaction, and areas of known groundwater contamination.

Using this data and information, the Council conducted a regional analysis that compared projected water demands to available resources. Metro Model 2, a computer model of the region's groundwater flow built upon the PCA's original Metro Model, was developed to assess the ability of the region's water resources to supply projected demands without adverse consequences. The model and other analyses highlighted areas where, based on projected demands, groundwater withdrawals could cause unacceptable impacts to water resources.

Information about special well construction areas and source water protection areas developed by the MDH was also compiled and presented in the plan to inform water supply planning decisions.

In addition, work was conducted to better understand how much more water could be withdrawn from the Mississippi River for water supply during low-flow conditions, while maintaining a minimum flow necessary for existing water withdrawal infrastructure and other uses including downstream navigation channels, sustainable habitat for fisheries and wildlife, recreation, and point-source-inflow dilution. The study evaluated the probability of low flows in the Mississippi River to inform communities currently using the river as a source as well as those who are considering its use.

Results: Metropolitan Area Master Water Supply Plan

Five years of stakeholder input, data collection, and technical analysis culminated in the development and approval of the Master Plan in March 2010. The plan provides a framework for long-term water supply development at the local and regional level that does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs. The plan recognizes the benefits of identifying, early in the process, issues that communities need to address.

Much of the analysis focused on evaluating the potential impacts of groundwater withdrawal, the preferred source for virtually all the growing suburbs in the region. A variety of scenarios were run, including one that assumes that the entire developable area of the region is developed at urban densities and that groundwater will be the water source used to meet all new demand in the region (ultimate development). The analysis for this scenario predicts that the magnitude of aquifer declines will vary across the metropolitan area. In the developed central cities and inner-ring suburbs, aquifer decline is expected to be minimal. In outer-ring suburbs and rural areas, particularly in the southern metropolitan area, aquifer decline on the order of 100 feet may occur.

The ramifications of this decline vary from aquifer to aquifer and from place to place. In some areas the projected decline will have little impact on natural resources, and in others could adversely affect aquifer productivity and/or surface water features. In areas where adverse impacts from use of traditional sources are predicted, communities will be able to meet projected demands through development of options including use of other aquifers, surface waters, conservation, and cooperation with neighboring communities, avoiding the adverse impact.

The plan presents results of the metropolitan area water supply availability assessment at both a regional and community scale. The region-wide water supply assessment highlights potential problem areas, so that they can be considered in the development of region-wide plans. The plan also provides enough detail on the potential local problems that water suppliers will know what needs to be addressed as part of development. This scale variability is intended to identify and coordinate water supply planning activities among utilities, local, regional and state planners and resource managers, and to reduce the likelihood that water supply problems will develop "under the radar."

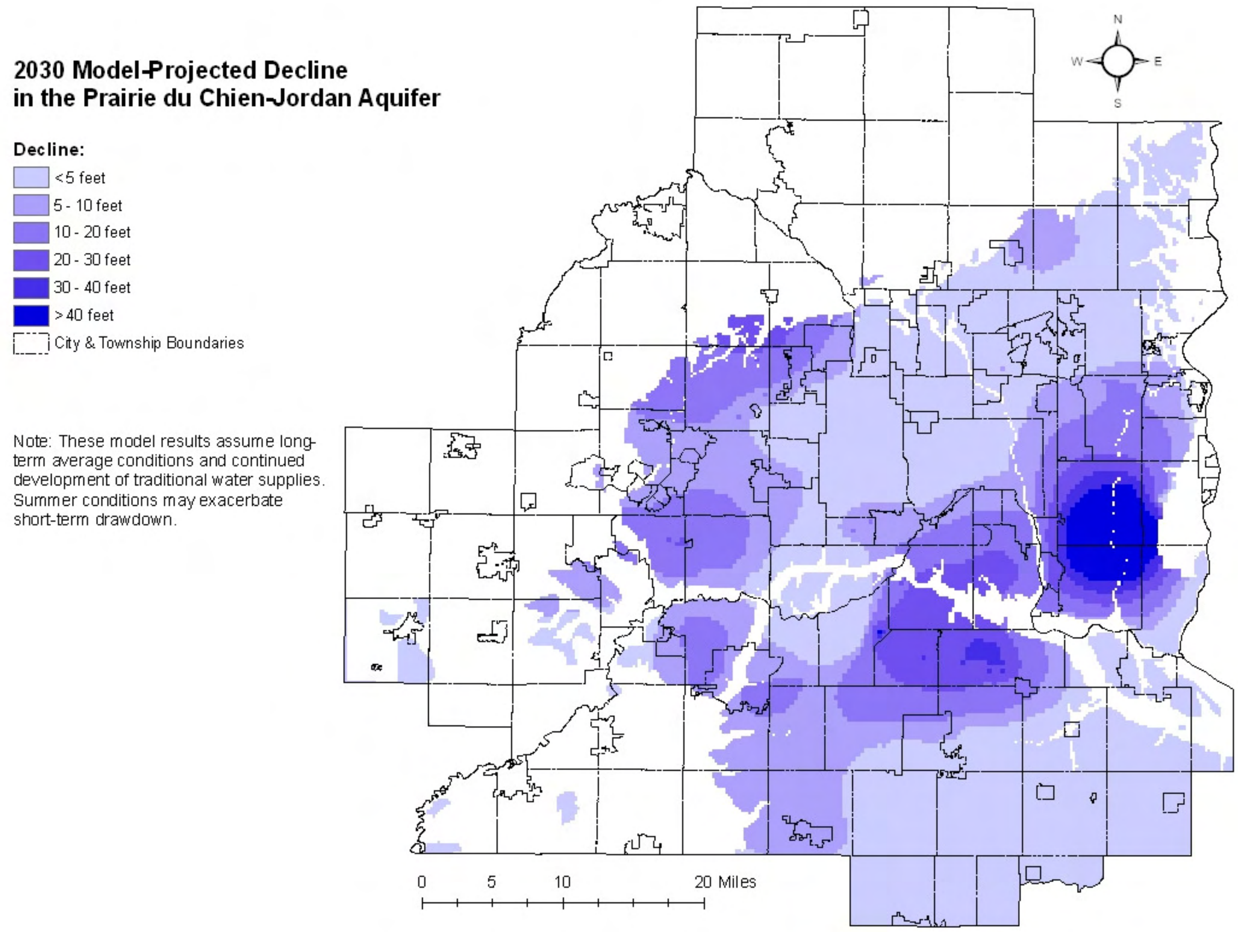


Figure 1: The analysis shows potential groundwater level drawdown primarily in outer-ring suburbs that rely heavily on groundwater. Should these communities continue to use their traditional groundwater sources, aquifer water levels are expected to decline significantly in some areas. Use of alternative water sources may neutralize predicted impacts.

The Master Plan presents local information in community-specific water supply profiles, one for each community in the region. The profiles provide information about each community's current and projected water demand, current potential supply sources, and issues identified through the technical analysis. In addition, the plan provides guidance for communities to address the issues identified in their profiles. With the information supplied in the profiles, communities will know what potential water supply issues they face and the range of appropriate solutions *before* they invest significant time and money in infrastructure planning. The information will also be used by the DNR to help ensure that potential issues are being addressed and appropriation permits can be issued with more confidence. Having this information available will help to avoid many of the costly and time-consuming delays in water supply development, as well as the challenging appropriation decisions, that have occurred in the past.

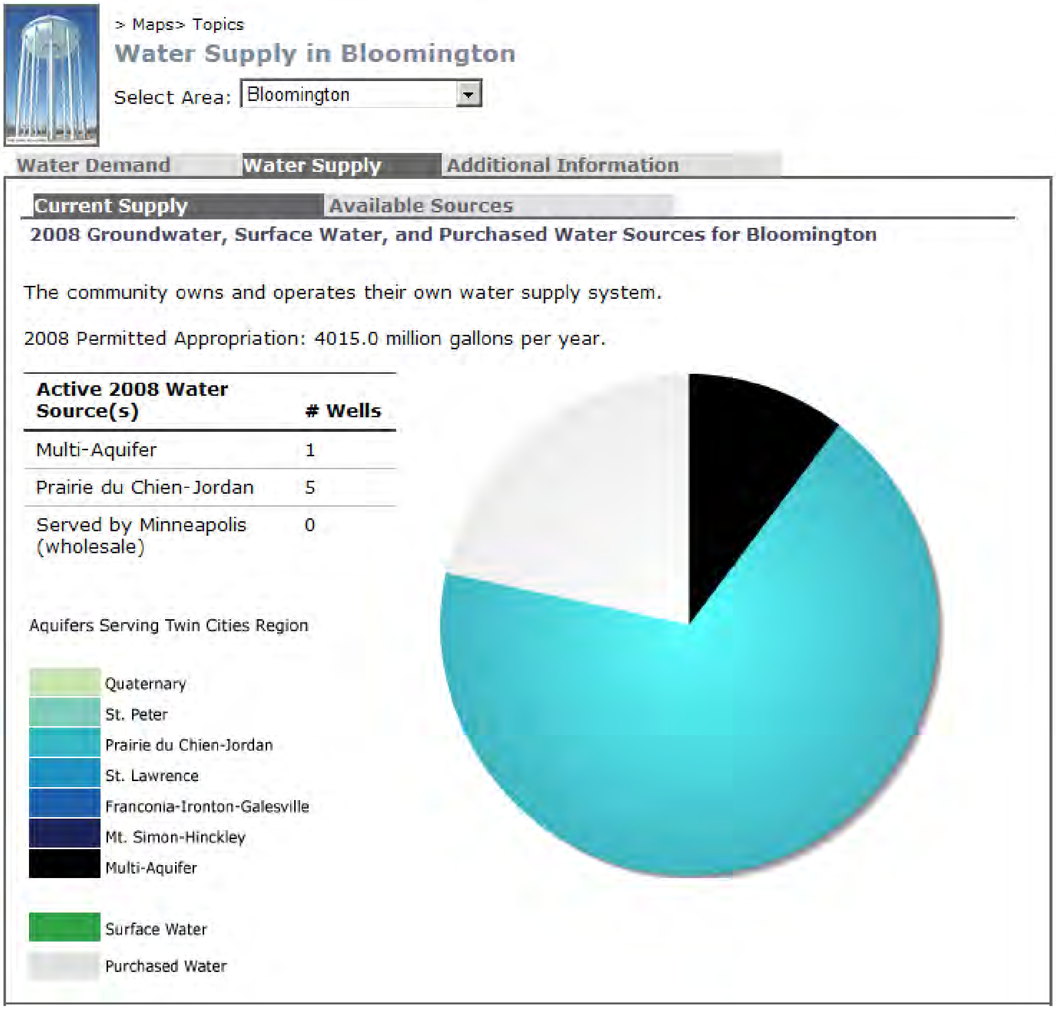


Figure 2: Community water supply profiles include information on each of the municipal water supplies in the region as well as issues that need to be addressed. They are presented in the online water supply information application as well as in paper or pdf format.

It was clear that providing public access to data and analyses was critical in the development of a useful master water supply plan. The Council created several online tools to put data and analyses in the hands of regional and local planners. Water demand, infrastructure, and groundwater model data are available as maps through the Make-A-Map application on the Metropolitan Council website. Community water use information is provided through the Council's online Topics application. An online water conservation toolbox provides water suppliers with program ideas and water customers with wise water-use tips.

As required by Minnesota Statutes 473.1565, the Metropolitan Council will consider the results of the planning effort when preparing the metropolitan development guide (Minnesota Statutes 473.145). Although water supply will not be the only factor in developing long-range growth forecasts, it will be considered alongside the other factors that shape the regional forecasts. Where other factors indicate that growth should occur and water supplies have some limitation, the Council will assist the communities in developing plans to meet projected demands sustainably. The Council will also review local comprehensive plans for consistency with the Master Plan in accordance with Minnesota Statutes 103G.291.

Ongoing Efforts

The Council's planning effort resulted in a collaborative and dynamic process for the evaluation of water supply availability, linked to long-term planning and based on a continuously improving foundation of technical information and management strategies. The plan recognizes the value of an adaptive approach to water supply management, guided by management tools developed with the best available information generated through resource monitoring, mapping and predictive analyses. The Master Plan describes the ongoing process for incorporating the information collected through efforts led by the Council, communities, watershed districts, local, county and state agencies, and others into the analyses and tools.

The primary outcome of the ongoing effort will be identification of sustainable sources to meet long-term demand for the entire Twin Cities Metropolitan Area. This will include the development of sub-regional or local plans that: identify water supply sources; establish management thresholds linked to resource monitoring networks; monitor and manage withdrawals; and identify options to address any emerging issues. In order to accomplish this, the Council intends to continue the established water supply planning process described below and illustrated in Figure 3.

- Improve the water supply availability technical analysis, including the metropolitan area groundwater model, with new data, methods and information. The updated analysis will include the evaluation of various land-use, climate and growth scenarios to identify potential local and regional water supply limitations as well as options to meet projected demands.
- Update water supply planning tools and guidance, including the water conservation toolbox, water supply development guidance and online water supply mapping. The tools are used by cities and regulators to identify actions to take and sources to develop to meet future demands without adverse impacts to natural resources.
- Collect data and information on: water levels, hydrogeologic properties, water chemistry, recharge rates, geology, water use, wells, water supply systems, water conservation, groundwater contamination and groundwater/surface water interactions. This information may be collected by the Council or others through regular programs or special studies, and will be used to improve the water supply availability analysis and planning tools.

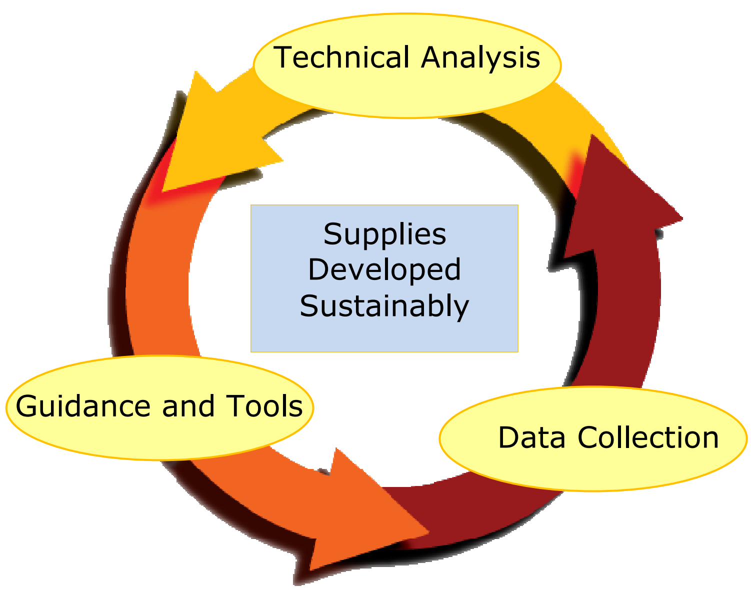


Figure 3. The ongoing and dynamic planning process.

Examples of specific efforts under way or on the horizon include:

- Developing a map of known groundwater contaminant plumes in the region.
- Convening a stakeholder group to develop a protection plan for the Seminary Fen and for a Valley Branch trout stream.
- Characterizing glacial aquifers in the region.
- Developing tools for communities to use to evaluate the feasibility of stormwater reuse.

These are examples of the types of information collection, analysis and tool development that will continue as part of the ongoing planning process.

Inclusion and transparency, informed by robust data collection and analysis, create the organizational basis that inspires better decision-making. In order to continue the collaborative process established in development of the plan, stakeholders will be engaged through a variety of collaborative venues. For example, the Council will continue to utilize technical work groups to gather input and provide review of the Council's technical analyses.

The Council's water supply planning effort balances regional growth against local resource vulnerability, recognizing that supplies appear to be regionally sufficient to meet foreseeable demands. However, supplies may be locally limited due to a number of factors that require active management. This dichotomy provides challenges for resource protection and opportunities for interjurisdictional cooperation. Cooperation could occur on many levels and include information sharing, shared monitoring points, coordinated source-water protection, co-development of supplies, and wholesale or retail purchase of supplies. Regardless, an iterative management process is necessary so that as new withdrawals are made, information is collected, impact predictions are improved and cost-effective supply development decisions are made. Integrating local data collection and resource management strategies with regional networks will allow managers at all levels to have the best possible sense of the long-term regional availability of water and to provide the framework for local withdrawal decisions.

Recommendations

Two specific recommendations were made by the Metropolitan Area Water Supply Advisory Committee/Metropolitan Council in the 2007 Report to the Legislature: 1) Consolidate and clarify the requirements for local water supply plans, and 2) Provide funding for capital projects that have a regional or state benefit, specifically to provide funding for the interconnection between the Minneapolis and St. Paul water supply systems. Other less formal recommendations in that report included conducting additional data collection, analysis and sharing, as well as improving coordination between agencies in the water supply permitting process.

The 2010 Master Water Supply Plan expands upon recommendations identified in the 2007 report, particularly those that support an adaptive management framework. The plan stresses ongoing data collection, analysis and update of tools for water supply decisions. As the regional planning process continues, these tools will support the development and implementation of long-term sustainable water system decisions. Lessons learned through this process are expected to result in future recommendations to ensure that water supplies are developed sustainably.

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