

Sustainability of Minnesota's Ground Water

A Statement of Issues and Needs

Prepared by the staff of the

Minnesota Department of Natural Resources

Division of Waters

for the

Minnesota Legislature

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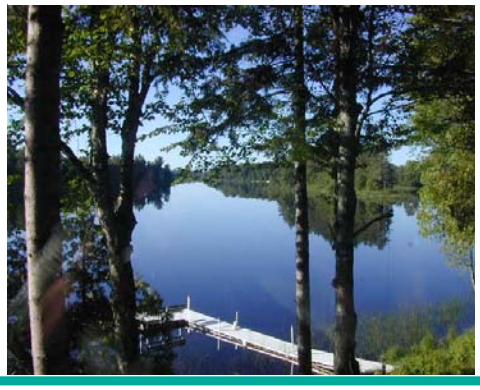

What is the charge?

A staff committee of the DNR Waters Division sought to answer this question: Is our ground-water use sustainable in Minnesota? The Minnesota Legislature presented that question to the Minnesota Department of Natural Resources (DNR) with this direction: "$50,000 the first year is for analysis of groundwater flows and aquifer recharge in the state in order to understand whether the appropriation of groundwater is sustainable" (Minnesota Laws 2003, Chapter 128, Section 5).

The staff committee, with more than 150 years of collective experience in technical and regulatory aspects of ground water, has conducted research, held discussions, and solicited ideas on the topic of sustainable ground-water use. No answer can be provided to this question on a statewide basis due to the lack of specific data about ground-water sources and the impacts of pumping from them. However, withdrawal from wells is adversely affecting surface-water resources or changing the landscape in unanticipated ways in some locations in Minnesota. Local impacts have been observed or documented to streams (Brooklyn Park, Park Rapids, Luverne) and wetlands (Savage Fen, Brooklyn Park, Eden Prairie, and others). In the southwestern and western parts of the state, there are several locations where withdrawals from wells are causing declines in ground-water levels that are continuing over time. If "sustainable water use" is considered to mean use that does not cause adverse impacts on these resources or render water unavailable for future use, then these uses are ***not*** sustainable.

FIGURE 1. A DNR hydrologist describes the characteristics of the aquifer from which this farmer pumps his water.

As the Twin Cities Metropolitan Area continues to expand beyond the limits of the Prairie du Chien–Jordan aquifer, the regional aquifer that supplies most of the ground water for the Twin Cities, considerable concern has arisen about water supply capability to support the expansion that is anticipated in the near future. Therefore, to monitor the impacts of this expansion toward the northwest, a new ground-water level monitoring well was installed in Otsego Township, Wright County, as part of this effort on sustainability to measure ground-water levels before and during this urban expansion. This new ground-water level monitoring well was installed using a portion of the directed funds and cost approximately $15,000. In addition, $10,000 of the legislative directive was added to other state agency funds for a cooperative project with the U.S. Geological Survey to map estimated ground-water recharge statewide. The remaining funds were used to prepare this report and related fact sheets about sustainable use of water.

What is sustainable ground-water use?

Staff members working on this project agreed early that a common and consistent definition was needed when using the word "sustainability" or "sustainable". The following definition reflects our current understanding of sustainable use of ground water: *Sustainable use of ground water is the use of water*

to provide for the needs of society, now and in the future, without unacceptable social, economic, or environmental consequences.

It is necessary to understand the water cycle (hydrologic cycle) to understand this definition, which can apply to water use from any source. Water moves continuously from the atmosphere to lakes and rivers to soil moisture and ground water. It returns to the atmosphere through evaporation to continue the cycle. When humans remove water from this cycle at any point, the rest of the cycle is affected. Ground-water withdrawals can lower water levels in lakes, rivers, and wetlands. These consequences have not usually been recognized and must become part of the decision-making process. Greater amounts withdrawn result in greater impacts, and those impacts accumulate over time. Changes may occur rapidly or take a very long time depending on the degree of connection between an aquifer and the land surface. Resource impacts may continue after water withdrawals have stopped.

Sustainable use of ground water is the use of water to provide for the needs of society, now and in the future, without unacceptable social, economic, or environmental consequences.

What is needed to manage the use of water toward sustainability?

To determine the sustainability of a particular ground-water use, it is necessary to consider both the technical aspects (a determination of the amount of water in circulation) and the desires of the community (the economic, social, and environmental impacts). The needs for this process include broader planning and trends analysis, more and new types of technical data collection and synthesis, more monitoring, broader conservation efforts, and authority and resources to manage aquifers and/or watersheds more restrictively where conditions require close scrutiny.

Using water in ways that minimize impacts on both ground water and surface water requires a comprehensive, long-term approach to water resources management that accounts for system interactions. In addition, our society must decide what limitations on water use and what impacts on lakes, wetlands, and rivers we are willing to tolerate in order for that use to proceed. Ultimately the question we were asked to answer in this report is not a technical one but a public policy one. To quote Mark Maimone (Ground Water, vol. 42, no. 6, Nov-Dec 2004, p. 812): "It is our responsibility as scientists and engineers to investigate as many of the impacts as possible, share the results with stakeholders, and help them make the management decisions that maximize benefits and minimize negative impacts." Therefore, while we must better define the options for ground-water users through technical work, public dialogue is needed as to tolerance for particular consequences.

Information is not currently adequate to provide a clear description of water-use options and impacts in many places in Minnesota. It will be necessary to map, update, and compile detailed information about aquifers, where they exist, and their geologic settings and relationships. Needed in addition are many more controlled aquifer tests to determine the water-bearing characteristics of these aquifers. In some areas of the state where aquifer mapping and characterization work has been completed, ground-water modeling could be used to assist stakeholders in identifying potential impacts under various management scenarios.

A planning process must be designed to obtain input from local citizens about their preferences and values. Discussions like those suggested here have been undertaken on a subregional basis in parts of the Twin Cities Metropolitan Area. There are many uncertainties involved in estimating likely impacts of a withdrawal of ground water, and the changes that will occur with time in both the natural and human systems are unknown. Therefore,, monitoring of the impacts must be undertaken during the period of water withdrawal and beyond. In essence, each new well or well field should be regarded as a controlled field experiment requiring flexible management, long-term monitoring of impacts and periodic review, and possible adjustment to the rate and amounts of withdrawal.

Some adjustment to the regulatory system in Minnesota might emphasize the value of water. The goals of Minnesota's current allocation program are to provide for human use while limiting impacts on the resource base. Work by the Pacific Institute (www.pacinst.org) suggests that humans could accomplish their goals with considerably less water withdrawal. Whether we call it "wise use" or "conservation", our future as a state with many water-oriented activities demands that we use water more efficiently at all levels: the household, business, community, and region.

FIGURE 2. DNR hydrologists may use seismic equipment to assist with geologic mapping of potential aquifers. The seismic data complements existing well data.

Water supply planning and management also must consider integrated use of both surface water and ground water, as well as the cumulative impacts of all existing users, in order to minimize impacts on other users and the resource. Distributing the withdrawal locations among sources (different water bodies or aquifers), and at some distance from each other, reduces impacts at any one location and reduces risk. As an example, the City of Moorhead, Minnesota, operates a consolidated regional water supply system. It has determined that conjunctive use of surface water and ground water will provide an adequate water supply for the Moorhead area for the foreseeable future. The city has concerns about possible sources of contamination being located on the Buffalo aquifer, an important ground-water resource supplying the city, and is working closely with the county and overlying landowners to limit these sources.

A possible plan for the Twin Cities Metropolitan Area in the future might include a similar conjunctive approach. A regional water utility might be established that would withdraw water from the Minnesota and Mississippi rivers, capture water discharged to waste from large quarries along the rivers, and integrate into the system existing city wells for distribution throughout the region. Using ground water and surface water in combination results in less severe local impacts and increased supply security.

What changes are needed?

Technical Needs:

- Complete geologic mapping of aquifers or potential aquifers at county scale using modern tools.
- Compile up-to-date regional and statewide aquifer maps.
- Accelerate physical and chemical testing of aquifers.
- Further analyze connections between aquifers and lakes, wetlands, streams, or springs.
- Expand the use of estimation techniques such as modeling to evaluate proposed development scenarios and describe the consequences of each.

Planning Needs:

- Emphasize that water has high value and is a scarce resource.
- Broaden conservation practices beyond major cities to statewide and to all regulated uses.
- Work with state agencies, utilities, communities, and industry to encourage use of water-efficient appliances.
- Continue subregional and regional water supply planning and expand participation to more stakeholders.
- Develop and implement a process for designating and managing areas where ground-water supplies are limited and water levels are declining.

Monitoring Needs:

- Restore measurement frequency and expand the ground-water level monitoring network to develop water-level data for aquifers in areas of increasing ground-water demand.
- Capture and analyze ground-water level data and pumpage from permittees.

- Construct new ground-water level monitoring wells in selected locations to enhance the capability to anticipate needed information and monitoring.
- Expand and coordinate precipitation, streamflow, ground-water quality, and lake level monitoring to fully examine the impacts of actual or potential ground-water withdrawals.
- Analyze and report information by aquifer, including an evaluation of the impacts of withdrawals.
- Recognize, monitor, and describe the impacts of surface activities on ground-water quality.

Regulatory Needs:

- Examine ground- and surface-water levels and flows for trends in conjunction with water use statistics.
- Determine whether adequate authority exists for the DNR Commissioner to designate water resources management areas within which withdrawals may be limited and allocated based on limited water availability.
- Adjust permitted pumping rates or withdrawal amounts within water resources management areas when needed to meet the goals determined in the water planning effort.
- Work with the regulated community to gain these mutual understandings:
  1) there is no absolute volume of water that they can be guaranteed,
  2) conditions will vary and water use adjustments may be required,
  3) flexibility in sources, design, and operation must be built into any water use installation to reduce risk.

Should sustainable water use be our goal?

The term *sustainable use of water* is based on an assessment of the consequences of withdrawals or diversions and the priorities of the populace. The underlying question is truly "What do you want to *sustain*?" If the answer is to maintain the wetlands, lakes, and streams at relatively high levels, less ground water can be used for other purposes. If society is willing to allow some lowering of these surface-water levels, more water can be withdrawn from ground-water sources. Finally, as climate change alters the amount of precipitation that typically falls in Minnesota, the whole cycle needs to be reevaluated and adjusted.

Minimizing the demand for additional water through conservation and efficient use can reduce peak rates of withdrawal, limit the need for additional wells, and reduce the potential local impacts of pumping. These considerations must be part of future broad-based water planning in Minnesota. As demand for water follows urban expansion beyond the limits of the main aquifers supplying the Twin Cities into areas with more limited ground-water resources, new cooperative efforts among neighboring communities will be essential to meet the needs of the growing population. Conjunctive use of surface water and ground water is a management approach with potential to supply those needs, as well as to limit adverse impacts. Distribution of withdrawals between the sources can reduce risk of water supply limitations.

Working toward sustainability requires us to monitor and analyze more; to address demands collectively; to use water efficiently; and above all to recognize water's value to our neighborhoods, communities, economy, environment, and continued existence on this planet.

There is an inherent tension between the water users' desire for certainty in their allocation of water and the limitations of estimating the future supply. The Minnesota regulatory system deals with this issue by stating that each permit is "permissive only" and is subject to change as hydrologic conditions change or are more precisely defined. This kind of flexibility or "adaptive management" is essential if our goal is water resource sustainability. We do not know where the next well will be located or when we will have drier or wetter years in the future. Human ingenuity will surely invent new ways to put demands on our water resources. That ingenuity can be applied to minimizing wastefulness and the adverse impacts of excessive pumping.

Working toward sustainability requires us to monitor and analyze more; to address demands collectively; to use water efficiently; and above all to recognize water's value to our neighborhoods, communities, economy, environment, and continued existence on this planet.

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