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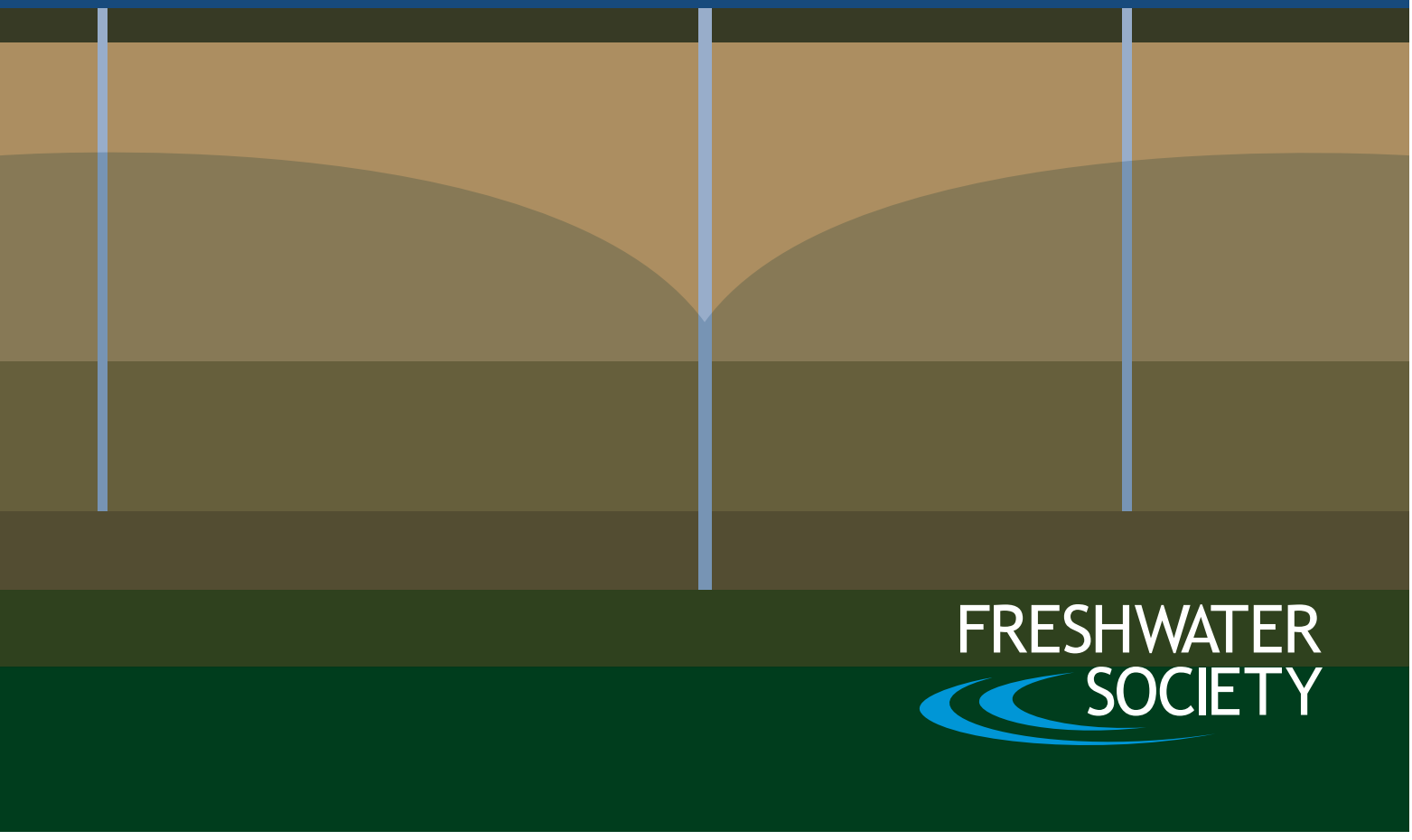
The Water Underground

Reframing the local groundwater picture



FRESHWATER SOCIETY

Contents

Foreword

Ask any city engineer to list the primary goals they have for their city's public water supply system and their overwhelming answer comes back as "safe and reliable." Pushed for a third goal they would likely add, "and under local control."

For the most part, Minnesota's water management system is among the best in the nation and wisely provides local governments (and their utilities) sufficient authorities to shape their water destiny—that is, until they demonstrate they cannot or will not manage water issues for the long haul.

A growing number of communities continue to over-pump drinking water from declining aquifers while dreaming of further population increases and economic expansion. The realities and the dreams don't match; available supplies won't support future demands unless the community actively manages the situation.

Effective management requires sufficient funding. Currently, we pay very little for drinking water services. If a water supplier were to charge for full system costs—pumping, treatment, storage, and distribution **plus** routine equipment replacement, meter upgrades, residential efficiency incentives, industry efficiency incentives, and systematic leak assessment programs—most of us would still be paying less than our cable bill. We can live without cable.

Public water suppliers choose what level of service to provide their customers and how much of that cost to include in their rate. Trying to compare rates with neighboring suppliers is tempting but ultimately not very useful unless it is known what costs they are including or deferring. A formal rate study that addresses full system costs and anticipates increased water efficiencies will minimize surprises from special assessments, system failure liabilities, or intervention from higher levels of government.

With the small, undramatic measures identified in this report, many water suppliers could stabilize their supplies so as to remain safe, reliable, and under local control for the long term.

Steve Woods

EXECUTIVE DIRECTOR

Executive Summary

Despite Minnesota's long-standing identity as a water-rich state, we can no longer assume that our groundwater supplies are adequate everywhere to meet future demands. Aquifer levels are declining in multiple spots, adversely impacting communities and impeding economic growth. Moreover, unlike water crises playing out in southern and western states, these local declines are not caused by severe drought, nor would one be necessary to draw down reserves further.

Minnesota has devised a system of shared groundwater management. Public water suppliers, given their critical influence over local groundwater supplies through planning, rate, and infrastructure management, can significantly change the long-term adequacy of local supplies to meet future needs. On the other hand, the Department of Natural Resources (DNR), given its charge to ensure that groundwater use is sustainable, may be compelled to take a more active role in limiting or managing usage based on projected or documented declines, and threats to natural resources.

Public suppliers have the most to lose if, or when, local groundwater resources decline significantly.

Public suppliers have the most to lose if, or when, local groundwater resources decline significantly. Local measures taken now can improve the effectiveness and authority of their management, and ensure the long-term availability of groundwater supplies.

In this report, we present recommendations to improve local groundwater management. Underlying our recommendations is the need to frame the urgency level required in local management, based on an assessment of the current state of local supplies.

We propose three possible urgency-level scenarios that illustrate the range of current realities in Minnesota communities and thereby frame local management recommendations:

The Steady Scenario
Communities where water reserves are in equilibrium and sufficient to keep up with current usage into the future. Urgency level for increased management is low. Priority should be placed on management for long-term sustainability goals.

The Declining Scenario
Communities where groundwater levels show long-term downward trends. Water supply is not an issue today, but without changes, future use will be limited. Urgency level for additional management is moderate.

The Deficient Scenario
Communities where there are immediate concerns about groundwater limitations. Immediate action is needed to prevent a crisis. Urgency level for considerably increased management is high.

Thankfully, most Minnesota communities are in the "steady scenario," and fewest are in the "deficient scenario." Regardless of scenario, the ranges of possible actions are similar. We use this framework to inform and forge a common understanding of the urgency level required from management.

Minnesota's overall abundant groundwater supply is an asset that supports local and state economies, communities, and ecosystems, but it must be valued, understood, and intentionally managed for sustainability if it is to support future generations.

Strengthening and establishing clear priorities for the local management of groundwater resources is critical if Minnesota is to take the path of long-term water availability. The recommendations for public water suppliers and state leaders are as follows:

For Public Water Suppliers

1. **Assess local groundwater trends (steady, declining, or deficient scenario) and the current state of the water system.** Conduct a water audit to categorize and track usage from season to season. Obtain existing information about aquifer levels and trends. Assess customer usage needs and the condition of the water infrastructure. Using this information, determine as realistically as possible the groundwater scenario that best fits the local system.

2. **Depending upon the identified urgency level, manage for immediate supply improvement or long-term supply maintenance**, selecting from the strategies recommended below.

   - ☐ **Reduce system losses.** Reducing water losses from within the distribution network helps a utility stretch its supply and recover lost revenue. We recommend funding a loss control program as an initial measure.
   - ☐ **Increase customer water use efficiency.** Increased efficiency represents the biggest opportunity for many communities to stretch existing groundwater supplies. Tailor water efficiency programs to the customer base and the challenges faced by the public water supplier. Options include improved metering systems, programs targeted to household, commercial, and industrial users, and using water rates to incentivize efficiency.
   - ☐ **Adjust water rates to recover full-system costs.** Recovering the full cost to deliver water to customers allows a city to provide a water supply that is reliable, safe, and adequate for generations. Rates should cover the cost of treatment and distribution, but also programs to reduce system losses, increase customer efficiency, provide for system replacement and maintenance, and provide an emergency reserve. Modest rate adjustments would likely have minimal impact on the majority of customers, but could raise revenue to finance system improvements and ensure long-term adequacy.
   - ☐ **Utilize and improve tiered customer rates to incentivize efficiency.** Tiered water rates incrementally increase the price per gallon as water use increases sending a signal to users to use water more efficiently.
   - ☐ **Expand groundwater management beyond the water utility.** The primary responsibility for managing groundwater in many communities may lie with the public water supplier, but suppliers do not operate in isolation. Partner with neighboring communities and other large users to cooperatively manage the shared groundwater resource and diversify supplies. They should also break down internal planning silos to integrate groundwater management with overall city development goals.

THIS REPORT – focusing on management recommendations to public water suppliers and state agency and elected leaders – is the first of three the Freshwater Society will release in 2016-17. Subsequent reports will address ways to extend supplies (reuse and aquifer recharge) and groundwater issues associated with crop production.

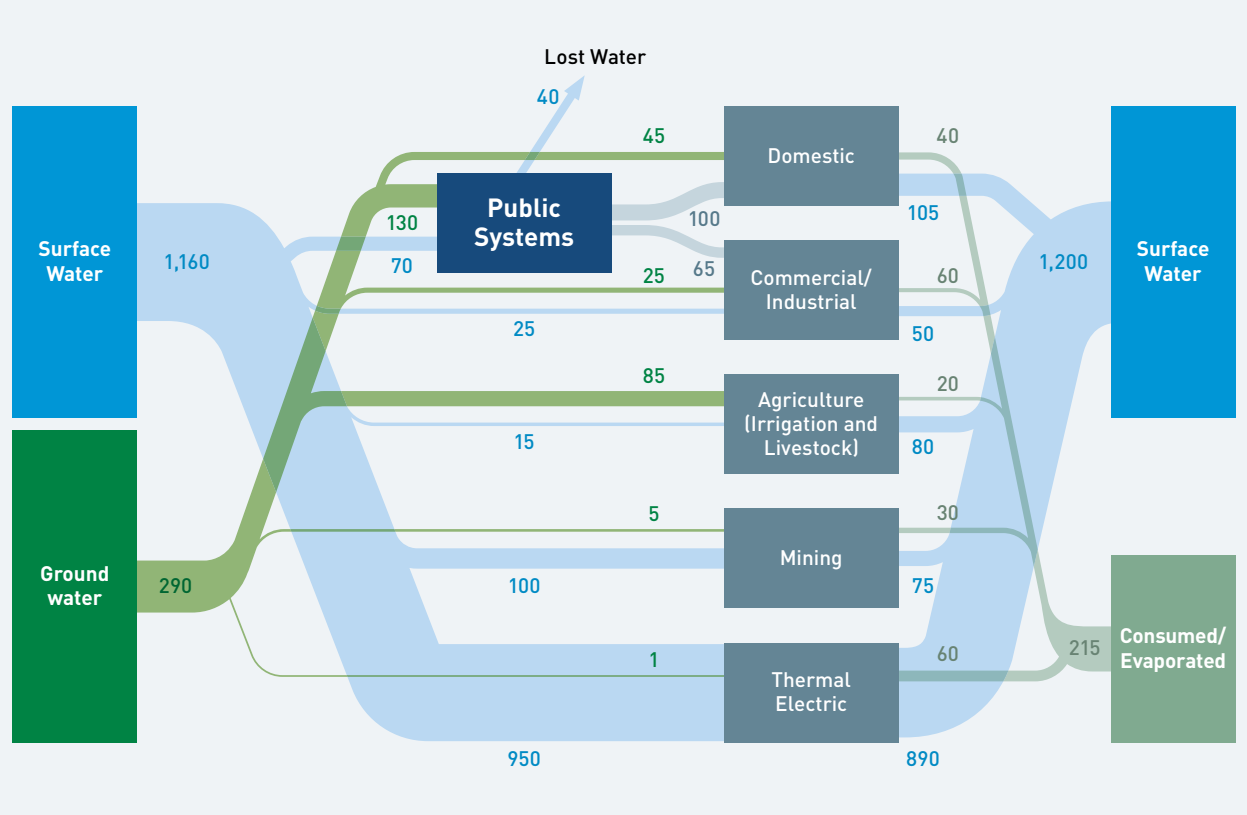


Diagram shows approximate proportions of water use in Minnesota. This report focuses on public systems that are the largest user of groundwater. A negligibly small portion of water used returns to groundwater. Values may not add up due to rounding errors. All values are billions of gallons. SOURCES: MN DNR, MDH, US EPA, AWWA

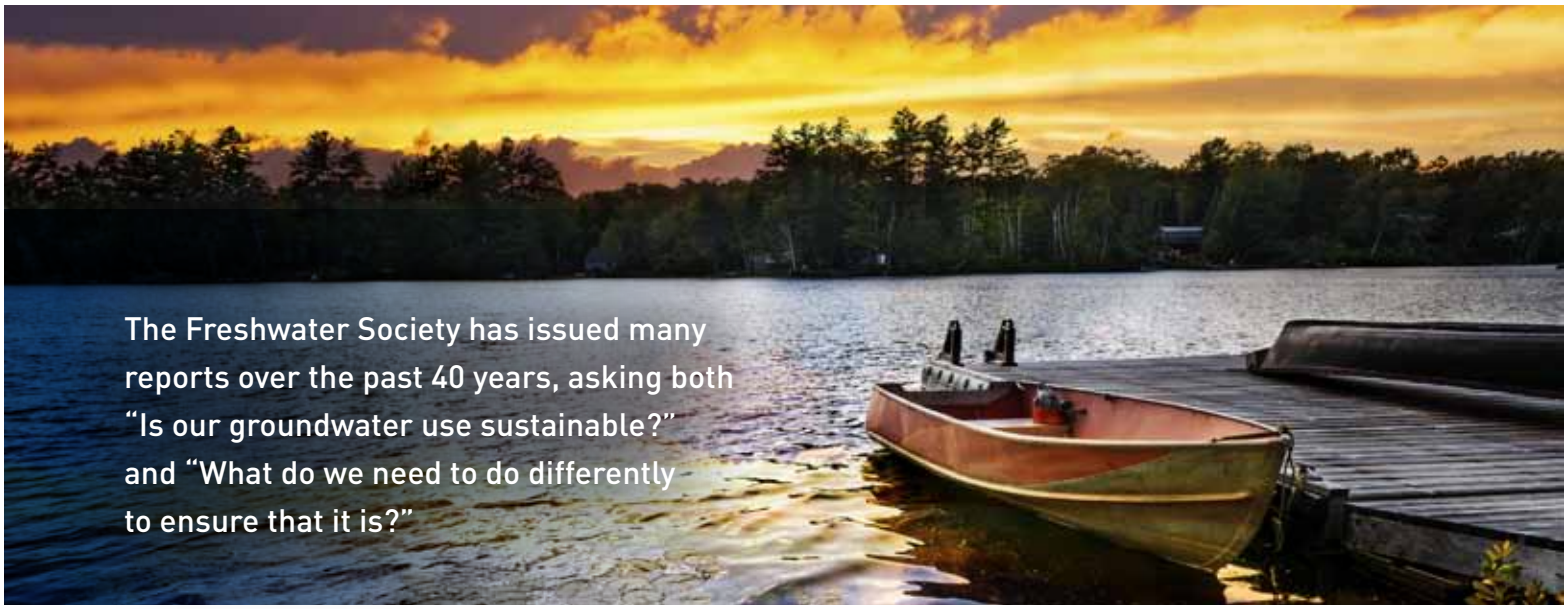
For State Leaders

1. **Continue filling gaps in monitoring, modeling, research, and communication necessary to support local groundwater management.** In many places, there is a need for improved assessment of water usage availability correlated with aquifer health and adverse local surface water impacts. This requires expanding the monitoring well network and increasing modeling to determine sustainable groundwater use. The DNR and Metropolitan Council must also communicate to communities the status of their groundwater supplies and relay the relative urgency necessary to protect the supplies.

2. **Fully fund executive branch groundwater management.** Insufficient funding and shifts between sources hamper DNR efforts. Adjust the application and annual water appropriation fees to place state groundwater management on a predictable funding base and lessen reliance on temporary funding sources.

3. **Limit appropriated groundwater.** Some communities may be unable or unwilling to manage groundwater to the extent needed to ensure sustainable groundwater use. The DNR should step in to limit water appropriations in those areas where users do not act to stop aquifer declines.

4. **Support local governments and water supply professionals in groundwater management.** Provide an inter-agency education series to train local non-water supply professional staff and officials on the tools they need for local groundwater management. These can include many of the topics mentioned in this report as well as others related to protection of groundwater quality.



Introduction

Minnesota's hydrogeologic landscape is complex and multilayered. Multiple glaciations resulted in a statewide mosaic of soils and rock layers holding aquifers of varied dimensions, at various depths, and with varied flow and recharge rates.

Many communities have enough groundwater supplies to support current usage needs as well as moderate future growth. Others have naturally limited supplies or face limitations due to past, and/or current, withdrawal rates higher than natural recharge rates.

The complexity of the physical hydrogeologic landscape has given rise to a management system similarly complicated. This report describes the multi-layered management system and recommends actions to strengthen local management and improve resource sustainability.

The Freshwater Society has issued many reports over the past 40 years, asking both "Is our groundwater use sustainable?" and "What do we need to do differently to ensure that it is?" Thankfully, we are not alone in grappling with these tough questions.

Minnesota state agencies are also tackling them, as are other states, some of which are already experiencing pronounced economic and political struggles stemming from depleted water supplies. Drought-stricken southern and western states are illuminating for us the essential value of water resources, and the compelling need to achieve sustainable usage before we face severe drought or a large-scale water crisis.

Some of these states have shown that curtailing water waste is an achievable, and simple, step toward sustainability. For example, the Atlanta-metro area reduced consumption by 10 percent, despite a 20 percent increase in population, through a combination of policy, planning, and educational efforts. In doing so, they avoided the need for additional, expensive reservoirs.

Minnesota has not had a crushing drought since 1987-1988, nor an extended drought since 1921-1942. Our fading memories combined with our image as a water-rich state has led to a false sense of security. Even without a severe drought, local officials in some parts of the state are seeing declines in groundwater reserves leading to adverse impacts on economic development or natural capital.

For example, limited water access has caused ethanol plants to alter or scrap expansion plans. Southwestern Minnesota communities are seeking to pipe Missouri River water from South

The management decisions and individual actions most profoundly impacting groundwater availability are intensely local.

Dakota to meet their basic consumption needs. Moreover, multiple high-profile stories illustrate how unsustainable groundwater use affects base flows in rivers, lakes, and wetlands.

Actively managing a shrinking, shared resource requires tradeoffs. It is tempting to avoid or defer confronting complex challenges, but, without better groundwater management, more communities in Minnesota will see water shortages regardless of drought.

The Department of Natural Resources (DNR) has a broad responsibility to manage groundwater and the power to regulate groundwater use. They have rarely limited usage but are signaling a willingness to do so in response to increasing evidence of supply limits.

Despite the DNR's charge, the management decisions and individual actions most profoundly impacting groundwater availability are intensely local. Communities have little control over the quantity of water naturally in the aquifer or the natural recharge rate. However, the history of local water usage and the policies influencing local usage, undoubtedly contribute to present levels and drawdown rates.

Most Minnesotans get their drinking water from a public water supplier. These public suppliers are typically the largest groundwater user in a community and are, therefore, in a unique position to influence usage rates, efficiency, and local policies.

The remainder of this report:

- Explores the parameters of sustainable groundwater use;
- Describes three scenarios (steady, declining, and deficient) that illuminate the current groundwater realities of Minnesota communities and frame management recommendations;
- Discusses the role of public water suppliers in sustainably managing groundwater;
- And provides recommendations for public suppliers and state leadership for improving the management and the sustainability of our state's groundwater resources.

We know we need to act to ensure a reliable groundwater supply – more urgently in some parts of Minnesota than others.

What is a sustainable water supply?

There are many ways to define "sustainable groundwater use," but the most relevant definition is the one enshrined in Minnesota law (at right). The Department of Natural Resources (DNR) is directed to manage groundwater in a way that ensures it supports current use, meets the needs of ecosystems, does not negatively alter water quality, and meets the requirements of future generations.

Ideally, groundwater supplies are sustained over the long term by maintaining withdrawal rates no greater than those of natural replenishment.

Groundwater supplies are affected by three main factors – geology, climate and weather, and land use – all of which vary dramatically around the state.

- **Geology** determines how deep the water is, whether the water is confined or moves between layers, if there is a connection to surface water, and the recharge rate.
- **Climate and weather** affect the availability of water for use on the surface as well as the amount that can percolate to recharge groundwater.
- **Land use** affects how water is used, whether it is a golf course, agricultural irrigator, industry, or homeowner. It also affects how much water infiltrates to recharge the aquifer versus forced to run off to surface water.

A long-term trend of declining groundwater levels is a lagging indicator of actions taken, or deferred, by communities drawing from the aquifer. Aquifers are slow to reflect usage patterns, but eventually, those trends are reflected in groundwater levels.

Unfortunately, the information needed to determine sustainable groundwater use levels is incomplete or missing in many areas of Minnesota. Communities often have to make decisions about groundwater use without fully knowing the current situation or the potential impacts of those decisions.

> "... the commissioner must consider the sustainability of the groundwater resource, including the current and projected water levels, water quality, whether the use protects ecosystems, and the ability of future generations to meet their own needs."
>
> – MS103G.287, SUBD. 3

Many locations still lack data on basic groundwater levels and trends over time. The DNR operates a statewide network of water-monitoring wells that measure static groundwater level. Monitoring is not done in all Minnesota communities because the prohibitive cost of expanding the well network. Some expansion has occurred in recent years, but newer wells will not show trends in groundwater levels for years to come – even when including historical aquifer levels from well logs.

Even spottier is the detailed modeling necessary to estimate how much groundwater can be withdrawn without adversely affecting surface waters or aquifer levels over the long term. This data is invaluable for local groundwater managers to determine an acceptable range of available water and to assess land use decisions and impacts.

Some communities have elected to fill in gaps in the monitoring well network at their expense. Few have the necessary expertise or resources to estimate how much groundwater is sustainably available. The DNR has a critical supportive role in local groundwater management – providing information that communities need. The Metropolitan Council shares this responsibility in the metropolitan region.

It is important to note, that a lack of information is not a reason to forego stepping up management of groundwater resources for long-term sustainability. All Minnesota communities have an interest in taking steps today that will put them on a solid footing should there be drought or new information indicating greater water limitations than previously understood.

In the following section, we describe three scenarios that illustrate the range of current groundwater realities in Minnesota communities. These scenarios serve to inform the urgency level required for groundwater management in any given locale. Each of these scenarios may be unique to a small area or a single community, or they can apply to a shared groundwater resources over a broad region.

Looking back on groundwater management

Managing an unseen resource has distinct challenges. Minnesota does better than most other states, but missteps have plagued past efforts to understand and manage groundwater. Among these are:

- **Over-reliance on statewide statistics.** Groundwater status and trends communicated as statewide statistics gloss over the localized nature of supply problems. Statewide numbers give a crude snapshot that does little to help manage local supplies or mobilize local action. Geology, climate and weather, and land use vary across the state, leading to highly localized groundwater situations. When problems occur, they are inevitably local, and solutions are highly dependent on local action.
- **Ineffective metrics.** A focus on easy-to-measure procedural parameters can lead to managing the system rather than managing the resource. For example, management often focuses on tracking the number of sealed wells on state property, the number of monitoring wells, and the number of plans written rather than whether aquifer levels are declining.
- **Lack of stable state funding.** In 2013, Freshwater Society[A] recommended an increase in water use and permit fees to support increased groundwater management activities (see Appendix A). The legislature did not act on the recommendation but instead provided a stopgap general fund increase. A patchwork of short-term funding sources and inadequate fee structures creates inefficiencies leaving communities and businesses unsure of how the DNR will manage resources in times of stress.
- **Lack of resources for staff on the front lines.** Public water supply managers, local government officials, and private sector users make the decisions having the most direct impact on groundwater use. Unfortunately, they often do not have the resources or training necessary for effective, sustainable groundwater management.

Hydrologic Areas of Concern

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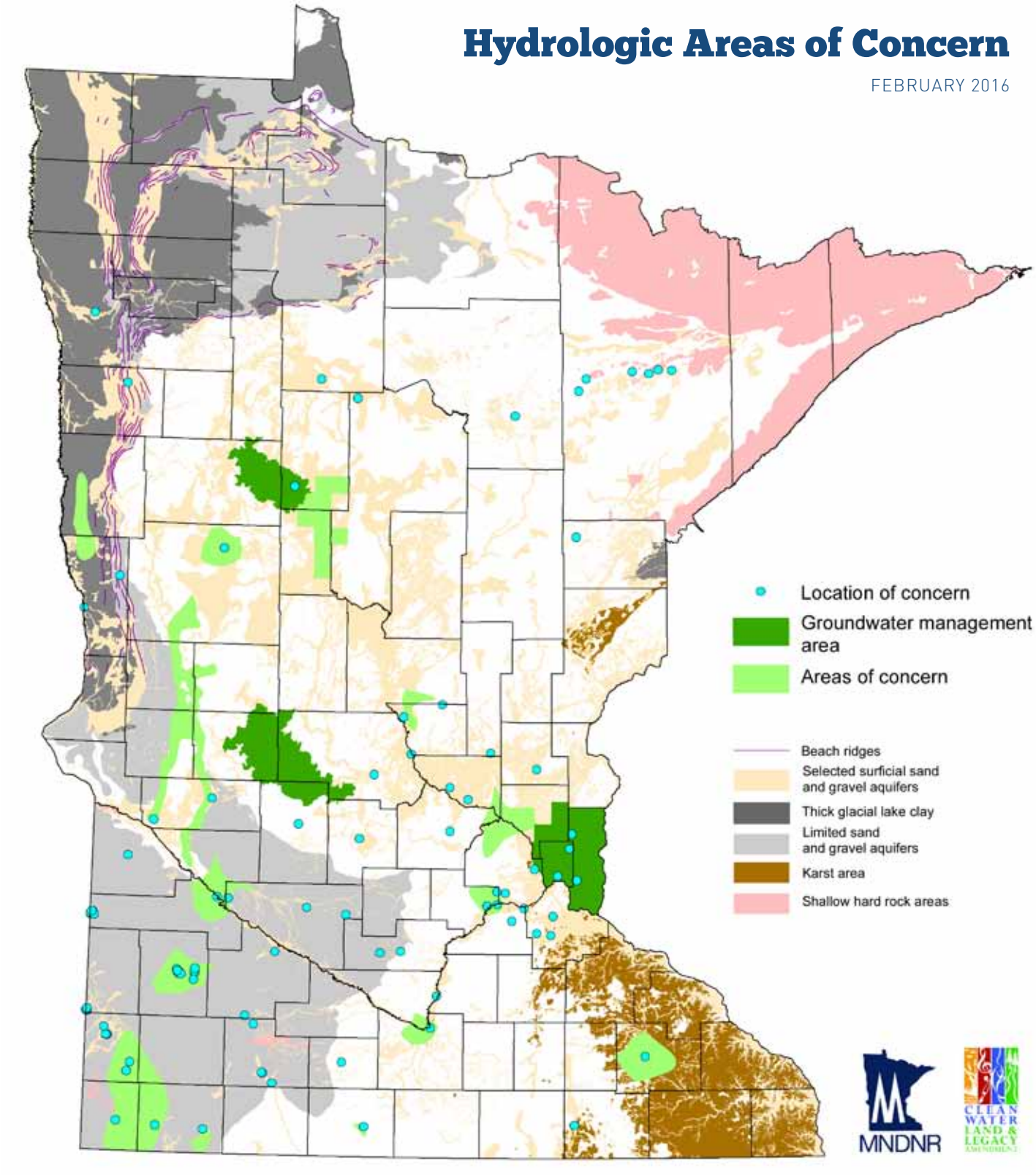


Three groundwater scenarios

The Steady Scenario

Communities or regions where groundwater reserves are in equilibrium and sufficient to keep up with the current usage levels. There are few incidences of well interference, and few surface water impacts related to groundwater declines. Not surprisingly, many communities that utilize surface water rather than groundwater for their public water supplies fall into this category. Other communities are in this scenario because they have sufficient groundwater supplies or have begun implementing water conservation programs.

Groundwater supplies are sustained over the long term by maintaining withdrawal rates no greater than those of natural replenishment.

The Declining Scenario

Communities and regions where groundwater levels show long-term downward trends. Water supply is not an issue today, but without changes, long-term use will be limited. Communities may fall into this scenario if their groundwater reserves are marginally sufficient now, but they expect substantial increases in use in the future.

The Deficient Scenario

Communities and regions where there are immediate concerns about excessive groundwater use. It may or may not be at a crisis point, but immediate action is needed. This occurs primarily in shallower aquifers but is not unheard of in deeper bedrock aquifers. Problems can include adverse effects on surface water resources and habitats, well interference with other pumpers, and exhaustion of the supply. As the groundwater supply becomes unreliable, quality of life and economic opportunities are stunted.

Unfortunately, many communities do not know which scenario best fits them due to lack of information or the appropriate resource experts have not been asked the right questions to ascertain the urgency of their situation. Communities should work with DNR and Metropolitan Council staff to determine the most applicable scenario based upon the best available information.

SCENARIO 1 Area has Steady Supply

SUMMARY

- Groundwater levels in equilibrium
- Surface waters and wells are not negatively impacted by groundwater use
- Limited economic development and population growth can be supported

RELATIVE URGENCY

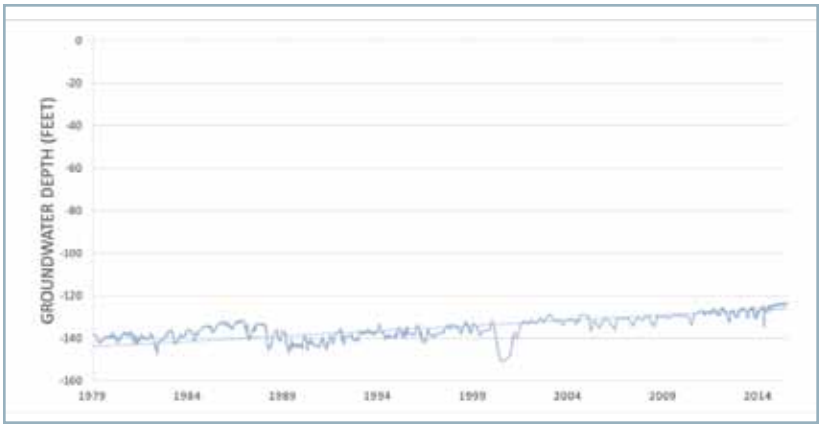
- Low
- Manage for long-term sustainability

CHALLENGES

- Meeting demands for future economic and population growth
- Lack of urgency means other issues outcompete for attention

EXAMPLE SUB-REGIONS IN THIS SCENARIO

AREA	WATER SOURCES
Central Twin Cities Metro	Surface water with limited groundwater backup
Northern Ramsey County/Southern Anoka County	Groundwater
Southern Dakota County	Groundwater
Northern Washington County	Groundwater
Eastern Scott County	Groundwater
St. Cloud Area	Surface Water



Groundwater levels near the City of Shoreview show a long-term increase as recharge is greater than use.

CASE STUDY **Encouraging Efficiency** SHOREVIEW, MN

The City of Shoreview, MN, is a northern suburb of St. Paul with a wealth of lakes and natural open spaces. The city grew rapidly in the 1970s and 1980s, and water use was high throughout that period with artificial lake level augmentation and new landscaping. However, since then, the population has stabilized, and groundwater levels have rebounded.

Shoreview customers use less than 70 gallons per person per day—one of the lowest in the metro area. City officials are still taking steps to increase efficiency. For example, they launched a voluntary water efficiency program in which participants receive free wireless meters that allow frequent reading.

The goal is to reduce water usage and promote conservation efforts through increased awareness of when and where water is used. Slow leaks like toilets and dripping faucets can be found with the new meters and fixed before hundreds of gallons of water are wasted.

The city also encourages more efficient water use by enforcing a seasonal odd/even sprinkling ban and educating customers about lawn and garden watering efficiency. They were also one of the first cities in Minnesota to implement a tiered water pricing system that incentivizes water efficiency by increasing the price for water as use increases.

SCENARIO 2 Areas with Declining Supply

SUMMARY

- Groundwater levels show long-term downward trend
- Wells and surface waters may show negative impacts
- Future economic development is likely limited unless active management can achieve a balance between groundwater withdrawals and replenishment

RELATIVE URGENCY

- Moderate
- Active management needed to reverse long-term decline

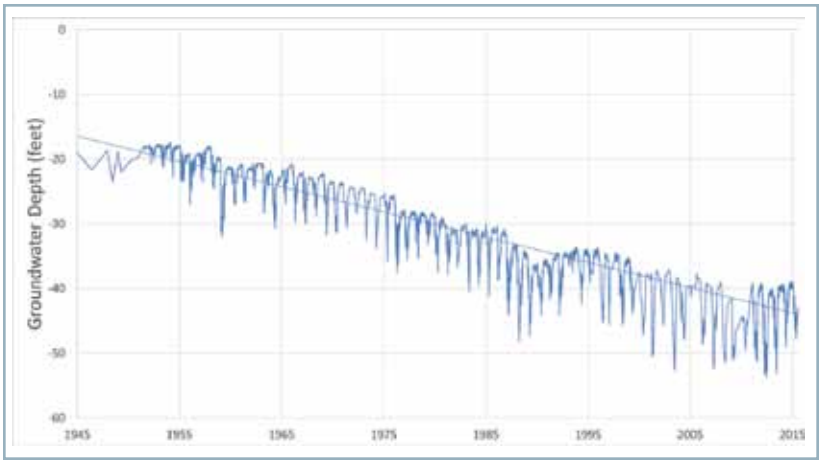
CHALLENGES

- Recognizing that the decline is a problem
- Incomplete data are available to guide decision-making
- Sub-regional coordination with other cities and large users

EXAMPLE SUB-REGIONS IN THIS SCENARIO

(See map, page 8)

AREA	WATER SOURCES
Lake Minnetonka area	Groundwater and surface water for some non-drinking water uses
Southern Washington County	Groundwater
North and East Metro	Groundwater
Suburban Dakota County	Groundwater



Groundwater levels near Lake Minnetonka communities show a six-decade decline. Long-term continual decline is not sustainable.

CASE STUDY **Rebates** VICTORIA AND WHITE BEAR LAKE, MINN

The cities of Victoria and White Bear Lake, Minn. are on opposite sides of the metropolitan area in different geologic settings. Both are known for their scenic lakes and concerns about the surface and groundwater connection.

The cities have taken steps to increase groundwater awareness and improve conservation practices. They offer rebates to residents for the purchase of ENERGY STAR®-rated water-efficient appliances, and for the purchase of EPA WaterSense-labeled products. The current rebates offered are as follows:

VICTORIA

- Up to $100 for ENERGY STAR®-rated washing machine or dishwasher

  Up to $50 for EPA WaterSense-rated toilet, shower head, or faucet

PHOTO: JEFFREY THOMPSON/MPR NEWS

WHITE BEAR LAKE

- Up to $150 for ENERGY STAR®-rated washing machine
- Up to $200 for EPA WaterSense-rated toilet

  Up to $200 for EPA WaterSense-rated irrigation controller

SCENARIO 3 Areas with Deficient Supply LOOMING CRISIS

SUMMARY

- Groundwater showing signs of immediate problems
- Surface waters and other wells are being adversely impacted
- Future economic growth and development are limited due to water constraints

RELATIVE URGENCY

- High
- Aggressive and extensive management needed

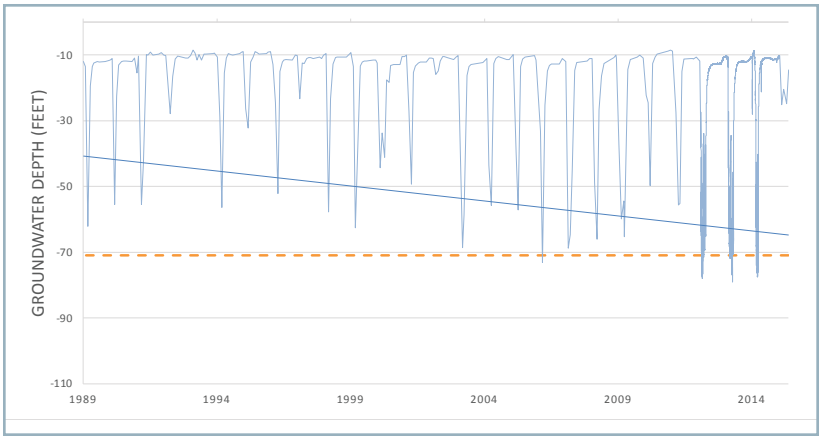
CHALLENGES

- Time for planning and coordination is limited, due to the urgency of problems and the need to act.
- Current water users competing for limited groundwater resources
- Public water suppliers affected by areas and users outside their jurisdiction
- Raising sufficient local revenue for extensive management needs
- Incomplete data are available to guide decision-making

EXAMPLE SUB-REGIONS IN THIS SCENARIO

(See map, page 8)

AREA	WATER SOURCES
Southwest Minnesota	Groundwater and Surface water
White Bear Lake area	Groundwater
Cold Spring, MN	Groundwater
Bonanza Valley	Groundwater
Straight River	Groundwater
Little Rock Creek	Groundwater



Monitoring wells in the Bonanza Valley Groundwater Management Area show increasingly large drops in groundwater levels during peak irrigation times. Water levels rebound each winter and spring, but the blue line shows how the drops are worsening as more irrigation wells are added. The dashed line represents what the DNR considers a "warning track." Crossing it indicates that action is needed soon to reduce use.

CASE STUDY **Wise Planning** TUCSON, AZ

In the 1960s, 100 percent of the water used in Tucson, Arizona came from groundwater—much of it used to grow green lawns in the desert. Faced with the unsustainability of the situation and the likelihood of running out of water, city leaders began to manage their water supply aggressively. Tucson now has a culture and water ethic that shines among southwestern cities.

Tucson diversified their sources in the 1970's to include surface water piped from the Colorado River. That was a wise choice, but overuse and the effects of climate change have since caused the Colorado River to become unreliable.

The City used a suite of programs to reduce water use and ensure long-term access to water:

- Reclaiming rainwater and greywater and reusing it for irrigation of home and commercial properties
- Recharging aquifers to rebuild reserves for future needs
- Aggressively restructuring rates to incentivize water efficiency
- Creating new social norms through public education campaigns
- Re-prioritizing economic development to move away from water-intensive uses

When Freshwater Society examined Tucson's early paradigm shift in 1985, Tucson's per capita water use had changed from 205 gallons per day in 1976 to 150 gpd in 1984. By 2012, it had fallen to 130 gpd. Despite a population increase of over 1,100 percent, ground-water use in 2012 was the same as it was in 1947.

PHOTO: AZ DEPARTMENT OF WATER RESOURCES

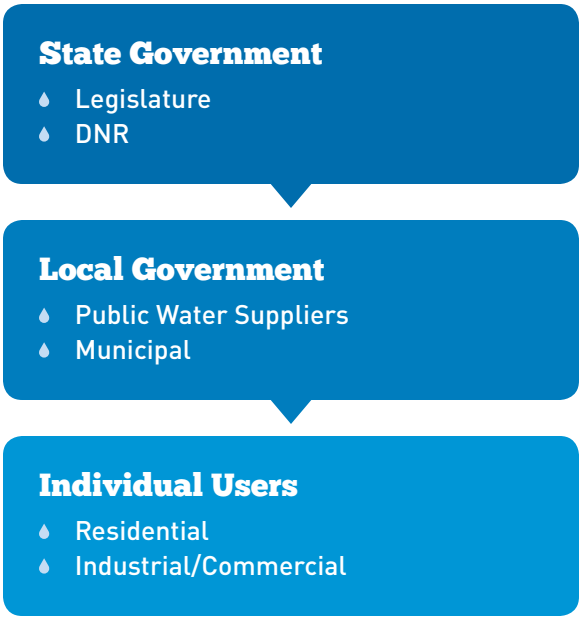
Tucson's per capita water use fell from 205 gallons per day in 1976 to 150 gpd in 1984. By 2012, it had fallen to 130 gpd.

Remarkable.

Tucson still has challenges as they navigate the drop in the Colorado River. They will need to continue identifying ways to reduce usage and stretch supply into the future. However, their metamorphosis offers significant and important lessons for communities with insufficient water supplies.

Snapshot of the System

Minnesota's groundwater management system is nearly as complex as its hydrogeology, including responsibilities at three distinct but interconnected levels: state government, local government, and individual users (see graphic at right). This report primarily focuses on improving groundwater management at the local government level.



There are three main levels to groundwater management in Minnesota. This report focuses most on local government.

The Role of State Government

The Minnesota Legislature has established an array of proactive groundwater management statutes that define what groundwater sustainability is and the role of state agencies (see a list of groundwater laws in Appendix B).

The DNR is the primary state agency responsible for sustainable water supply management through various programs including permitting, monitoring and analysis, enforcement, and technical assistance. The Minnesota Department of Health (MDH), the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Agriculture (MDA) and the Board of Water and Soil Resources (BWSR) have secondary authorities related to water use, source water protection, and public health.

The DNR requires a permit to pump large amounts of water from surface or groundwater.[1] Historically, with rare exceptions, the DNR granted pumpers the volumes they requested without taking into account what the resource holds or the cumulative impacts of multiple users. This is beginning to change.

The Legislature has traditionally appropriated money to support state groundwater management programs from the general fund and the Water Management Account.[2] More recently, the Clean Water Fund has provided for a modest expansion of the observation well network, enforcement of requirements to have permits, the establishment of Groundwater Management Areas, groundwater quality monitoring, and better data management systems.

[1] All wells, for any use, drilled in Minnesota require notification to the Minnesota Department of Health. Pumping more than 10,000 gallons per day or one million gallons per year requires a water appropriations permit from the Department of Natural Resources. There are several exemptions to water appropriation permit requirements: domestic uses serving less than 25 persons for general residential purposes, test pumping of a ground water source, reuse of water already authorized by a permit (e.g., water purchased from a municipal water system), or certain agricultural drainage systems (check with your area hydrologist for applicability).

[2] All water appropriation permit application fees, water use fees, and water management penalties go into the Water Management Account.

Permitted water users pay a fee for their application along with annual renewal based on the amount of water used. Both go into the Water Management Account to partially support water management work at the DNR.

The DNR also approves Water Supply Plans, which are required of all public water suppliers serving more than 1,000 people and all cities in the seven-county metropolitan area. Recent changes to the Water Supply Plan template require strategies that:

- Reduce unaccounted water loss to less than 10%,
- Reduce residential use to less than 75 gallons per capita per day,
- Achieve at least 1.5% per year reduction in institutional, industrial, commercial, and agricultural use,
- Reduce peak demand to less than 2.6 times the average demand, and
- Implement a water conservation rate structure

Within the three-tier system, the Metropolitan Council is a regional entity that assists in groundwater management in the seven-county metro area. The Metropolitan Council provides a framework for long-term water supply planning at the local and regional level, convenes subregional groups to address localized supply problems, conducts groundwater modeling and water supply feasibility assessments, and reviews local water plans.

The Role of Public Water Suppliers

How much groundwater is available to a community can depend on local hydrogeologic factors outside of its control. At the same time, public water suppliers have significant influence over aquifer levels through local planning, rate setting, infrastructure maintenance, and customer-relations decisions. Public water suppliers are typically the largest single groundwater user in the community and are, therefore, often in a position to influence local usage and efficiency rates.

Many also have trusted relationships with their customers through which they can facilitate voluntary efforts to improve water efficiency. Public water suppliers also have the most to lose if, or when, local groundwater supplies decline significantly. For all those reasons, we stress the importance of local public water supplier management for ensuring the long-term sufficiency of groundwater supplies.

Public water utilities have two important priorities for their systems: public health and reliability. They develop and maintain water supply infrastructure, monitor drinking water quality, and develop and enforce water-related ordinances.

Some public water suppliers do not consider long-term supply management a priority. This will need to change, especially for those communities facing declining or deficient water supplies. Not taking steps to address overuse of limited groundwater supplies is an invitation for state intervention. Local public suppliers have a great deal to lose if the state finds it necessary to intervene in their situation.

Public water suppliers can choose from a range of management strategies. Decisions about those strategies can occur at different points along the supply-distribution-usage chain. Which strategies a supplier or community wants to implement, and to what extent, depends upon the nature of the system and the customer base and, as we maintain here, the urgency level of the local groundwater situation.

The management strategies available to public water managers include:

Reduce demand. A well-designed water efficiency program, including public education, can significantly reduce customer water use with no decrease in service while saving them money. The utility can develop a water efficiency program that fits the customer base and addresses the challenges of the local system. One supplier may choose to prioritize reducing landscape irrigation while another may find more success helping customers replace old appliances and faucets. Commercial and industrial customers may find water reuse attractive, although policy barriers in Minnesota limit some aspects of that strategy.

Reduce waste in the system. Addressing waste in the system is attractive for water utility managers because it is something over which they have direct control. Finding and fixing leaks is a systematic effort that offers long-term savings and captures additional revenues, but can be difficult to fund if not built into base water rates.

Improve financial performance. A crosscutting issue is ensuring sufficient financial resources to support groundwater management programs. However, many communities do not take into account full-system costs,[3] thus, their public water systems are not self-sufficient. Water rates vary from community to community due to differences in water utilities and their water supply. Those that cover full water delivery costs in customer water rates provide sufficient resources for maintaining and upgrading systems as well as for water supply management activities. The rates also need to account for decreased use as efficiency increases. Various strategies for improving financial performance are detailed in the recommendations section that follows.

Collaborate with neighboring communities and large users. Managing a shared aquifer requires cooperation among large volume pumpers using the same groundwater. There are at least seven inter-community workgroups in the Twin Cities metropolitan area collaborating to better manage their shared aquifers for the long-term. (See Appendix C.)

Diversify and/or protect water supplies. Using water sources other than groundwater may be an option for some communities. Aquifer recharge and aquifer storage and recovery are possible strategies but currently face significant policy barriers in Minnesota. Also, it may be necessary to address contamination issues through treatment or prevention strategies. While this report focuses on groundwater quantity, groundwater quality could play a meaningful role in the availability of usable water.

[3] Public water suppliers have costs associated with energy, treatment, distribution, leak detection and condition assessment, regular maintenance, planning, debt-service, intergovernmental coordination, monitoring, reporting, life-cycle replacement or rehabilitation of equipment and pipes, and metering.

Recommendations

Strengthening and establishing clear priorities for the local management of groundwater resources is critical if we are to take the path of long-term water availability. The recommendations for public water suppliers and state leaders are as follows:

For Public Water Suppliers

1. **Assess local groundwater trends (steady, declining, or deficient scenario) and the current state of the water system.**

   Public water suppliers should first determine which groundwater scenario best describes their situation. The information available is likely incomplete, but rather than wait decades for better information to arrive, suppliers should use what information is available to determine the most likely scenario and act accordingly. Engineering consultants, DNR, U.S. Geologic Survey, Minnesota Geological Survey, and Metropolitan Council (within the seven-county metro) can assist in this effort. Suppliers should also assess their usage trends, their customer base, and the condition of their water infrastructure.

2. **Depending upon the urgency level identified, adopt management strategies for immediate supply improvement or long-term supply maintenance.**

   Select the strategies that best fit the local situation and urgency level. There are no one-size-fits-all recommendations. To suggest as much would misrepresent the solutions as much as the problems. Once groundwater trends and the state of the water system are assessed, a manager can assemble an array of management strategies suited to the local situation. Those in declining or deficient scenarios may need to choose multiple strategies and implement them quickly to turn around long-term overuse trends. Management strategies include the following:

   ☐ **Reduce system losses.** Reducing water losses from within the distribution system can help a water utility stretch its water supply and recover lost revenue. Water lost to leaks within the system is not only wasted, but also generates no revenue. Unmetered water is used but not billed. It has less of a direct effect on groundwater management, but can be an important factor in water utility financing as it is water used without recovering treatment and delivery costs. The new Water Supply Plan template sets a goal to reduce lost water[4] to below ten percent of total water processed. Some key related recommendations are (See Appendix D for water loss control resources):

   a. *Perform a water audit* – this can identify sections of a system where water is lost to either leaks or unmetered use. Understanding the magnitude of the problem and narrowing down sections of the system to investigate further is an essential starting point.

   b. *Detect and repair leaks* – Leaks can occur at any spot in the water distribution system. Significant advances have been made in leak detection to more easily, thoroughly, and accurately determine the location and scale of water loss. Similar advances have been made to allow for in-place refurbishment of system components saving time and expense.

[4] The DNR calls this "unaccounted for water." The term often used in industry is non-revenue water. This refers to the difference between the water produced by a utility and the water billed to customers. The difference can be due to leaks as well as unbilled water use. The American Water Works Association Water Loss Control Committee found that non-revenue water was 23 percent of water supplied by 32 U.S. cities surveyed.[B]

Recommendations CONTINUED

c. *Reduce unmetered water flows* — Potential causes of unmetered water flows include unmetered use (such as in city facilities and hydrant flushing), meter inaccuracies, and unauthorized use. Metering water to city facilities can increase accountability for water use helping to improve efficiency.

☐ **Increase customer water efficiency.** Increased customer water efficiency represents the biggest opportunity for many communities to stretch existing groundwater supplies. There is an array of proven industry references available for water efficiency programs (see Appendix D). Some steps a public water supplier could take are:

a. *Develop a water efficiency program tailored to the local customer base* — For example, suburban communities with large expanses of new housing developments will likely experience huge spikes in use during the late summer months. They should focus on increasing landscape irrigation efficiency. A neighboring community's largest users may be food processors requiring an entirely different approach.

b. *Incentivize efficiency with tiered water rates* — Tiered water rates increase the price paid per unit of water as water use increases. For example, a household might pay $7.50 per 1000 gallons for the first 5000 gallons they use in a month and then $9.00 per 1000 gallons for any use after 5000 gallons. See Appendix D for rate analysis and rate design tools available to help set rates that will recover system costs, provide economic incentives for efficiency, and remain affordable to low-income customers.

c. *Reduce peak use* — Peak use that is significantly higher than an average day is a challenge for public water suppliers. This is often due to irrigation use during the summers. High peak usage can put heavy stress on groundwater supplies and require the construction of system expansions that are underutilized most of the year. The new DNR Water Supply Plan template requires communities to set a goal to reduce peak use to below 2.6 times baseline.

d. *Improve the metering system* — Upgrading and modernizing a water utility's metering system can have multiple benefits for groundwater management. Frequent reading can detect customer-side leaks and allow for demand management programs similar to those already used by the electric utility industry. Utilities can also more effectively enforce watering restrictions.

☐ **Adjust water rates to recover full-system costs.** Full-system costs include treatment, storage, distribution, maintenance, meter replacement, leak assessment, intercommunity coordination, stakeholder involvement processes, modeling, efficiency incentive programs, source diversification, and potentially reuse and aquifer recharge. Water rates should be able to cover debt service on capital investment needed to replace aging system components and provide a reserve to cover emergency expenditures or reduced water use due to emergency drought responses. See Appendix D for tools to aid in setting water rates.

Water utility managers also need an asset management system to budget for system maintenance and eventual replacement.[5] See Appendix D for industry standard asset management methodologies.

[5] A recent survey by Wilder Research[D] found that many Minnesota cities do not have acceptable asset management practices. Responses indicate that only 8% of smaller cities and 21% of larger cities in Minnesota know the value of their water supply and distribution systems.

☐ **Utilize and improve tiered customer rates to incentivize efficiency.** Tiered water pricing incrementally increases the price per gallon as water use increases. A 2015 Metropolitan Council study[c] of 126 public water utilities in the Twin Cities metro region found that about half already have a tiered rate structure designed to encourage water conservation and household efficiency.

☐ **Expand groundwater management beyond the water utility.** The primary responsibility for managing groundwater may lie with the public water supplier, but they should not operate in isolation. Some other steps communities should take are:

a. *Coordinate with neighboring communities* — Aquifers rarely follow jurisdictional boundaries. Groundwater management is a shared responsibility between multiple communities and multiple large users. Public water suppliers will need to manage shared groundwater resources cooperatively with other stakeholders in their region. For example, there are seven Water Supply Work Groups organized in the Twin Cities metro area to determine sustainable levels of water use cooperatively. (See Appendix C)

b. *Integrate local land use, water supply, and watershed management planning* — Local governments have traditionally undertaken planning activities in relative isolation from each other. Breaking down these silos can ensure that community goals mesh with the reality of their available water supply. For example, a comprehensive land use plan may call for significantly increased population and economic development, yet, this would create conflict if the area already has declining groundwater levels. Either the growth goals will be incompatible with long-term groundwater availability, or more aggressive groundwater management is needed to not only reverse the downward groundwater trend but also account for future demand.

☐ **Diversify water supply options.** Communities may have other water supply options that will take pressure off groundwater resources and reduce the risk of water shortages. Alternatives include surface water and connecting to neighboring water systems.

☐ **Increase water available for use.** Communities can explore opportunities to increase available water. Water reuse, aquifer recharge, and aquifer storage and recovery have been used in other states but still face significant policy barriers in Minnesota. The reuse of stormwater for irrigation and reuse of industrial process water are options available today. Infiltration of stormwater in areas of high aquifer recharge can also be done, but must be appropriately sited to avoid contamination of groundwater. Aquifer storage and recovery – where treated water is stored underground when a system has extra capacity and then pumped out during times of peak use – may be a long-term option for communities who want to level out their system capacity. Municipal support for systematically addressing policy barriers is needed.

For State Government

Unlike the recommendations for public water suppliers and local governments, where managers can customize management strategies, all of the recommendations at the state level are necessary. However, due to limited resources, the DNR and Metropolitan Council should prioritize taking steps first in those areas in deficient scenarios.

3. **Continue to fill gaps in monitoring, modeling, research, and communication necessary to support local groundwater management.**

   A critical piece of information is an accounting of the water available for use that maintains the health of the aquifer and avoids adverse impacts on surface waters. The recent focus by the DNR and the Met Council on areas facing declining groundwater is a positive step. Critical steps needed to fill the information gaps are:

   a. *Continue expansion of the monitoring well network to track aquifer water levels better* — The DNR's current network includes approximately 900 wells, and they have stated their wish ultimately to have 7000. This magnitude of expansion will require them to build broad political and funding support for both implementation and maintenance.

   b. *Improve modeling to determine available groundwater* — Groundwater level data is used in sophisticated models to estimate groundwater movement, interactions with surface waters and the amount of groundwater recharge. Unfortunately, limited data and resources have restricted the use and calibration of modeling. The DNR and the Metropolitan Council should continue to improve the accuracy of current modeling and expand its use in declining- and deficient-scenario communities to aid in local groundwater management.

   c. *Communicate the status of groundwater supplies to communities* — Unfortunately, many communities do not know if their groundwater supplies are declining or already deficient. The DNR and Met Council should work closely with public water suppliers to determine the most likely condition of their groundwater resources. Even with uncertainty, communities can act to ensure a long-term sustainable water supply.

4. **Fully fund executive branch groundwater management.**

   Communities are counting on the state's ability to follow through with support for local groundwater management. Insufficient funding and shifts between sources hamper DNR efforts. We recommend using a mix of application and annual water appropriation fees to place state groundwater management on a predictable funding base. The Clean Water Fund and one-time general fund dollars have temporarily buoyed state efforts. However, inconsistent funding for ongoing needs leads to government inefficiency and increased risk to communities and businesses.

   We recommend raising revenue for groundwater management from existing DNR water appropriation fees instead of creating a new mechanism. The DNR should support fee increases during the Governor's budgeting process in the fall of 2016, and the Legislature should approve it during the 2017 legislative session.

   The Public Water Supply Service Connection Fee is collected annually from each connection to the public water system to support MDH groundwater programs. The fee, set by the state, has not kept pace with the growing cost of these programs and should be increased.

STATE	PERMIT APPLICATION FEES	FEES FOR 10 MGY[1,2]
Minnesota	$150	$140
Iowa[3]	$350	$99[4]
Wisconsin[5]	$0	$125[6]
Michigan	$2,000	$628[7]

Minnesota's permit application and water appropriation fees compared to other upper Midwestern states.

5. Limit appropriated groundwater.

Some communities may be unable or unwilling to manage groundwater to the extent needed to ensure sustainable groundwater use. The DNR should be prepared to step in to limit water appropriations in those areas that do not halt declining groundwater levels per statutory requirements.

6. Support local governments and water supply professionals in groundwater management.

We found a broad base of knowledge among local water supply professionals and extensive technical resources available from peers, professional associations, and state and regional agencies. Freshwater Society has also found that other local staff and officials often do not have the tools they need. The DNR, MDH, the Metropolitan Council, and other agencies should provide an interagency education series to train local (i.e. public water supplier, municipal, county, Soil and Water Conservation District, and Watershed District) staff and officials on the tools they need for local groundwater management. These can include many of the topics mentioned in this report as well as others related to protection of groundwater quality.

[1] 10 million gallons per year is enough to support a small community of more than 350 people consuming about 75 gallons per person per day.

[2] Fees are annual charges based upon water used.

[3] Water use permit required for any use of water in excess of 25,000 gallons per day (9.125 MGY). Permit renewal required every 10 years. If there is no increase in the water appropriated there is no additional fee.

[4] The annual water use permit fee varies from year to year based upon the program's budget. Individual fees are based on DNR needs and active permits that use over 25,000 gallons per day.

[5] A water use permit is required for any use of water in excess of 100,000 gallons per day (36.5 MGY); no fees are associated with the permit application.

[6] The maximum annual fee is $9,625 for any consumption over 1,820 MGY in Wisconsin.

[7] Michigan has a $2000 application fee with a $200 annual use fee. They also have a separate program regarding drinking water supply, which has a sliding scale and a larger annual fee. This is the value shown in the table.

APPENDIX A Revisiting Freshwater's 2013 report

Freshwater Society's 2013 report, *Minnesota's Groundwater: Is Our Use Sustainable?*,[A] recommended six state-level actions. Three recommendations are in place, two are underway, and one has made no progress. Here is the current status of those recommendations:

1 **Freshwater Society recommended an increase in water use and permit fees to support increased groundwater management activities. The legislature has not taken action to change fees.**

The current fee structure remains insufficient to expand efforts of the executive branch agencies to meet sustainability goals in Minnesota statutes.

2. **Freshwater Society recommended changes to the process of notifying state agencies before drilling new wells. The Minnesota Legislature made this change in 2013.**

When a new water well is planned, the owner notifies the Department of Natural Resources (DNR) and the Department of Health (MDH). The DNR evaluates the likelihood of impacts on groundwater, surface water, and other users and provides the well owner feedback. This gives the applicant an opportunity to take preemptive steps to reduce impacts. Once the well is drilled, the well owner is required to submit an appropriation permit application to the DNR.

3. **Freshwater Society recommended that the DNR limit the appropriated amount of water to levels necessary to ensure sustainable groundwater use. The agency is developing processes to make this possible.**

Appropriation permits are evaluated based on the reasonableness of the request for the expected use. It is not uncommon for amounts to change from the original application. The DNR can alter permit limits during initial issuance and at annual renewal.

4. **Freshwater Society recommended that the DNR be given authority to use APOs for enforcement of water use violations. The Minnesota Legislature made this change in 2014.**

The DNR can issue Administrative Penalty Orders (APO) to those violating state water use requirements. These include the need to have a permit, water withdrawals exceeding appropriated levels, water use reporting, and any other conditions placed on the permit.

5. **Freshwater Society recommended that the DNR create Groundwater Management Areas (GWMAs). Three pilot GWMAs have been established.**

GWMAs are geographic areas with declining and/or degrading groundwater resources requiring special attention. The DNR has the authority to establish GWMAs to develop an area-focused strategic plan for addressing groundwater sustainability issues. The DNR developed GWMA pilot programs in the North and East Metro, the Straight River area, and Bonanza Valley.

6. **Freshwater Society recommended that the DNR improve enforcement of permit conditions for groundwater use. DNR has ramped up efforts and is moving in the right direction.**

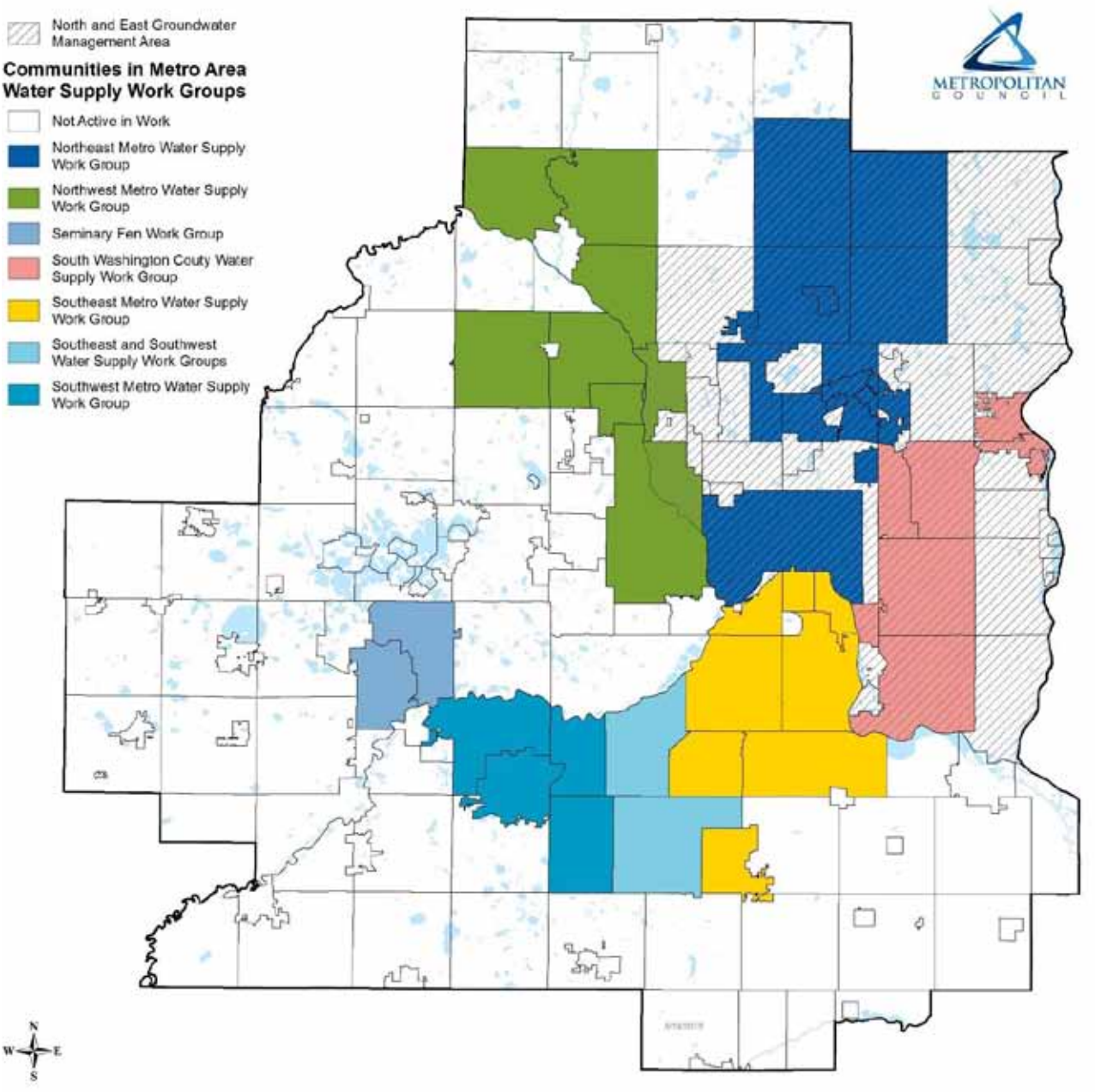
Freshwater Society found that an estimated twelve percent of well users required to have a permit did not have one and that the terms of permits were often not followed. The DNR efforts since 2013 have reduced non-permitted users to about two percent. The MNDNR Permitting and Reporting System (MPARS) makes it easier for permittees to report usage and manage their permit. Over 91 percent of permit holders used the system in 2014.

APPENDIX B A Partial list of Minnesota Statutes (MS) and Rules (MR) related to groundwater use

PARTIAL LIST OF MINNESOTA STATUTES (MS) AND RULES (MR) RELATED TO GROUNDWATER USE	
MS 103G.261	*Water Allocation Priorities* General priority of permitted groundwater uses during restrictions.
MS103G.265	*Water Supply Management* Management of state water resources to assure an adequate supply (quantity and quality) of water to meet long-term requirements all users.
MS 103G.271	*Appropriation and Use of Waters* Water appropriation permit from DNR required if use exceeds 10,000 gallons in any one day or 1,000,000 gallons in a year. No permits allowed for once-through cooling systems using groundwater.
MS103G.285	*Surface Water Appropriations* Water use limits for surface waters of the state and minimum protective water levels.
MS103G.287	*Groundwater Appropriations* Water use limits for groundwater so that the use must be sustainable and protect ecosystems, water quality, and the ability of future generations to meet their needs. Restrictions if groundwater use has adverse impacts on surface waters. Allows for establishing groundwater management areas.
MS 103G.291	*Public Water Supply Plans; Appropriation During Deficiency* Governor may declare a critical water deficiency requiring public water supply authorities to adopt and enforce water conservation restrictions. Every public water supplier over 1,000 customers must submit a water supply plan that includes efforts on conservation, demand reduction, infrastructure improvements, and allocation priorities.
MS 103H	*Groundwater Protection* Groundwater must be maintained in its natural condition, free from any degradation caused by human activities, if practical.
MR6115.0730	*Well Interference Problem Involving Appropriation* Procedure to apply when wells interfere with public water supply wells or private domestic wells.
MR6115.0770	*Water Conservation* Appropriators and users must use best available means and practices to promote the efficient use of waters.
MR 6115.0810	*Water Appropriation and Use Management Plans* DNR sets the process for preparation and implementation of water appropriation management plans.

APPENDIX C Groundwater cooperation in Twin Cities Metro Area

Communities are participating in sub-regional workgroups in the Twin Cities Metro Area.[E]



APPENDIX D Partial list of resources available

Water Efficiency

"M52 Water Conservation Programs – A Planning Manual," American Water Works Association

"M60 Drought Preparedness and Response," American Water Works Association

"AWE Resource Library: Water Conservation Programs," Alliance for Water Efficiency

"AWE Resource Library: Landscape, Irrigation, and Outdoor Water Use," Alliance for Water Efficiency

"Water Conservation Tracking Tool," Alliance for Water Efficiency

"Home Water Works water use calculator," Alliance for Water Efficiency

"Water Conservation Toolkit," Metropolitan Council

Water Loss Control

"AWE Resource Library: Water Loss Control," Alliance for Water Efficiency

"Water Loss Control – What Can Be Done?" Alliance for Water Efficiency

"Pipe Location and Leakage Management for Small Water Systems (Report #4144)," Water Research Foundation

"AWWA Free Water Audit Software© (Audit Software)," American Water Works Association

"Leakage Component Analysis Model," Water Research Foundation

Water Rates

"M1 Principles of Water Rates, Fees and Charges, 6th Edition," American Water Works Association

"M54 Developing Rates for Small Systems," American Water Works Association

"Water and Wastewater Rates Analysis Model," University of North Carolina Environmental Finance Center

"Water Utility Revenue Risk Assessment Tool," University of North Carolina Environmental Finance Center

"Water and Wastewater Residential Rates Affordability Assessment Tool," University of North Carolina Environmental Finance Center

"Building Better Water Rates for an Uncertain World," Alliance for Water Efficiency

Asset Management

"Government Accounting for Fixed Assets: GASBE guidelines for your organization," Sage Software, Inc.

Water Metering

"M6 Water Meters–Selection, Installation, Testing and Maintenance, Fifth Edition," American Water Works Association

"AWE Resource Library: Metering and Submetering," Alliance for Water Efficiency

"Advanced Metering Infrastructure: Best Practices For Water Utilities," Water Research Foundation

APPENDIX E **Bibliography**

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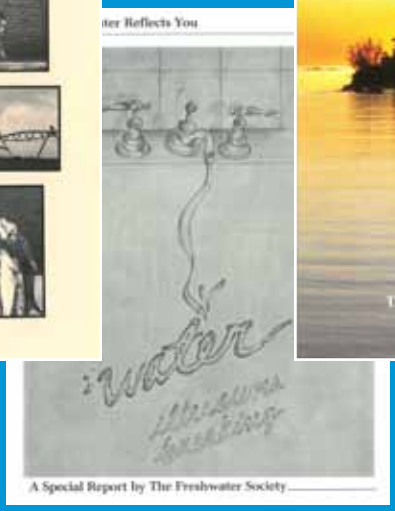
1979



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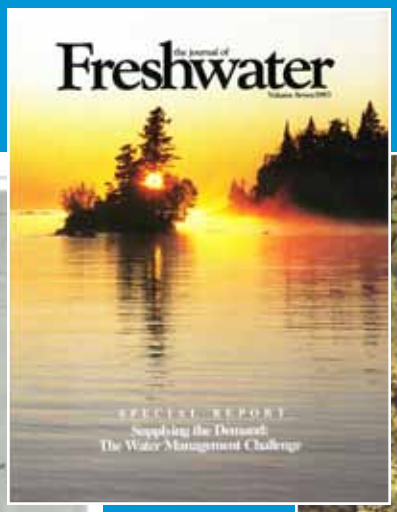
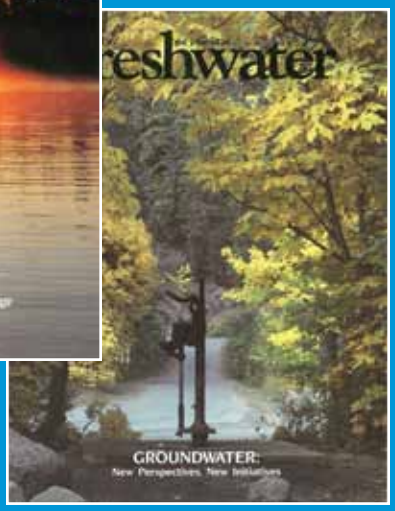
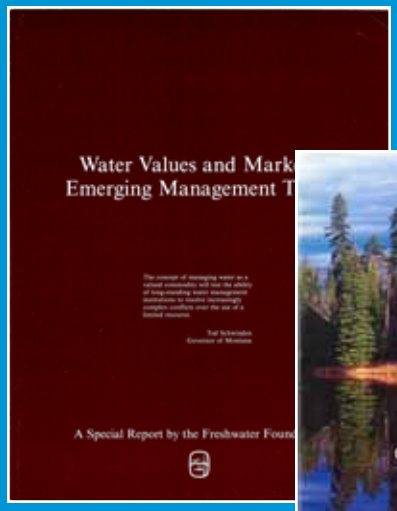


1983



1985



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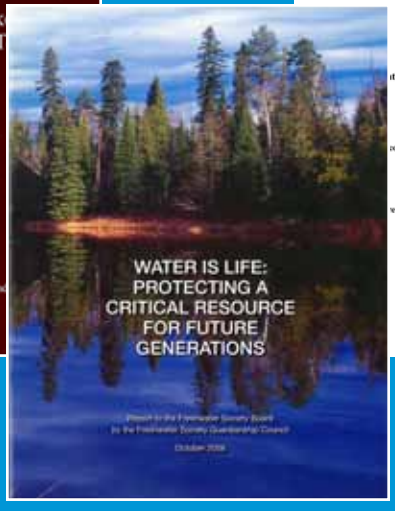

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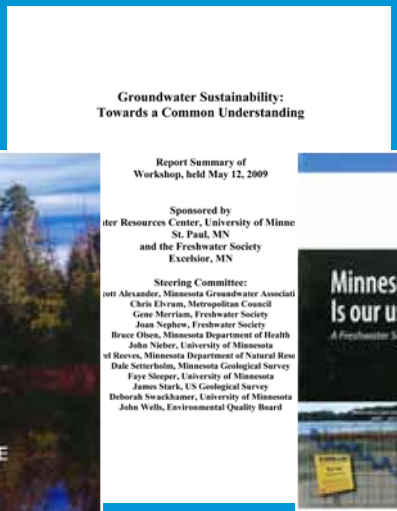

2009

2013

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FRESHWATER SOCIETY

2424 Territorial Road, Suite B
Saint Paul, Minnesota 55114
651-313-5800

freshwater.org