Minnesota's 1989 Ground Water Protection Act: Legacy and Future Directions

MINNESOTA GROUND WATER ASSOCIATION
WHITE PAPER 05

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Cover Photo

On June 2, 1989, the Ground Water Protection Act was signed into law. Many legislators, government officials, and advocates of the law attended the event on a Southeastern Minnesota farm, from left to right: Senator Steve Morse, Governor Rudy Perpich, Representative Willard Munger. Courtesy of John Wells.

Minnesota Ground Water Association. (2022, November). Minnesota's 1989 Ground Water Protection Act: Legacy and Future Directions.
https://www.mgwa.org/documents/whitepapers/minnesotas_1989_ground_water_protection_act.pdf

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List of Legislative Author Bios and Governor Bio

We recognize the authors of House File 534 and Senate File 262 and cite their legislative bios below. The Act became law when Governor Rudy Perpich signed it on June 2, 1989.

Legislative Authors

Representative Henry Kalis legislative bio

Representative Willard Munger legislative bio

Representative Len Price legislative bio

Representative Dave Bishop legislative bio

Representative Elton Redalen legislative bio

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Senator Steve Morse legislative bio

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Senator Charles Davis legislative bio

Senator John Bernhagen legislative bio

Governor

Governor Rudy Perpich - Minnesota Senator 1963 to 1970, Lieutenant Governor 1971 to 1976, and Governor 1976 to 1979, 1983 to 1991 legislative - gubernatorial bio

DEDICATION

For nearly four decades, all Minnesota environmental or natural resource legislation originated or was reviewed by John Helland, chief researcher and policy analyst for the Minnesota House of Representatives (1969-2007). John played a central role in researching, developing, and passing the 1989 Minnesota Ground Water Protection Act. His 2001 assessment of the Act became a model for this White Paper. His many contributions toward numerous environmental amendments and laws throughout his career became critical to the Act as well as other water protections in Minnesota.

Deborah Swackhamer, PhD, studied the processes affecting the behavior of toxic chemicals in the environment. As a researcher and professor at the University of Minnesota Water Resource Center, she also contributed to policies that address the risks posed by those chemicals. She viewed water supply and quality issues through a public health lens. Publication of her 2007 Sustainability Plan, and her leadership on the 2011 Sustainability Framework were critical contributions to Minnesota and this White Paper.

Both Deborah and John passed away in mid-2021. The MGWA White Paper authors dedicate this White Paper to them. We thank and recognize Deborah and John for their significant contributions to Minnesota law and policy.

Source:
Dennis Anderson, July 18, 2021, StarTribune, Conservation groups and legislators alike mourn John Helland, driver of environmental policy, p C14.

University of Minnesota, Institute of the Environment article: Remembering Deborah Swackhamer

University of Minnesota, Hubert H. Humphrey School of Public Affairs article: Remembering Deborah Swackhamer, Researcher and Environmental Advocate

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GLOSSARY OF TERMS

Aquifer - any water-bearing bed or stratum of earth or rock capable of yielding groundwater in sufficient quantities that can be extracted (as defined in Minnesota Rule 6115.0630)

Contaminants of Emerging Concern - Contaminants of emerging concern are substances that have been released to, found in, or have the potential to enter Minnesota waters and pose a real or perceived health threat, do not already have Minnesota human health-based guidance, or have new or changing health or exposure information that increases the level of concern.

County Well Index - a database that contains information on water wells constructed in Minnesota. The publicly-available version of County Well Index is called the Minnesota Well Index.

Drinking water - Section 115.01 MN Statutes defines potable water as "water which is or may be used as a source of supply for human consumption including drinking, culinary use, food processing, and other similar purposes, and which is suitable for such uses in its untreated state or when treated using generally recognized treatment methods."

Groundwater - water that collects or flows beneath the surface of the earth, filling the porous spaces below the water table in soil, sediment, and rocks

Health Based Value - established by the Minnesota Department of Health; the concentration of a chemical that is likely to pose little or no risk to human health; not promulgated

Health Risk Limit - established by the Minnesota Department of Health; the concentration of a chemical likely to pose little or no risk to human health; promulgated

Hydrogeochemistry - the chemistry of groundwater

Hydrogeology - the study of subsurface water, including its physical and chemical properties, geologic environment, role in geologic processes, natural movement, recovery, contamination, and use

Infiltration - the movement of water from the land surface into the subsurface under unsaturated conditions

Minnesota Well Index - the publicly-available version of the County Well Index database

Nitrate - a salt of nitric acid, commonly used as a plant nutrient

Recharge - process by which water enters the groundwater system

Riparian - relating to or situated on the banks of a river

Runoff - water from rain, snowmelt, or other sources that flows over the land surface

Surface water - water that is open to the atmosphere and subject to surface runoff

Sustainability - groundwater use that supplies the needs of future generations, and will not harm ecosystems, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells constructed according to the Minnesota Well Code (from MS 103G.287, Subd. 5)

Water table - the uppermost water surface of an unconfined aquifer at atmospheric pressure

ACRONYMS

ACRRA - Agricultural Chemical Response and Reimbursement Account

BMP - Best Management Practice

BWSR - Board of Soil and Water Resources

CEC - Contaminants of Emerging Concern

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

CWA - Clean Water Act

CWC - Clean Water Council

CWI - County Well Index

CWLLA - Clean Water Land & Legacy Amendment

CWLA - Clean Water Legacy Act

ENRTF - Environmental Natural Resources Trust Fund

EQB - Minnesota Environmental Quality Board

EQuIS - Environmental Quality Information System

ERCCF - Environmental Response, Cleanup and Compensation Fund

DNR - Minnesota Department of Natural Resources

GRAPS - Groundwater Restoration and Protection Strategy

GWMA - Groundwater Management Area

HBV – Health-Based Value

HRL - Health Risk Limit

ICT - Interagency Coordination Team

LCCMR - Legislative and Citizens Commission on Minnesota Resources

LSOHC - Lessard-Sams Outdoor Heritage Council

MDA - Minnesota Department of Agriculture

MDH - Minnesota Department of Health

MERLA - Minnesota Environmental Response and Liability Act

MGS - Minnesota Geological Survey

MGWA - Minnesota Ground Water Association

MNGEO - Minnesota Geospatial Information Office

MWI - Minnesota Well Index

MPCA - Minnesota Pollution Control Agency

PFAS - Perfluoroalkyl Substances, or Per- and Polyfluoroalkyl Substances

RCRA - Resource Conservation and Recovery Act

SDWA - Safe Drinking Water Act

USEPA - United States Environmental Protection Agency

USGS - United State Geological Survey

WRPR - Water Resource Protection Requirement

WRAPS - Water Restoration and Protection Strategy

WRC - University of Minnesota Water Resources Center

WSP - Water Safety Plan

EXECUTIVE SUMMARY

Passing with broad bipartisan support, the 1989 Ground Water Protection Act established a framework for protecting Minnesota's groundwater based on a comprehensive approach designed to prevent degradation of groundwater quantity and quality.

Much has changed in over thirty years since passage of this landmark environmental legislation. Groundwater demand has grown. Technology to detect and measure groundwater contaminants has improved, making clear that activities on the land surface affect groundwater quality. The effects of climate change on groundwater quantity and quality are becoming evident. Minnesota Statutes evolved since 1989 to place greater emphasis on groundwater stewardship by formalizing a definition of water sustainability. Funding mechanisms have changed such that funding shortages for important groundwater projects can be expected if the Clean Water Land & Legacy Amendment is not extended beyond the sunset date of 2034.

The existing and expected changes in water demand, technology and surveillance, climate, statute, and funding make groundwater protection in the 21st century more critical than ever. These factors trigger the need for this Minnesota Ground Water Association White Paper. Through the lens of groundwater sustainability, this White Paper advances a conversation about needed priority policy and management actions, beyond those outlined in the Ground Water Protection Act of 1989. The priority actions are summarized in three main categories:

Ensured Stable Funding: Funding for critical groundwater activities must itself be sustainable for groundwater sustainability to be achieved. The Clean Water, Land & Legacy Amendment sunsets in 2034, creating a potential funding gap for critical groundwater activities.

Groundwater Sustainability: Minnesota contains a large volume of groundwater, yet groundwater sustainability is not assured. Sustainable groundwater management should be based upon water budgets, where thresholds leading to unacceptable effects are understood, including those related to recharge, discharge, storage, aquatic habitats, and ecological conditions in streams. Minnesota Department of Natural Resources defined groundwater sustainability in statute; this definition could be made more useful through adoption of operational or practical definitions. Specific priority actions to promote groundwater sustainability include:

- Integrating groundwater sustainability assessments into water programs;
- Accounting for global climate change in groundwater sustainability assessments;
- Assuring public drinking water and groundwater sustainability;
- Assuring private drinking water supply and groundwater sustainability;
- Coordinating policy for land-use and groundwater sustainability;
- Providing data and information for groundwater sustainability;

- Addressing inter-basin groundwater exports and groundwater sustainability;
- Addressing contaminants of emerging concern and groundwater sustainability;
- Promoting technical innovation and groundwater sustainability.

Water Governance: Recurring proposals to change the structure of Minnesota's water governance may impede progress toward groundwater sustainability. Proactively meeting these concerns may prevent the creation of unnecessary obstacles to groundwater sustainability efforts.

The priority actions discussed above are opportunities to continue the work that originated from the Act, and address issues, ideas and approaches that have arisen in the meantime. Those invested in Minnesota's groundwater resource should continue to unify policy and management efforts around the central unifying theme of groundwater sustainability. Sustained funding for activities described in this White Paper, and a unified approach to water governance will both be critical to achieving and maintaining groundwater sustainability.

Thirty years after its passage, Minnesota groundwater professionals recognize the far-sighted impact that the Act has had on the management of Minnesota's groundwater. Yet the Act has not accomplished everything intended. It did not address all critical risks to groundwater quantity or quality, nor did it provide a complete strategy for protecting Minnesota's groundwater. Minnesotans must continue to capture the critical measures to support the achievement of sustainable groundwater use and protection. One great accomplishment of the Act is that much of the work necessary for this next step is already done.

1.0 White Paper Purpose and Scope

In May 1989, Minnesota Governor Rudy Perpich signed into law the Minnesota Ground Water Protection Act, Laws of Minnesota 1989 Chapter 326 (the "Act"). The Act established a framework for the protection of Minnesota's groundwater based upon a goal of preventing its degradation (Bruemmer, 1989). Further, the Act envisioned how Minnesota was to use good policy and management to complement existing laws, regulations and programs.

During the 1980s, broad public and legislative support arose alongside a growing collective sense of precarity regarding Minnesota's water supply. A "superstorm" struck, drought threatened, and widespread detection of nitrate in water table aquifers fueled urgency. New abilities for low-detection analytical methods confirmed the presence of pesticides and other synthetic pollutants. Insufficient regulation of pollution sources and water withdrawal by users threatened both the quality and the quantity of Minnesota groundwater. The authors of the Act responded to these challenges by outlining what was missing: an integrated, coherent effort to ensure Minnesota's future groundwater sustainability.

This Minnesota Ground Water Association (MGWA) White Paper examines the Act three decades after passage, with the aim of highlighting future directions that could result in improved protection of Minnesota groundwaters. This White Paper considers progress made during three decades under the requirements of the Act, discusses technical and policy issues that have emerged since passage of the Act, and identifies critical unmet needs awaiting future explorations by Minnesota's groundwater scientists and the MGWA. While most requirements of the Act have been addressed, emerging threats to groundwater protection exist that could not have been anticipated in 1989.

Appendix A of this White Paper contains summarized interviews with former legislators and water professionals who were involved in the passage and early implementation of the Act. Comments by active professionals about recent implementation are provided in Appendix A as well.

The process of preparing this White Paper followed an enhancement to the normal review effort required by MGWA. The White Paper writing subcommittee thanks all the reviewers for attention to detail and thoughtful contributions. Reviewers included: Jeff Stoner (expert initial review); the Interagency Ground Water/Drinking Water Team (executive branch review); and MGWA White Paper Committee and MGWA Board review. The final MGWA reviewers also provided their approval of this White Paper.

Anticipated readership for this MGWA White Paper includes members of the State executive and legislative branches, MGWA membership, environmental non-government organizations that work on water issues, and groundwater stakeholders across Minnesota.

This report adopts consistent nomenclature for the following terms:

- "Water"—with no modifiers, this term denotes all waters of the State. Modifiers may include "surface", "ground", "drinking", and "source".
- "Water agencies"—this term refers to the State agencies, boards and councils that host programs concerned primarily with water: Minnesota Department of Natural Resources (DNR); Minnesota Pollution Control Agency (MPCA); Minnesota Department of Health (MDH); Minnesota Department of Agriculture (MDA); Minnesota Board of Water and Soil Resources (BWSR); Metropolitan Council; and Environmental Quality Board (EQB).

2.0 Political and Environmental Conditions Leading to Passage of the Act

Section 2 outlines the political and environmental events leading to the passage of the Act.

2.1 Before 1960

- The original basis of Minnesota water law in the 1800s was the modified English common law doctrine of riparian rights and reasonable use (University of Minnesota Water Resources Center, WRC, 2011). Early Minnesota water law focused on the drainage of surface water for agriculture.
- By 1937, changes to the law recognized water as a valuable resource and required appropriation permits and reporting by large-volume water users (MPCA, 2013). Emerging regulations restricted pesticides, addressed land pollution, created local water management, encouraged comprehensive water resource planning, and funded partnerships between State and local governments.
- Amendments to water law in 1947 included the notion of "public waters" (MPCA, 2013).
- By the 1950s, the "Save the Wetlands" program used public funds to buy wetlands for wildlife management areas (MPCA, 2013). Watershed districts received tax levy authority (MPCA, 2013).

2.2 The Years 1960 to 1980

- Surface water regulations focused on wetland protection and restoration, soil and water conservation, and water quality standards (MPCA, 2013).
- The Minnesota Legislature created the MPCA in 1967.
- Passage of the Federal Clean Water Act (CWA, 1972), Safe Drinking Water Act (SDWA, 1972), Resource Conservation and Recovery Act (RCRA, 1976), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 1980) triggered the passage of parallel State laws (Water Pollution Control Act, 1973; Safe Drinking Water Act of 1977; 1980 Waste Management Act; and Minnesota Environmental Response and Liability Act, MERLA, 1983). The Minnesota Legislature passed the Environmental Rights Act and the Environmental Policy Act (personal communication, Elizabeth Lincoln, Legislative Reference Library, State of Minnesota).

- Minnesota Department of Conservation (forerunner of the DNR) and the United States Geological Survey (U.S. Geological Survey) stated that water scarcity threatened the Twin Cities Metropolitan Area (Norvitch, and others, 1973).

- Mid-1970s drought triggered changes to water appropriation law addressing water use priorities, surface water protections, and well interference (MPCA, 2013).

2.3 The Years 1981 to 1989

- MPCA housed the Federal and State Superfund cleanup programs. Investigations and remediation projects generated substantial news coverage.

- Scientists and regulators asked the question "what level of groundwater remediation is adequate?" (MPCA, 2013). Funded by the United States Environmental Protection Agency (USEPA), the discussion included state water agencies, and culminated in a groundwater strategy document (MPCA, 1988).

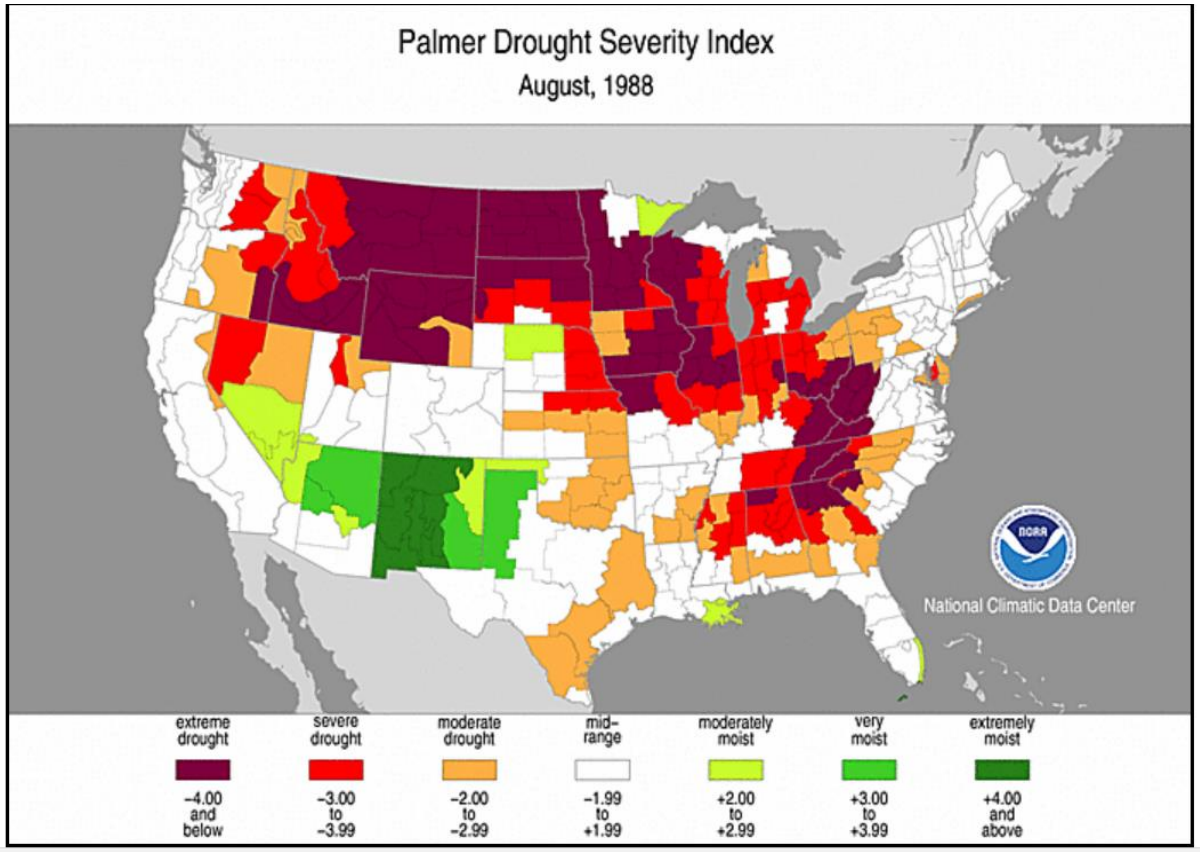
- Advances in laboratory analytical techniques supported low-level pollutant detection, revealing widespread and previously unrecognized groundwater quality threats (EQB, 1988).

- Chemicals in groundwater were traced to their use on agricultural lands (EQB, 1988), clarifying the connection between land use and groundwater quality.

- By enacting Minnesota Laws Chapter 18 (A, B, and C), the Minnesota Legislature moved to restrict pesticides, clean up land pollution, encourage local water management, enable comprehensive water planning, and fund state and local clean water partnerships (MPCA, 2013).

- In 1987, the Minnesota Legislature created BWSR.

- Extreme weather events raised public awareness about groundwater protection. A July 1987 superstorm dropped ten inches of rain at the Minneapolis-St. Paul airport, followed by the 1988 drought that threatened much of Minnesota (see August 1988 National Oceanic and Atmospheric Administration Drought map). Groundwater levels declined to record lows. News reports showing parched fields, dry creek beds, and low-yielding wells reminded the public of the drought's severity.



- The Minnesota Ground Water Protection Strategy (MPCA, 1988) and the Strategy for Wise Use of Pesticides and Nutrients (EQB, 1988) laid the groundwork for the language that became the Act.

2.4 Passage of the Act

A team of five senators (Morse, Davis, Bernhagen, Dahl and Merriam) and five representatives (Munger, Price, Bishop, Redalen and Kalis) drafted a bill to address groundwater contamination, overuse and protection. After more than forty hearings (Senate File 262 and House File 534), the conference committee worked through the final night of the legislative session to produce the bill.

With bipartisan support in both chambers, the Act was passed on May 22, 1989, and Governor Rudy Perpich signed it into law. The Act outlined the provisions described in Section 3 and Appendix B of this White Paper, and included more than $17 million of biennial funding for water protection at state and local levels of government.

3.0 Post-1989 Legacy of the Act

Section 3 summarizes how state water agencies fulfilled their requirements of the Act. Most requirements were met, but efforts lagged in some areas.

3.1 Major Advances of the Act

3.1.1 A declaration of Minnesota's groundwater ideals

The authors of the Act knew that addressing the need to sustain Minnesota's groundwater supply would rely upon a statement of Minnesota's ideals with respect to groundwater. Therefore, the Act articulated the ideals of degradation prevention, groundwater conservation, and planning.

Degradation Prevention

The degradation prevention language in the Act stated:

> **"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 encouraged."**

The default 1980s-era groundwater remedial strategy of pump and treat produced uneven success and high costs (Mackay and Cherry, 1989). Although new remedial technologies emerged, it became evident that preventing groundwater contamination is more practical than fixing problems after they occur.

Groundwater Conservation

In requiring water-use fees to increase with the quantity consumed, the Act formalized the ideal of groundwater conservation. The Act also required DNR to develop a consumptive water-use study (DNR, 1990). The use of "once-through" cooling systems was restricted. To avoid unacceptable drawdowns, the Act restricted extraction from new wells that produce from the Mt. Simon Aquifer within the Twin Cities Metropolitan area.

Planning

The Act defined several planning tools and coordinated them across the state. Coordinated planning (for example, the One-Watershed/One-Plan approach promoted by BWSR) is now the accepted method of groundwater management.

3.1.2 A call for groundwater protection

The Act added groundwater protection to the legal framework that until that time had emphasized surface water. It boosted local groundwater protection efforts with increased funding. The Act established education, research, monitoring, and incentives as areas of work or strategies to enhance groundwater protection where coordination between State agencies is important.

Preventing Groundwater Contamination

The Act established measures to protect groundwater against contamination by:

- Establishing sensitive areas;
- Prohibiting placement of contaminant sources near drinking water wells;
- Using conservation easements to protect areas sensitive to groundwater contamination;
- Establishing local water resource protection and management programs;
- Developing statewide nitrate and pesticide management plans;
- Incorporating and expanding well and boring construction standards including grouting, sealing and wellhead completion standards, prohibiting multi-aquifer wells, and prohibiting the interconnection of water sources;
- Implementing a mechanism for “common detection” contaminants—where monitoring shows a pollutant to occur in groundwater due to common practice—would trigger Best Management Practices (BMP) development. Determining that a voluntary BMP was ineffective in turn would trigger the development of mandatory Water Resource Protection Requirements (WRPRs);
- Promoting agricultural chemical site cleanup by reimbursing costs from the Agricultural Chemical Response and Reimbursement Account (ACRRA);
- Directing MDA to promote sustainable agriculture and integrated pest management, establish the disposal of waste pesticide containers, increase fees for pesticide registration, and establish standards for licensing pesticide applicators;

- Providing liability relief for those using agricultural chemicals in accordance with rules.

Preventing human exposure to groundwater contamination

To prevent human exposure to groundwater contaminants, the Act:

- Required revision of the Minnesota Well Code, and established fees to fund the program;
- Provided funds to meet SDWA requirements, and to support the MDH Source Water Protection program;
- Authorized the development of Health Risk Limits (HRLs).

3.1.3 A directive to conduct groundwater research

The Act supported scientific research, including a comprehensive study of nitrogen in Minnesota groundwater (MPCA and MDA, 1991). The Act defined groundwater "sensitive areas" for special protection and required DNR to identify them.

The Act ordered the storage and distribution of research and regulatory data, including the County Well Index (CWI; the publicly-available version is the Minnesota Well Index, MWI). The Act required MPCA and MDA to share data through what is now the Minnesota Geospatial Information Office (MNGEO). Today, the primary database of hydrogeochemical data is the Environmental Quality Information System (EQuIS), but additional statewide water quality databases exist at MDH. The exception is MDA, which does not maintain a separate water quality database other than the Laboratory Information Management System which exists to manage the analytical process and not to manage monitoring data. Today, the Act's requirement of a centralized data storage system for hydrogeochemical and other related data is generally met by web-based electronic data sharing capabilities.

3.2 Groundwater Protections Provided in the Act

Details of the Act are outlined in Appendix B. The ten articles of the Act were developed to improve groundwater protections in four general ways:

- Groundwater and human health protection (Articles 1, 2 and 3);
- Groundwater and water conservation (Articles 4 and 9);
- Improvements to management of pesticides, fertilizers, agricultural practice, and potential contaminant sources (Articles 5, 6, 7, and 8); and
- Funding (Article 10).

3.2.1 Groundwater and human health protection

Articles 1, 2 and 3 addressed groundwater and human health protection. Article 1 established the goal of degradation prevention for groundwater, and provided tools for its attainment. These tools included "sensitive areas" (areas vulnerable to threats to water quality and contamination) and their incorporation into rules and programs at MDA, MDH, MPCA and others. The Act required DNR to integrate the mapping of sensitive areas into geologic mapping, and it required MDH to incorporate sensitive areas into a scheme for source water protection.

The tools outlined in Article 1 also included a system of voluntary and mandatory controls to address non-point source groundwater contamination. The voluntary tools were BMPs. If BMPs failed, WRPRs were to become mandatory. Article 1 directed responsibility and program funding within MPCA to develop BMPs to address the effects of changing land use on groundwater quality. Article 1 directed responsibility to MDA for the development of BMPs for nitrogen fertilizer and pesticides.

Article 2 promoted activities to generate and provide accurate information and public education about groundwater with the goal of supporting wise groundwater management and policy.

Article 3 formally adopted the requirements of the Minnesota Water Well Construction Code (now the Minnesota Well Code). Article 3 also applied restrictions to drilling projects associated with mineral exploration, and to the underground storage of gas or liquids.

The progress of each water agency with respect to groundwater and human health protection (Articles 1, 2, and 3 of the Act) is as follows:

- Article 1: DNR adopted all requirements. Sensitive area mapping began, and today these maps are included as "Part B" of the County Geologic Atlas mapping program. As of 2022, DNR completed or initiated sensitive area mapping for 50 counties.

- Article 2: DNR was assigned no responsibilities under Article 2.

- Article 3: DNR adopted all requirements, including the administration of a program to seal unused wells on State land.

- Article 1: MDA adopted all requirements. MDA contributed to the joint study on nitrogen in groundwater (MPCA and MDA, 1991). MDA developed BMPs for pesticides (e.g., atrazine) and chemical fertilizers, and enacted pesticide rules. Elements of the MDA Ground Water

Rule include sensitive areas, and a WRPR for fertilizer use, the first promulgated in Minnesota.

- Article 2: MDA fulfilled the sustainable agriculture and environmental agriculturist education program requirements.

- Article 3: MDA was assigned no responsibilities under Article 3.

- Article 1: MDH initiated and continues to develop and update health-based guidance (Health Based Values, HBVs, and HRLs), using the best available science for contaminants found in groundwater. MDH incorporated sensitive areas into the Source Water Protection program.

- Article 2: MDH initiated participation in comprehensive water planning where source water protection was involved.

- Article 3: MDH initiated and continues to administer the Minnesota Well Code through the Well Management program.

- Article 1: MPCA contributed to the joint study on nitrogen in groundwater (MPCA and MDA, 1991). MPCA nominates compounds for HBV/HRL development. MPCA developed BMPs for groundwater protection (MPCA, 2019). MPCA (2019) pointed to a lack of BMP effectiveness data and analysis, suggesting the presence of an obstacle that prevents WRPR implementation.

- Article 2: MPCA was assigned no responsibilities under Article 2.

- Article 3: MPCA was assigned no responsibilities under Article 3.

- Article 1: BWSR contributed to the joint study of nitrogen in groundwater (MPCA and MDA, 1991).

- Article 2: As part of the environmental agriculturalist program, BWSR funded projects targeted to improve farm performance in the protection of source water protection areas and other designated sensitive areas.

- Article 3: BWSR provided cost-share funds for sealing high-priority abandoned wells.

3.2.2 Groundwater and water conservation

Articles 4 and 9 of the Act addressed groundwater and water conservation. Article 4 established measures to encourage groundwater conservation. Article 9 initiated water planning across the seven-county Twin Cities Metropolitan area. State water agencies participate in this planning through the Metropolitan Area Water Supply Advisory Committee led by the Metropolitan Council.

The progress of each water agency with respect to groundwater and water conservation (Articles 4 and 9 of the Act) is as follows:

- Article 4: DNR adopted all requirements.
- Article 9: DNR was assigned no responsibilities under Article 9.

- MDA was assigned no responsibilities under Article 4 or Article 9.

- MDH was assigned no responsibilities under Article 4 or Article 9.

- MPCA was assigned no responsibilities under Article 4 or Article 9.

- BWSR was assigned no responsibilities under Article 4 or Article 9.

3.2.3 Improvements to management of pesticides, fertilizers and agriculture

Articles 5, 6, 7, and 8 of the Act addressed improvements to management of pesticides, fertilizers and soil amendments. Article 5 repealed pesticide law and provided registration, licensing, inspection, and application requirements. Pesticide releases associated with storage and handling were prohibited and accidental releases became reportable. Article 5 required MDA to establish a program to recycle waste pesticides and empty containers, and to provide reports of annual sales and application volume.

Article 6 repealed earlier law and addressed other non-pesticide agricultural chemicals and practices. Fertilizer labeling and testing requirements were adopted, including laboratory certification. Article 6 imposed new requirements on application, handling, and storage of fertilizers, including licensing and inspection requirements, and a fee structure. Article 6 required the development of fertilizer BMPs and WRPRs.

Article 7 extended MERLA cleanup requirements to agricultural chemical sites.

Article 8 adopted requirements for remediation activities associated with agricultural chemical sites, and provided MDA access to the Environmental Response, Cleanup, and Compensation Fund (ERCCF) to reimburse for remediation costs.

The progress of each agency with respect to improvements to management of pesticides, fertilizers, and agriculture (Articles 5, 6, 7, and 8 of the Act) is as follows:

- DNR was assigned no responsibilities under Articles 5, 6, 7 or 8.

- Article 5: MDA adopted all requirements.
- Article 6: MDA initiated and continues to administer the fertilizer program, using BMPs to discourage wasteful fertilizer practices. MDA rules established WRPR requirements for the handling of fertilizer.
- Article 7: MDA adopted all requirements.
- Article 8: MDA created ACRRA to act with the Department of Commerce in carrying out reimbursement for responses to pesticide releases.

- MDH was assigned no responsibilities under Articles 5, 6, 7 or 8.

- MPCA was assigned no responsibilities under Articles 5, 6 or 8. Under Article 7, MPCA coordinates with MDA on other responsibilities (MERLA).

- BWSR was assigned no responsibilities under Articles 5, 6, 7 or 8.

3.2.4 Funding

Article 10 of the Act addressed funding. Article 10 assigned $17 million from the General Fund for Act requirements in Budget Years 1990 and 1991.

The progress of each water agency with respect to funding (Article 10 of the Act) is as follows:

- All State water agencies received funding as directed by Article 10.

3.3 The Act's Legacy and Groundwater Issues Emerged Since 1989

3.3.1 The years 1990 to 1999

The Environmental and Natural Resources Trust Fund (ENRTF), approved by voters in 1988, became a source of funds for environmental projects and research. The legislature passed laws related to water quality and quantity, including the Wetland Conservation Act (Brand, and others, 1990; Helland, 2001). The USGS (Alley and others, 1999) outlined inputs required to manage groundwater sustainability: the geologic framework; hydrologic budgets and stress; and the chemical framework. The County Geologic Atlas program followed the USGS model for technical analysis.

Picture: *Renew America recognizes the Minnesota Pilot for Local Water Planning for the Searching for Success National Environmental Achievement Awards - Groundwater Protection. This Pilot program comprised 52 participating counties and their state partners in water planning. John Wells (pictured with President George H.W. Bush), EQB lead project manager, and Marilyn Lundberg, key EQB staff member, accepted the award in April 1990. Minnesota Ground Water Protection Act of 1989, Article 2 requirements envisions multi-level water planning in the state. Photo provided by John Wells.*

3.3.2 The years 2000 to 2010

The County Geologic Atlas program increased staff to map subsurface geologic and hydrogeologic conditions. Swackhamer and others (2007) reported the critical need for the mapping of geology and groundwater resources.

The DNR created a definition of groundwater sustainability for adoption into statute (https://www.revisor.mn.gov/statutes/) :

> **(103G.287, Subd. 5) "Sustainability Standard. The commissioner (Commissioner of the Department of Natural Resources) may issue water-use permits for appropriation from groundwater only if the commissioner determines that the groundwater use is**

sustainable to supply the needs of future generations and the proposed use will not harm ecosystems, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells constructed according to Minnesota Rules, chapter 4725."

The ENRTF supported the development of the Statewide Conservation and Preservation Plan (Swackhamer and others, 2007). The 2006 passage of the Clean Water Legacy Act (CWLA) provided $25 million for environmental work, an interim amount intended to bridge the time gap until stable funding could be enacted. However, few of these dollars were directed to projects related to groundwater.

In 2008, Minnesota voters passed the Clean Water, Land & Legacy Amendment (CWLLA). Through a portion of the state sales tax, the CWLLA provided twenty-five years of stable funding for monitoring, planning, restoration and protection of surface water and groundwater. Significant funding from the amendment has aided implementation of the Act, including (the list is not exhaustive): programs to address contaminants of emerging concern, CECs (MDH), and fertilizers (MDA); groundwater monitoring (MPCA, DNR and MDA); expansion of laboratory capacity (MDA and MDH); Total Maximum Daily Load program staffing (MPCA); and local water planning efforts. The Legislature also established the Lessard-Sams Outdoor Heritage Council (LSOHC), to provide annual funding recommendations to the Legislature from the Outdoor Heritage Fund.

Also in 2008, "Managing for Water Sustainability" (EQB, 2008) examined the long-term adequacy of Minnesota's water supplies. The report suggested determining the volume of water available, its quality, how it has been used, what or who depended on it, and what would happen if change occurred.

3.3.3 The years 2011 to 2020

In 2012, the legislature directed DNR to create three pilot groundwater management areas (GWMAs). DNR addressed water balance issues in the three GWMAs and the Little Rock Creek Area, with a focus on water quantity. Results with implications for other state water agencies included aquifer residence time calculations in support of groundwater quality assessments, base flows to streams, and lake level fluctuations that result from changes in groundwater use, land use and climate change.

In 2014, MPCA released the Minnesota Nutrient Reduction Strategy (MPCA, 2014b). The strategy sought to retain water and nutrients, thereby reducing pollutant loads to surface water and groundwater.

MDA developed and applied modeling tools to estimate nitrate losses to groundwater from agricultural and land management practices in various hydrogeological settings. These tools

supported the prediction of impacts by these practices, thus avoiding the risk of delaying action until degraded groundwater quality is detected in monitoring wells.

The Minnesota Geological Survey (MGS) developed the ability to electronically merge atlas data across county boundary lines, allowing complete aquifers and watersheds to be modeled.

In 2017, Governor Dayton and State agency leaders conducted meetings around the State in which to solicit input from over two thousand Minnesotans about protecting and improving water quality. The ideas generated included: improving education; reducing runoff; empowering local water planning; protecting drinking water; repairing and replacing failing wastewater infrastructure; and providing long-term and sustainable funding.

3.3.4 Post-2020

The CWLA and CWLLA have encouraged a strong commitment to clean water. The water agencies continue to manage and protect groundwater, with the additional effort of MGS, Clean Water Council (CWC), LSOHC, and the Legislative and Citizens Commission on Minnesota Resources (LCCMR).

Minnesota's clean water approach involves local and state partnerships and incorporates surface and groundwater quality and quantity, drinking water, habitat, and recreation. Watershed Restoration and Protection Strategies (WRAPS) identify surface water-quality issues and restoration strategies. Groundwater Restoration and Protection Strategies (GRAPS) identify groundwater-quality issues and restoration strategies for the protection of private and municipal drinking water wells. Local comprehensive watershed plans following the "One Watershed-One Plan" approach use the WRAPS and GRAPS planning approaches to improve surface water quality and quantity.

According to the water agency information (executive branch reviews), as of 2022, all major watersheds in Minnesota have been assessed, yielding a good understanding of surface water challenges. State water agencies have restored surface water quality in fifty lakes and streams. Vulnerable public drinking water systems are engaged in protecting source waters. Over 30,000 private wells in fifty counties have been tested for nitrate. More than 500,000 acres on 800 farms now meet agricultural water-quality certification standards. Minnesota's per capita water use is down by twenty percent over eight years. Municipal wastewater treatment upgrades have reduced phosphorus discharges by over 139,000 pounds per year.

4.0 Strengthening Groundwater Sustainability

Upon passage in 1989, the Act received nationwide accolades for its scope and vision. Even so, the Act does not every critical risk to Minnesota's groundwater that is recognized today. The remaining critical risks represent opportunities to strengthen groundwater sustainability.

MGWA proposes the following priority actions to respond to these critical risks. The priority actions (denoted by check boxes) are grouped under three categories (denoted by numbered headings): ensured stable funding; groundwater sustainability; and water governance.

4.1 Ensured Stable Funding

It is certain that sustainable groundwater policy or management is impossible without adequate funding, which must itself be sustained to support critical long-term efforts such as hydrogeologic mapping and groundwater monitoring. As outlined in Section 3, while the CWLLA currently supports many critical long-term activities, it sunsets in 2034. In the meantime, General Fund dollars for some critical activities have shifted elsewhere. Uncorrected, shifts and effective reductions in funding will disrupt the critical long-term activities that support groundwater sustainability.

- ☑ To prevent unnecessary disruption to critical long-term activities that support sustainable groundwater management, create a stable, ensured, long-term funding strategy that combines support from the CWLLA, General Fund, and perhaps other sources. The creation of a stable, ensured long-term funding strategy will be critical if the CWLLA disappears in 2034.

4.2 Groundwater Sustainability

Although large volumes of water are stored in Minnesota's aquifers, lakes and streams, groundwater sustainability is not assured. For instance, in some locations declining groundwater levels affect surface water and ecosystems that rely on stream baseflow and domestic drinking water supplies, or simply deplete important water supplies faster than they can be replenished. Although a comprehensive discussion of the complex topic of groundwater sustainability is beyond the scope of this White Paper, the following paragraphs summarize the need for managing groundwater sustainably, and the resources needed to accomplish that goal.

Prior to the 1989 passage of the Act, discussions about adequate groundwater supply used the term "safe yield". Safe yield was defined as a groundwater withdrawal rate that does not exceed the average aquifer replenishment (recharge) rate. The term is no longer used because even low-volume groundwater pumping may harm hydrologic systems. The concept of sustainable water use, based on accurately defined water budgets, is now the dominant

resource management approach. Maintaining groundwater sustainability is the baseline outcome that policy and management need to meet (Nieber and others, 2010).

Sustainable groundwater management should be based on water budgets, which essentially are estimates of the groundwater volume available for use. Developing a water budget requires an understanding of two key elements. First, groundwater and surface water use are to be evaluated as a single system. The groundwater volume available changes with groundwater recharge, discharge, and storage. Information (quantification of the fluxes) about these processes is needed to develop a water budget. Secondly, water managers need to recognize that all uses of groundwater affect surface and subsurface environments.

In areas where groundwater depletion is a real or potential problem, pumped water must be supplied by increased recharge, decreased discharge, removal of water from storage, or some combination. It is therefore necessary to understand thresholds that lead to unacceptable effects, and to assess tradeoffs between these effects and the allowed volume of groundwater use. Within a systemwide analysis of groundwater and surface-water resources, these thresholds determine the appropriate limits for consumptive use.

Sustainable water management must also consider aquatic habitat and ecological conditions in streams. Factors to consider include maintaining minimum stream flows, high-flow protection standards for habitat, and the protection of the natural variability of flows. These factors provide multi-scale understanding of groundwater and surface water exchange, including processes that link hydrology and aquatic ecology (WRC, 2011).

The DNR created a definition of groundwater sustainability that was adopted into statute (103G.287, Subd. 5):

> **"Sustainability Standard. The commissioner (Commissioner of the Department of Natural Resources) may issue water-use permits for appropriation from groundwater only if the commissioner determines that the groundwater use is sustainable to supply the needs of future generations and the proposed use will not harm ecosystems, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells constructed according to Minnesota Rules, chapter 4725".**

This definition provided the opportunity to begin policy development of sustainable groundwater management across all water agencies. The definition also recognized that sustainable groundwater management involves waterquantity and water quality, and that both factors affect water supply, industrial and agricultural use, recreation, and ecosystem health.

The definition links the protection of water quantity, quality and aquatic ecosystems and stream habitat conditions to the degradation prevention goal of the Act. However, the degradation prevention goal itself is vague because all uses of water potentially negatively impact water quantity, water quality, or ecosystems. Thus, any use of groundwater may violate the degradation prevention goal and thus the sustainability requirement. Maintaining wetlands,

lakes, and streams at natural elevations leaves less groundwater pumped for other purposes, because allowing some decline of stream and groundwater levels and flows conflicts with the law.

The concern presented by the vagueness of the degradation prevention and sustainability definitions could be offset by use of an operational (practical) definition of sustainable groundwater management. An operational definition would clarify the statutory sustainability definition by considering available environmental, ecological, social, cultural, and economic information and data.

The operational definition of sustainable groundwater management would include the evaluation of trade-offs. An operational definition of this type would support balancing costs and benefits of ensuring groundwater sustainability, quantifying the value of ecosystems within properly managed streams and lakes, and assessing costs of water losses due to aging infrastructure.

- ☑ To support sustainable water management, reinforce and facilitate the use of the statutory sustainability definition by creating an operational definition of sustainable groundwater management. If necessary, build in opportunities to develop distinct operational definitions for the specific and unique tasks that face each water agency. Operational definitions will incorporate scientific, environmental, ecological, social, cultural, and economic factors.

- ☑ Efforts to manage groundwater sustainably will require collection or collation of specific information types, at minimum including:

    - Aquatic habitat and ecological information such as minimum and maximum stream flow, and flow-variability requirements for habitat protection. These measurements require a multi-scale understanding of groundwater and surface water exchange, including processes that link hydrology and aquatic ecology (WRC, 2011);

    - Factors related to changes in land use, land cover, and population density;

    - Factors related to climate change, especially as they affect groundwater quality and quantity.

<u>Integrating groundwater sustainability assessments into water programs.</u> Even before the relatively recent availability of a statutory definition for groundwater sustainability, water agencies coordinated to promote sustainable groundwater management. This coordination between state water agencies could be expanded through integration of sustainability assessments into regulatory programs. Doing so will promote the statutory definition of sustainable groundwater management.

- ☑ To foster the implementation of sustainable water management, recognize that the sustainability statute applies to all of the water agencies. In areas of depletion of natural flow systems, increased emphasis on sustainable water management would greatly improve statewide groundwater management.

For instance, integrating sustainability assessments into the water appropriation process could incorporate watershed area, median streamflow, stream thermal regime, and trout habitat, while providing estimates of streamflow depletion, as well as a means of evaluating and enforcing appropriation permits.

In Michigan, an automated tool simplifies the process for small appropriators. The Michigan tool evaluates proposed high-capacity withdrawals by considering groundwater and surface water exchange under pumping stress, and apportions streamflow depletion among neighboring streams.

- ☑ To strengthen groundwater management, integrate sustainability assessments into water regulatory programs. This could include cumulative-impacts process and numerical models to support permit decisions. It could also include efforts to protect groundwater quality from sources of nitrate and chloride.

Some progress has been made in protecting and improving groundwater quality from sources of nitrate and chloride. The MDA Groundwater Protection Rule addresses agricultural nitrate through the use of BMPs, and MDH and BWSR work with public water suppliers to implement BMPs for nitrate in drinking water supply management areas. MPCA is working toward BMPs for chloride.

Accounting for global climate change in groundwater sustainability assessments. Climate change is a significant global issue that is already affecting groundwater resources. Climate changes can be expected to affect all of the important hydrogeologic variables that determine the available groundwater quantity and quality: precipitation, runoff, evapotranspiration, and recharge.

Scientists have already measured changes in precipitation intensity and frequency, and these changes may be associated with significant changes in land and water management practices. In cascading fashion, significant changes to groundwater quality and quantity can also be expected. For example, increased precipitation and recharge may increase the flux of pollutants to groundwater. More frequent flooding increases the risk of surface pathogens flushing into private or public drinking water wells.

The 2020 State Water Plan (EQB, 2020) states that ensuring safe and sufficient drinking water is critical, especially in light of expected demographic and climatic changes.

- ☑ Continue/complete the geologic and hydrogeologic mapping of the state at the county scale to provide base mapping for continued future reassessments of groundwater recharge.

- ☑ Support collaborative efforts between Minnesota's groundwater scientists and experts in areas other than ground water. Encourage further collaboration between state water agencies on the causes and groundwater effects of climate change in Minnesota.

- ☑ Assist MDH in providing outreach and education on climate change readiness and source water protection to private well owners and public drinking water supply systems vulnerable to the impacts of climate change (objective 2b2 of Minnesota Climate and Health Strategic Plan, page 9).

- ☑ Assist the water agencies in collaborating to meet the requirements of the federal Clean Water Act and Safe Drinking Water Act within new limitations caused by uncertainties related to climate change (objective 2b3 of Minnesota Climate and Health Strategic Plan, page 9).

Assuring public drinking water and groundwater sustainability. Public drinking water suppliers, and over 3 million Minnesotans who are their customers, depend critically on sustainably managed groundwater (Drinking Water by the Numbers, 2022). According to WRC (2020), there is currently no requirement that public drinking water suppliers possess a coordinated assessment and management plan combining water supply plans, wellhead protection plans, emergency response plans, treatment/distribution network diagrams, and best operating procedures. Localized source-to-tap risk assessments and water safety plans (WSPs) would provide a transparent and flexible approach to locally tailored drinking water management.

- ☑ To improve the mapped boundaries of source water protection areas, increase data availability to public drinking water suppliers, including information on nearby large groundwater appropriators (WRC, 2020).

- ☑ To drive the creation of WSPs, continue to support localized source-to-tap risk assessments and the preparation of local water plans.

Regional assistance committees could benefit community and industrial/agricultural water systems pumping the same resource. These regional committees, in their advisory role, would serve an important role in drinking water security and groundwater sustainability.

- ☑ To support the development of WSPs, adopt successful regional water planning models of technical advisory committees supporting local water suppliers and users in sensitive areas.

- ☑ To support public water supply planning, continue to monitor, assess and research geologic (e.g., manganese; MGWA, 2015) and anthropogenic contaminants in groundwater.

Assuring private drinking water supply and groundwater sustainability. Private (domestic) wells supply drinking water to 1.2 million Minnesotans with no access to public drinking water (Minnesota Well Owners Organization). Since 1986, the Minnesota Well Code has regulated private well construction and initial testing for nitrate, total coliform, and (since 2008) arsenic. Private drinking water testing and monitoring are otherwise unregulated and voluntary, with no formal tracking of water quality over time.

- ☑ To protect the health of Minnesotans who drink water from private wells, support testing of privately supplied drinking water during property transfer (Helland, 2001).

Because groundwater moves slowly, efforts to prevent groundwater contamination and minimize resulting risks are usually cost-effective and should be considered a success. Any resulting contamination of groundwater requires implementing costly, long-duration cleanups, point-of-use treatment, supplying alternative water, or all these steps or other actions to protect humans and the environment.

State water agencies are responsive to well owner inquiries, and provide information and education. Efforts to educate and engage citizens promote public interest and knowledge about drinking water sources. Stable funding of groundwater activities is most likely to occur when decision-makers, many of whom are well owners, know and care about the resource.

- ☑ Fund development of a dedicated hotline for private well owners to get accurate, up-to-date information on their drinking water quality.

- ☑ To protect the health of Minnesotans who drink water from private wells, expand State water agency monitoring, assessment and research of anthropogenic and geologic contaminants in groundwater (MGWA, 2015).

- ☑ To remove contaminant conduits that may threaten future groundwater quality, encourage and support the proper sealing of wells that are abandoned or in poor condition.

- ☑ To protect source water quality in broad areas of private drinking water well use, identify and protect recharge areas to aquifers supplying water to these wells.

- ☑ To capitalize on reasonable concerns that private well owners may have about their drinking water source, provide stable funding for groundwater and scientific educational efforts that target citizens and decision-makers.

Coordinating policy for land-use and groundwater sustainability. Connections between land use, water quality, and water quantity are long recognized, but not fully understood (WRC, 2011). Virtually any land use may potentially alter water quality or quantity, rendering the degradation prevention goal of the Act easily violated. The time scales are offset: the benefits of changed land use occur in the short-term, while changes to water quality occur in the long-

term. Additionally, land use changes may involve temporary subsurface construction activities that may affect groundwater. For these reasons, it is important that selected land uses provide as much protection for groundwater quality and quantity as possible.

- ☑ Enact changes to policy and management to recognize interconnections between land-use planning and groundwater resource management that were envisioned in the Act.

Prevention of groundwater degradation requires effective and coordinated land-use and water sustainability policy. However, they are singly managed at different scales: land-use planning is a local government action, while water sustainability is accomplished at multiple governmental levels. Coordinating policies for land use and water sustainability will require merging the two scales.

- ☑ Ensure that water programs recognize as a foundational principle the existence of "an effective and enduring connection between water sustainability and land use decisions" (Issue D The Land, Air and Water Connection; WRC, 2011). Existing implemented examples include the MDA Ground Water Rule and the MDH Source Water Protection program.

Providing data and information for groundwater sustainability. Advances in data management, especially the completion of county geologic atlases for much of the state, make rigorous water-budget assessments possible. Improvements to data management and data assessment are therefore critical to achieving and maintaining sustainable groundwater.

State agencies and partners are estimating the impacts of groundwater withdrawals on aquifers and surface water. Partners are also evaluating the effects of groundwater withdrawals on aquatic ecosystems in critical areas (WRC, 2011), such as GWMAs and the Little Rock Creek Area study.

- ☑ To continue the Act's critical legacy of collecting and interpreting groundwater data, expand geologic and hydrologic databases to include the interactions between aquifers, and between groundwater and surface water.

- ☑ To support implementation of sustainable groundwater management, continue strengthening links between databases and improving the accessibility of groundwater quality databases. Important steps are to link groundwater and surface water data seamlessly, and merging county geologic atlas data across county lines.

Accurate water budgets support groundwater flow modeling efforts to assess sustainability, and also the evaluation of development options and management strategies. Critical data for water budget and sustainability assessments include consumptive use, withdrawals, water levels, recharge rates, recharge chemistry, baseflow, flow estimates between aquifer systems, and flows between groundwater and surface water (WRC, 2011; MGWA, 2018 and 2020).

Factors affected by climate change, such as land use, land cover, and population density, may affect groundwater quality and quantity, and are also to be considered.

- ☑ To integrate all the aspects involving groundwater management, collect information that supports assessments of relationships between surface water, groundwater, and aquatic ecology, and associated eco-services. This information supports efforts to manage groundwater sustainably. Include the development of criteria to assess water levels and streamflow conditions required to support ecosystems and habitat conditions, such as minimum streamflow and high-flow protection standards for habitat-forming flows.

- ☑ To support sustainable groundwater management, rigorously develop aquifer water budgets and water-quality assessments. The analyses discussed above could be included as a proposed Part C of the County Geologic Atlas format.

The Act envisioned a centralized database to promote data sharing, a goal that today is largely met through online data availability. However, strengthening links between existing online databases would support data sharing and groundwater sustainability efforts.

- ☑ To support groundwater sustainability efforts, increase accessibility and strengthen the links between existing online databases.

MPCA (2019) identified a need to improve the management and use of data reported to regulatory programs. There was no consistent database, even within programs, to compare impacts and determine the need for WRPR development if existing BMPs were ineffective.

- ☑ To ensure sustainable groundwater management, provide resources to promote and support technical proficiency among water agency staff and other database users.

- ☑ To support aquifer water budget assessments, ensure that aquifer assignments are made for wells associated with appropriation permits. Doing so will improve the efficiency and accuracy of automated water appropriation tools to assess streamflow depletion based on the cumulative effects of groundwater withdrawals.

Addressing inter-basin groundwater exports and groundwater sustainability. A recent proposal ("Dakota County Pushes Back on Fresh Attempt to Ship Groundwater to Southwest", Erin Adler, Star Tribune, April 28, 2020) tested Minnesota's ability to prevent large inter-basin groundwater exports. A railroad company proposed to freight 500 million gallons of Minnesota groundwater per year to a southwestern state. The Act specifically restricts groundwater extraction from new Mt. Simon Aquifer wells, so the recent proposal failed. However there appeared to be no available prohibition to a potential future proposal targeting an unrestricted aquifer.

The legal case demonstrated that the inter-basin export of groundwater may be difficult to prevent under current Minnesota law. This is significant, because it means that State policy regarding large-scale inter-basin water export may be inadvertently inconsistent with the maintenance of groundwater sustainability. Requiring local water plans to dovetail with a basin-wide compact to prevent unsustainable withdrawals may be a successful approach to future proposed inter-basin groundwater exports.

- ☑ To guard against appropriation permits that prevent sustainable groundwater management, require local governments to adopt integrated regional long-term groundwater plans.

- ☑ To support the effectiveness of integrated regional long-term groundwater plans, provide technical assistance to local governments to determine surface water-groundwater exchange and ecosystem impacts, climatic predictions, population projections, and economic growth projections. Consider incorporating these plans into the existing water planning framework (e.g., One Watershed-One Plan).

- ☑ To further protect against inter-basin groundwater exports that are counter to sustainable groundwater management, enact a legally binding agreement (similar to the Great Lakes-St. Lawrence River Basin Water Resources Compact) that covers the Upper Mississippi Basin. The proposed compact could prevent the removal of water directly from the Mississippi River, its tributaries, or groundwater that supports the river through recharge.

Addressing contaminants of emerging concern (CECs) and groundwater sustainability. Examples of CECs that have already received attention include perfluoroalkyl substances (PFAS), pesticide metabolites, endocrine disruptors, and pharmaceutical compounds (although not human-caused, and therefore commonly excluded from discussions about CECs, geologic contaminants such as arsenic, radium, manganese, and polonium have also received attention). The surprise discovery of CECs in groundwater prevents sustainable management by degrading groundwater quality.

It is generally true that when first discovered, CEC sources and environmental fate are poorly understood (WRC, 2011), and toxicological data are typically scarce or unavailable. Laboratory analytical methods for exotic compounds may be expensive to develop, or unavailable. Investigations involving CECs can be urgent and highly visible. Costs for fast, accurate innovation may be unanticipated and high.

- ☑ To support continuous reconnaissance efforts that will minimize response times and human exposure, proactively develop indicator analytes as water-quality screening tools.

- ☑ To support the proactive determination of potential contaminant pathways to human or ecological receptors, thus minimizing response times and exposure, develop a statewide understanding of surface and groundwater flow paths through multiple aquifer systems.

To be effective, efforts to address CEC occurrence must be sustained and proactive. These factors drive the need for accurate screening tools to save time and limit human exposure to pollutants.

- ☑ To minimize human exposure to CECs, proactively develop the data needed to evaluate human exposure to CECs: toxicological data, HBVs and HRLs, and the development of alternative methods to assess health risks in the absence of preferred data.

Promoting technical innovation and groundwater sustainability. The Act embraced an innovative approach to groundwater problem-solving, for instance in calling for the development of coordinated groundwater data sets, and continued research to support groundwater management. Sustainable groundwater resource management relies on building comprehensive, hydrogeologic data sets over time, the use of analytical methods (computer models), and devising multiple management strategies (Alley and others, 1999).

To achieve groundwater sustainability, efforts that drive technical advances and develop rules are needed. Technical challenges include rigorous understanding of water budgets and aquifer water quality of major aquifers, maintaining and expanding databases, and a better understanding of interactions between major aquifers and surface water and ecosystems.

The availability and cost of real-time time-series sensors in wells, and the ease of storing large amounts of data has greatly expanded available data sets. Innovative techniques such as artificial recharge, water reuse, aquifer storage, natural attenuation, and others, expand the array of potential management strategies. Nevertheless, these options may be rendered impractical if they encounter administrative obstacles.

- ☑ To expand the benefits of innovative groundwater management strategies, avoid creating administrative obstacles.

- ☑ To preserve the option to use certain innovative approaches in the future, manage resources in anticipation of their use. An example is to protect land area and recharge water quality where recharge may be a reasonable future option.

- ☑ To continue the development of common land-use/water-resource planning approaches, strengthen coordination between government (local, regional, and state) and academia.

4.3 Water Governance

This paper considers "water governance" to be structures and processes used to protect and utilize Minnesota's water resource. Recurring proposals to change the structure of Minnesota's water governance may impede progress toward groundwater sustainability. Proactively meeting these concerns may prevent the creation of unnecessary obstacles to groundwater sustainability efforts.

Two reports summarize the history of efforts to reform Minnesota water governance. The WRC prepared the first report at the request of the Minnesota Legislature after CWLLA passage. The purpose of the Minnesota Water Sustainability Framework ("Framework"; WRC, 2011) was to construct a path to accomplish the goals of the CWLLA. The report included suggestions about revised water governance. Most remain unaccomplished.

Subsequently, the Minnesota Legislature (Laws 2011, 1st Special Session, Chapter 2, Article 4, and Section 33) directed MPCA to cooperate with state water agencies, the Metropolitan Council, and the University of Minnesota, to develop recommendations for improving Minnesota's system of water governance (MPCA, 2014a). The legislation directed the evaluation of water-related statutes, rules, and governing structures to streamline, strengthen, and improve sustainable water management.

These two reports recognized the coexistence of numerous Minnesota State agencies and programs focused on water (see Appendix C). The current arrangement of water governance and policy provides the benefits of oversight, healthy competition, and collaboration of ideas among water agencies. Turf protection and non-cooperation may also arise.

Two opposing views have arisen to address the obstacles presented by the existing water governance and policy arrangement (Brand and others, 1990; Helland, 2001; MPCA, 2013; MPCA, 2014a). The first view suggests that the existing network of water programs discourages coordinated long-term water planning and policy. This view recommends combining all water-related efforts into a single department of water to improve efficiency and simplify services to citizens.

Combining all water-related efforts in this way may risk the dilution of existing objectives within the all-encompassing priorities of a single department of water. Some protective features could be lost. For example, the combined department of water would house the functions currently within MDH (safe drinking water) with the functions currently at MDA (water and agriculture), forcing them to compete within a single agency. A large-scale change to water governance and policy also risks interrupting existing federal funding mechanisms and individual state agency mission goals.

The second view recognizes the cooperative benefits of the current multi-agency scheme of water governance and policy. It suggests that a network of strong and autonomous agencies promotes coordination and healthy competition. This view of water governance and policy focuses on the importance of agency missions and goals, and looks to legislative rather than administrative resolutions to priorities, tradeoffs, and conflicts.

Largely due to increases in CWLLA funding, Executive Branch collaboration and management of groundwater activities has improved. The assistant commissioners of water agencies sit on the Interagency Coordination Team (ICT). To respond to major water topics and activities, the ICT established teams accountable through charters and work plans. Examples of such teams that leverage interagency cooperation include the Interagency Groundwater/Drinking Water Team, and the Groundwater Restoration and Protection Strategies (GRAPS) Sub-team. GRAPS details are available on a MDH webpage.

The ICT and its teams and sub-teams are well-positioned to address issues regarding water governance and policy, including improved coordination of groundwater efforts among the state water agencies. The cooperation of the ICT and its sub-teams with the CWC has developed the Minnesota Water Management Framework, which lays out state agency and local partner roles for managing both surface water and groundwater.

- ☑ To improve coordination between water agencies, establish stable, transparent interagency structures that are accountable, responsive, inclusive, and empowered. If the ICT role is expanded beyond coordinating CWLLA funding, then the ICT could provide the needed coordinating role for all groundwater programs. The Interagency Groundwater/Drinking Water and Interagency Watershed Management/Implementation Teams could optimize the work on groundwater issues and coordinate water resource management through a watershed approach.

The collaborative approach promotes groundwater protection through numerous prevention activities. Water agencies collaborate with partners to offer assistance in integrating prevention activities into state and local plans that include local water management plans, wellhead protection plans, groundwater management area plans, surface water protection plans and a nutrient reduction strategy.

In contrast, the DNR has authority to adjust appropriations in support of groundwater sustainability. However, there is no enforcement portion of MS 103G.287, Subd. 5. for DNR to pursue violations of permit conditions. Reducing barriers to existing enforcement authorities across the water agencies could be a fundamental step toward ensuring groundwater sustainability.

- ☑ To make changes in governance as efficient as possible, use existing successful organizations as examples. The Metropolitan Council relied on the Metropolitan Area Water Supply Advisory Committee and the associated TechnicalAdvisory Committee to

prepare the TwinCities Master Water Supply Plan (2010, updated 2015), a regional framework for long-term water supply planning supported by regional groundwater flow modeling.

- ☑ To support efforts toward groundwater sustainability, reduce barriers to existing enforcement authorities, including those related to groundwater protection according to the degradation prevention goal of the Act.

4.4 Final Considerations

The existing obstacles to achieving and maintaining the sustainability of Minnesota's groundwater discussed above present opportunities to continue the work that originated from the Act, and address issues, ideas and approaches that have arisen in the meantime. Those interested in Minnesota's groundwater resource should continue to unify policy and management efforts around the central unifying theme of groundwater sustainability. Sustained funding for activities described in this White Paper, and a unified approach to water governance will both be critical to achieving and maintaining groundwater sustainability.

Thirty years after its passage, MGWA and other Minnesota groundwater professionals recognize the far-sighted impact that the Act has had on the management of Minnesota's groundwater. Yet, the Act has not accomplished everything intended. It did not address all critical risks to groundwater quantity or quality, nor did it provide a complete strategy for protecting Minnesota's groundwater. Minnesotans must continue to capture the critical measures to support the achievement of sustainable groundwater use and protection. One great accomplishment of the Act is that much of the work necessary for this next step is already done.

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6.0 APPENDICES

6.1 Appendix A: Interviews

The MGWA White Paper Work Group represented a range of professional experience with respect to the Act. To eliminate bias and establish working knowledge from primary sources, the Work Group conducted interviews with those available who played critical roles in the passage and early implementation of the Act. The Work Group interviewed those individuals with the following objectives in mind:

- To understand the events and information that motivated lawmakers to overwhelmingly adopt the Act;
- To define challenges encountered during the implementation of the Act, particularly with regard to degradation prevention;
- To learn what the Act did not address, and what gaps might remain.

The interviews took place during January 2020 to May 2020. Interviews 1 and 2 were face-to-face, and the remainder were via Zoom during the COVID-19 pandemic. The table below lists the interview dates and the names of those interviewed, followed by summaries of each interview.

Interviewees were offered the opportunity to review and modify their comments in the transcripts to assure accuracy. The Work Group thanks the interviewees for their time, candid insight, and anecdotes about the passage of the Act.

Table: Interview Dates and Interviewees

Interview #	Date	Interviewees
1	1/6/2020	Representative Jean Wagenius
2	1/14/2020	Representative Rick Hansen
3	3/25/2020	John Helland and John Wells
4	4/9/2020	Senator Gene Merriam, Ron Nargang, Jay Frischman, Jason Moeckel
5	4/16/2020	Greg Buzicky and Dan Stoddard
6	4/23/2020	Don Jakes and John Linc Stine
7	4/30/2020	Dave Kill and Roger Renner
8	5/7/2020	Jeff Broberg and Bruce Olson
9	5/14/2020	Ray Wuolo, Kelton Barr, Bob Karls

6.1.1 Interview #1: Representative Jean Wagenius

Date: January 6, 2020
Location: State Office Building
Attendees: Laurel Reeves, Kara Dennis, Carrie Jennings., Jim Stark, David Crisman, Jim Lundy

Representative Wagenius was a newly-elected (Democrat) legislator when the Act was passed in 1989.

Wagenius: One clear benefit was that the well code was firmed up. Ground water awareness has faded, though White Bear Lake and other ground water problems have increased focus. Drinking water is always an important topic to the legislature. Representative Rick Hansen (MDA at the time) will have a useful perspective.

The 1980s drought did play a role. Passage of the Act was bipartisan. There were five (House) authors, each wrote a different section of the (House) bill. Rick (Representative Hansen) will know what compromises were made. Dave Bishop (Republican) was one of the authors.

MERA--the Minnesota Environmental Rights Act, allows Minnesotans to sue to protect the environment.

The last time federal standards for drinking water were updated was in the 1990s.

Beginning with Governor Carlson, it was no longer "polluter pays", but rather "polluters are the customers". This was not a backlash, but it's what happened. Fallout was that staff at MPCA (and all environmental agencies) grew up with this attitude, and so it has persisted. The result is we have more polluted ground water and drinking water. Willard Munger held hearings on ground water--after Democrats were out of power, nobody talked about ground water anymore.

We need infrastructure to deal with flooding (for instance, southeastern Minnesota) as a result of climate change.

The laws are much better than enforcement. Consequently, the gaps are in the implementation of the law. As an example, Bisphenol A causes obesity and is commonly detected, yet MDH does not want to establish a HRL[1].

[1] MDH adopted the Bisphenol A HBV into rule as a HRL in 2015.

According to an MPCA report from three years ago, about thirty percent of surface water pollution (nitrate) is from ground water.

Check with House Research for help on export of ground water to other states, they might have already written a report about it.

Changes to the law in about 2010 established criteria for groundwater appropriation permits: 1) groundwater must be sustainable for future generations; 2) can't affect fens or other surface water features; 3) can't contaminate other drinking water wells.

Direct quotes:

- "I am a generalist."
- "It might be dangerous to open the law up for update."
- "Emerging contaminants? 'Emerged', more like."

6.1.2 Interview #2: Representative Rick Hansen

Date: January 14, 2020
Location: State Office Building
Attendees: Carrie Jennings, Laurel Reeves, Jim Lundy, Jim Stark, David Crisman

Representative Rick Hansen was first elected in 2004, representing West St. Paul, South St. Paul, and northern Dakota County. He studied soil management (MS) at Iowa State University during 1985-1987, and worked at MDA during the time the Act was passed.

Hansen: The 1983 Big Spring study found atrazine and nitrate. This was a shock. The study established the connection between land use and water quality, and resulted in the 1987 Iowa Comprehensive Ground Water act.

Noting what was happening in Iowa, Freshwater Foundation held several conferences around Minnesota. Subsequently, in 1987 the MPCA updated the Pesticide Act (dates to approximately 1972), including the non-degradation provision.

The onset of the Carlson administration (1990) caused setbacks:

- Feedlots shifted focus away from 1989 GWPA requirements;
- Regulated community became customers, and regulating polluters was de-emphasized;
- Agriculture commissioner reduced emphasis on ground water;
- University of Minnesota Extension programs were reduced;
- Co-ops were consolidated;

- Farms were consolidated, farming became industrialized.

There was some progress too:

- MDA screened data on pesticides;
- Studies examined sensitive surface water-ground water systems, such as the Whitewater basin, Central Sands, and alluvium along rivers and streams;
- Remediation began to occur at pesticide spill sites;
- The pesticide collection program was established.

The Clean Water Legacy Amendment provided funds to MDA, which was good. Thirty years have passed since the Act, and not much has improved. Issues of the day have diluted the programs. Special interests have slowed down progress. Looking forward, Minnesota needs to tax fertilizer.

6.1.3 Interview #3: John Helland and John Wells

Date: March 25, 2020
Location: Zoom
Attendees: Gretchen Sabel, Laurel Reeves, Jim Stark, David Crisman

Wells: The EQB was formed in 1973, but its focus on water was enhanced with the merger of the Water Planning Board into EQB in 1983. With the establishment of the EQB Water Resources Committee in 1984, EQB began the series of conversations leading to the passage of the Comprehensive Local Water Management Act of 1985, and the 1989 Ground Water Protection Act.

The concern with groundwater crystalized in the mid-1980s in a joint MDH-MDA study funded by USEPA to find pesticides and nitrate in public and private water supply wells. The study detected pesticides in thirty-seven percent of water samples. This finding raised awareness of the risks of groundwater contamination posed by agriculture and other land uses. Water availability and water use issues also had been raised by drought in the late 1970s, as well as water use conflicts throughout the 1980s, but the 1988 drought following record floods the year before helped heighten water awareness.

These concerns were a key factor leading the MPCA to develop a Minnesota Ground Water Protection Strategy. And in 1988, the MPCA asked EQB to convene an Advisory Committee on Ground Water Protection to review its draft strategy. The EQB did so and also worked with the committee to develop a companion Strategy for the Wise Use of Pesticides and Nutrients. Both strategies provided the foundation for the groundwater protection legislation that EQB initially drafted in 1988 through its water committee and member agencies.

A first draft of the bill was ready in 1988 but held back to add well code amendments and other sections. The delay led ultimately to a better bill. For example, early bill discussions favored the approach of developing Regional Hydrologic Assessments (RHAs) as a rapid way to cover the state with good hydrogeologic information, before completing the more rigorously developed County Geologic Atlas program statewide. Atlases were viewed as important, but maybe a more Cadillac approach. The RHAs were meant to be a quick evaluation of an entire watershed or basin. The key point was the importance of using geologic information in land use decisions.

The new bill added sensitive areas and health requirements. The House bill directed MDH to develop HRLs on any chemical, but the Senate bill directed HRL development only on pollutants, or chemicals already found in ground water. The prevention language was altered between versions too, starting as "non-degradation" and finally becoming "degradation prevention".

With five lead authors on the House bill, the legislative effort was bipartisan. It was unusual to have so many key authors, and it required some unusual steps to execute. It points to the willingness of the Legislature to act on the issue at this time. Notably, the bill passed both chambers with only three "no" votes.

Q: How important was the drought in 1988?

Wells: The drought elevated concern and generated focus on water priorities: drinking, power generation, and so on. However, drought issues were already on the table. The new jolt in consciousness came with the findings of pesticides and nitrates in public and private water supply systems in 1985.

Q: BSWR sections of the law?

Wells: Fifty-two counties and two watershed districts requested funds for water planning following passage of the Comprehensive Local Water Management Act of 1985. These were funded through the LCMR in 1987 with grants administered by the EQB and State Planning Agency. The EQB and BWSR, which had been established in 1987 upon recommendation of the EQB Water Resources Committee, saw the ground water legislation as an opportunity to make such funding a long term commitment through the general fund.

The water connection fee was to help fund federal SDWA requirements at MDH. The newer Safe Drinking water requirements were amended in 1986 (and subsequently in 1996).

Q: What drove the Review of the Act in 2000?

Helland: The House assembled a subcommittee on ground water, triggering the review of the Act. No legislator pushed for the review; John (Wells) thought it a good idea. It wasn't exhaustive. The goal was brevity.

To prepare it we surveyed most of those originally involved, either in the legislature or agencies. We sent the survey to those responsible for portions of the Act requirements, but not to the agency heads. It was a select group, not meant to be all inclusive. Because John (Wells) had working relationships with those receiving the survey, we believed the feedback was valuable.

We presented the report to the subcommittee during an early meeting. The subcommittee may not have written a report. So the value of the survey is really undetermined as it may not have gotten beyond the legislative discussion.

Wells: With the bill's passage, there were grandiose ideas on planning and reporting requirements. The 1990-1991 Water Plan fostered great cooperation between agencies and the EQB.

Q: What new things in the Act stood out?

Tracking abandoned wells on deeds, and sealing them. Development of Sensitive Areas.

Q: During your 2000 review, what things in the Act stood out?

Helland: Sustainable use of water and ground water.

Q: What recognition did the Act receive from elsewhere in the United States?

Wells: Some Law Reviews contacted John (Helland), but not anyone from other surrounding States. John Wells (in his capacity as program administer at the State Planning Agency for the LCMR water planning grants), EQB, and fifty-two Minnesota counties received a National Renew America Award in 1990 in the category of groundwater protection. County water plans talked about ground water protection, and this was recognized.

Q: Future?

Wells: Look at the trends and reporting and find if we are doing it. This was an important part of the Act as we knew our knowledge of the resource needed to improve.

Helland: Present the White Paper to Paul Gardner and the Clean Water Committee.

John Wells provided photographs:

- Signing of the Act in southeast Minnesota;
- Renew America Award in the White House Rose Garden with President George H. W. Bush;
- Governor Rudy Perpich, after touching the stinging nettles.

6.1.4 Interview #4: Gene Merriam, Ron Nargang, Jay Frischman, and Jason Moeckel

Date: April 9, 2020
Location: Zoom
Attendees: Gretchen Sabel, Jim Stark, Jim Lundy, Laurel Reeves, and David Crisman

Gene Merriam was a Minnesota State Senator from 1975 to 1997, and DNR Commissioner during 2003-2007. Ron Nargang was DNR Deputy Commissioner. Jay Frischman and Jason Moeckel both work at DNR, Division of Ecological and Water Resources.

Q: What were the driving issues behind the Act?

Nargang: Several. Most prominent was the 1988 drought, which drove a focus on the State water resources. A long term legislative study on water was issued about this time and covered many topics: the Twin Cities Metropolitan area ground water basin, the western buried drift aquifer, municipal water supplies drawn from the Mississippi River, drawdown within the Mt. Simon-Hinckley Aquifer in the Twin Cities basin, and others. The legislature was interested to take action.

Charles 'Chuck' Davis (agriculture background) and Ron Harnack (DNR Permitting) led the concerns over the ground water resource. Cost of the resource use surfaced at the time so fees and cost allocations were incorporated into the Act. The fee structure did not change with the volume used, so there was no incentive to conserve water.

The Coon Rapids municipal water system was under design and expected to draw from the Mississippi River. The idea seemed crazy since 'cleaner' groundwater was widely available (the existence of several nearby federal Superfund sites may have influenced the design). But the situation brought to mind existing rule/law language about stream minimum base flow during the drought. Some landowners' took any available water without consideration of effect on others or the ecosystem.

Q: What successes did the Act achieve?

Nargang: Fees for using water resources. Restricting the pumping of the Mt. Simon-Hinckley Aquifer for heating and cooling.

Q: Is Minnesota in a better position to manage droughts today as a result of the Act?

Nargang: Hard to say. It's based on your reference point. We may have "flattened the curve" so to speak, but we need to factor in new impacts such as irrigation, agricultural chemical impacts, and so on. We still extract more of the resource than can be replenished.

Frischman: I worked on the once-through cooling inventory and these changes were a benefit. The Act expanded staff and scope of work that in turn enhanced the State monitoring network.

Moeckel: (showed several slides illustrating the number of monitoring wells now used in the State). The monitoring well network provides trend information and is a data source for models. The fees help to fund many new studies and programs, for example the Little Rock Creek study.

Frischman: Early on, if you had till between the creek and buried aquifer then you were good. Now we know these layers leak, and this fact informs decisions made today. Building the network datasets has changed the game, and greatly improved our understanding. Another benefit was the municipalities on discussing interconnecting water supply systems, but these connections have not been built, except for New Brighton connecting with Minneapolis, but that was a TCAAP contaminant issue.

Moeckel: Drought planning is required and needs to be updated and made more robust. We need to improve our preparedness. Unfortunately, this may be put on hold given the current situation with the (COVID-19) virus.

Q: Atlas mapping?

Moeckel: Funding is strong and we are making progress. Minnesota Geological Survey has made great progress (on Part A, geology), and DNR is making progress on Part B (ground water).

Q: Ground water supply sensitive areas?

Moeckel: In the Act, the term was "yield" and now the term is "sustainability". There are four considerations for making appropriations associated with sustainability. The last to consider is ecosystem. Taking care of ecosystem addresses the other three considerations.

Q: What future issues are there?

Nargang: Extracting water to transport out of Minnesota.

Moeckel: The question is tools? There is Law to help but it's untested.

Nargang: It was a Great Lakes issue (but this may only pertain to Lake Superior.)

Q: The inter-basin transfer proposal in southwestern Minnesota (Lewis and Clark Rural Water) has opened this issue. The system stopped within the Missouri watershed, but is it too far? Construction terminated before crossing into the Mississippi River basin. There are other examples too. It may remain an open question. Legislature is reviewing, with varied interpretations.

Moeckel: Protections for the Mt. Simon-Hinckley Aquifer are being extended to aquifer-wide.

Frischman: How well does the Act address new widespread contamination (e.g., PFAS)?

Merriam: Freshwater Foundation has looked at chloride contamination in surface water, but there is also a ground water component.

Nargang: Look at the connection the between ground water, surface water, and flooding. A study in Crookston assessed using restored natural areas to hold back water in the Red River Valley, which seemed to benefit Crookston. Is there an opportunity to move forward with this idea?

Moeckel: Runoff is increasing and we are seeing widening surface water channels. We need to get perennial vegetation on stream edges to hold water back.

Q: Anything else? Others to talk to?

Contact the Clean Water Council, rural water groups, irrigation association, John Linc Stine, former senator Steve Morse (now with Minnesota Environmental Partnership).

6.1.5 Interview #5: Greg Buzicky and Dan Stoddard

Date: April 16, 2020
Location: Zoom
Attendees: Gretchen Sabel, Jim Stark, Laurel Reeves, Jim Lundy, David Crisman

Greg Buzicky developed the pesticide survey (1985-1986), and worked on developing the Act. He was a division manager with MDA until his recent retirement. Dan Stoddard is currently an MDA Assistant Director for pesticide and fertilizer management.

Q: Why conduct the pesticide survey in 1985-6?

Buzicky: It was a Legislative Commission on Minnesota Resources (LCMR) project jointly with MDH and was the first statewide pesticide survey by any state. It focused on point of application, rather than handling, and MDH focused on rural community water supply. It caused concern because pesticides were detected in nearly forty percent of wells tested, and some wells had multiple chemicals. Before the survey MDA and MDH worked with Health Advisory Levels (sic; the speaker's reference may be to Recommended Allowable Limits, RALs) so they could communicate results. Later, these (RALs) became HRLs.

Q: Describe the well network.

Buzicky: MDH did 400 community wells. MDA used both USGS and private wells. They estimated the ground water flow direction using topography and surface water. Wells were sampled four times, seasonally. Distribution of the sampled wells was: forty percent in a sand plain, twenty-four percent in southeastern Minnesota, and rest were located throughout Minnesota. In small towns, the well might be in an area close to an agricultural chemical handling facility that may be a spill source. They started talking about spills in towns right away. So they recognized the problem and rewrote the pesticide law in 1986 to address spills. MDA was given access to MERLA for enforcement and liability.

Q: What were the laboratory capabilities at that time (the mid-1980s)?

Buzicky: MDA and MDH jointly addressed the needed laboratory method development.

Q: After the Act passed, how did you deal with it?

Buzicky: The Act gave a large number of rules to a small group with many responsibilities: monitoring, MERLA, and so on. Before the Act, the focus was on pesticides. Nitrates was brought in later. The task force studied agricultural chemicals and BMPs. The Legislature did not include funding for both chemicals, so MDA chose to work on pesticides, and set aside work on nitrates. MDA did FANMAP and just limped along on a minimal budget to keep the nitrate efforts alive.

Q: How come we haven't done anything on nitrates?

Buzicky: Money. Pesticide had a funding mechanism. Fertilizer had none.

Stoddard: We have had an effective pesticide program for the past 25 years because there has been adequate funding. Work on fertilizer non-point programs continued during this time, but funding was limited with only one or two positions funded in the early 1990s. Much of the early

work was funded with soft money, including a grant from MDH. Clean Water Legacy funds allowed MDA to significantly increase our work. The first thing we did with Clean Water funds was to form an advisory committee and revise the Nitrate Fertilizer Management Plan (NFMP). We brought in experts on nitrogen management and developed a plan based on the requirements of the Act.

An outcome of the revised NFMP was that MDA began an extensive Clean Water funded testing program of private wells in vulnerable areas (the township testing program), eventually offering tests for over 70,000 private wells in over 300 vulnerable townships. MDA also began the development of the new Groundwater Protection Rule (GPR). The NFMP determined that working with farmers would be more effective on a local (township) scale although the Act is not specifically designed to work at the township level. Reducing nitrate losses to groundwater is very challenging because nitrate is easily leached. A farmer can follow all of the recommended practices and do everything right, and under adverse weather conditions still have significantly leaching to ground water.

Q: Say something about the Act and related programs, compared to neighboring states?

Stoddard: I'm not an expert on other states, however in Minnesota farmers are very aware of ground water concerns and have been changing their practices because of the visibility of the issue. MDA did review Wisconsin ground water law as part of the revision of the NFMP. The Act requires a preventative approach by developing voluntary BMPs when a contaminant is commonly detected in ground water, before allowing enforcement. Writing a rule is a slow and inflexible process, and does not provide an easy way to adopt new research of BMPs. We tried to address this through the use of local teams to evaluate local practices. Wisconsin used a different approach with a higher action level but faster regulatory decisions. Wisconsin is currently developing a new rule to address nitrate in ground water.

Buzicky: The nitrate rule we just passed is the first in the country. Nebraska has a pretty good nitrate rule too, but it is voluntary and suited to just irrigated areas along rivers. The Act was more suited for pesticides. Past pesticide practices dictated this be the focus. And the culture has changed--in the 1980s we could not talk openly about these issues, there were barrels in the ditch and mixing areas washed into recharge zones. Today we know of pesticide cleanups in approximately 500 towns. Nitrogen was long overdue, and the delay was all funding-related. And remember, this rule is first in the country. The Act was a big deal.

Stoddard: Nitrogen fertilizer BMPs are a good thing that did not exist before the Act. MDA also piloted approaches to address nitrate concerns, developing FANMAP and many other tools which became the foundation for the NFMP and the GPR, and helped to span the funding gap over the years.

Buzicky: The ground water debate was based on the science. FANMAP was data driven, which got the discussion away from opinion and based on data, which farmers could understand. It was persuasive--farming behavior could change voluntarily because the discussion was based on data. The cleanups are complex with multiple products and settings. FANMAP is data- and science-driven, unlike any other State approach. A FANMAP depiction can be understood by farmers.

Q: Is there a monitored approach to pesticide cleanups?

Buzicky: The MDA program was modeled after Petrofund. Dan was the link between the Petrofund and MDA program.

Q: New BMPs?

Stoddard: We are looking at the use of cover crops, vegetative cover and the promotion of advanced nitrogen management practices called Alternative Management Tools (AMTs) to reduce nitrate levels. We also are using computer modeling based on Minnesota-specific regional data so that nitrate losses from practices under different settings can be estimated. This approach can work at different scales. The smaller the scale the better it works with farmers. The strategy is to work with farmers to adopt recommended practices voluntarily before going to regulation. We would only regulate if the voluntary approach does not work. It is difficult to regulate some agricultural practices and many factors influence the presence of nitrate in ground water. This will happen through local advisory teams. There are MDA agricultural scientists, computer modelers and hydrogeologists working with local farmers and crop advisors on each team and they are a high priority for implementation funding. We are very hopeful the voluntary approach will be successful.

Buzicky: There are sophisticated growers already doing some of these practices.

Q: The change in farming business over the decades?

Buzicky: The more business-like, the more sophisticated the organization, the more adaptable. Example: the Perham community is very proactive in protecting ground water and invites town residents to visit and learn about their activities. These Ag businesses want the same thing as all of us. One change from the past is a lot of land is owned by widows renting to larger farming operations.

Stoddard: Farm operations have been increasing in size. Larger operations are frequently better informed on new technology, have greater resources, and are able to take on more farming risks, so they are potentially better positioned to adopt new technologies and practices. However, the greatest risk from an environmental perspective is always the weather. More than fifty percent of the land is rented. A renter might not care as much as the owner about

long term strategies to manage a field. There may be an opportunity to work with renters to better manage rented land. Animal agriculture has also significantly changed over the years.

Buzicky: Smaller farms may not have changed practices much over the decades.

Q: How do farmers manage inputs to maximize profit?

Stoddard: Many farmers still don't follow the University of Minnesota BMPs, especially regarding proper crediting for all nitrogen sources. The BMPs are based on extensive field research. Nitrogen inputs include not only fertilizers but also contributions from previous crops, manure and other sources.

Q: How much cover did the Act give MDA in these activities?

Buzicky: It was great cover, and nothing would have happened without it.

Stoddard: It laid out all the activities that were needed to address a contaminant in ground water, and placed an emphasis on promoting practices that would prevent contamination from occurring, so it was of huge importance. Adequate funding is also critical. It provided a basis for developing requests for increased funding.

Q: Next actions or issues?

Stoddard: Promoting vegetative cover in high risk areas is a focus for MDA. We are also working on evaluating and promoting other practices such as precision agriculture. One of the challenges for addressing nitrate in ground water is lag time. The monitoring may be measuring older water (years to decades old) and recent practices may have changed. MDA is investing in the use of computer modeling tools to estimate nitrate losses for a wide range of practices and conditions. We believe this will be one of the most important tools for improving water quality from agricultural sources.

Q: Manure management progress?

Stoddard: MDA does not directly regulate manure but proper crediting for nitrate is addressed in the NFMP and the GPR. The University of Minnesota would benefit from increased funding to evaluate and promote Minnesota-specific manure management practices. MPCA is the lead agency for regulating manure and recently revised their permitting process.

Q: Nitrate HRL?

Stoddard: Some groups believe the health standard for nitrate should be 3 milligrams per liter (mg/L). MDA does not develop standards, but we consulted with MDH who indicated that the HRL should remain 10 mg/L.

6.1.6 Interview #6: Don Jakes and John Linc Stine

Date: April 23, 2020

Location: Zoom

Attendees: Gretchen Sabel, Jim Stark, Laurel Reeves, Jim Lundy, David Crisman

Don Jakes (MPCA, retired) worked on development of the Act, and for several MPCA ground water programs. John Linc Stine held positions at DNR, MDH, and MPCA (Commissioner), and is currently Executive Director of Freshwater Society.

Q: How was the Act developed?

Jakes: Comprehensive ground water protection was a goal of the MPCA ground water program through the 1980s and 1990s. Using Clean Water Act funding, the USEPA pushed State governments to fill the gaps of the big federal regulations--CWA, SDWA, Superfund, and so on—in order to protect ground water in a more comprehensive way. One step was developing a ground water protection strategy. It was clear from the outset that these law and capacity gaps extended well outside of the MPCA authority. In 1987, several starting points for the protection act existed: a new state Ground Water Protection Strategy, identifying sensitive areas, efforts toward better pesticide and nutrient management, wellhead protection of public water supply wells, ground water data management, overall state water plans, and so on. There were extensive stakeholder meetings to develop first the strategy and then the content of new legislation. EQB established an advisory committee involving diverse stakeholders. There were also various sources of pushback on new ground water protection authorities as concerns were raised about the goals and possible increased costs, fees, and regulation. Ultimately, the legislation crafted was successful in addressing or overcoming any remaining objections: it passed and was enacted.

Q: The MPCA separated ground water and surface water.

Jakes: Federal authority over ground water was, and still is, implemented through the big laws addressing different sources of either pollution or drinking water supply. At the MPCA, these were predominantly RCRA and Superfund, as the Clean Water Act focuses on surface waters. Mirroring the federal structure to some extent, the MPCA put these programs, and the Ground Water program along with them, into the Solid Waste and Hazardous Waste Division. This made

some sense but also created challenges in connecting surface water and ground water protections.

Q: What other outside factors played into the MPCA Ground Water Program?

Jakes: Many other topics and areas of need played into the initiative: nitrates, agricultural practices and other non-point sources, unsealed wells, protection of private water supply wells, better data and mapping to understand ground water systems and vulnerability, underground storage tanks, and flood/drought cycles culminating in the very severe drought of 1988. From a water supply standpoint, these extremes drove plenty of activities in the agencies in response. All the hydrologic buttons were being pushed during this time. We were starting to think of all the places where contamination might be also. "What haven't we thought of yet?" Wetland protection was also emerging as we were experiencing more wet areas during the wet years in the mid-1980s. By the late 1980s, there was increasing interest in water topics.

Q: Recollections of adopting the Act?

Stine: I was regulating (at DNR) so I was not involved.

Jakes: MPCA, BWSR, MDA, MDH, DNR, State Planning and others were involved or called on by the Legislature. The House bill was drafted first, by Representative Munger and others, and the Senate bill (Morse) soon followed, with numerous marathon hearings in the Senate.

Q: What topics were not included in the Act that should have been?

Stine: Wish it had more goals set to achieve or work toward prevention. We left so much room in achieving the objectives. We should have set benchmarks to work toward. The law failed to provide a numerical standard. Well testing didn't make it into the Act.

Q: Successes?

Jakes: Just a couple of major examples: many, many unused and abandoned wells got sealed, eliminating them as conduits for cross-contamination of aquifers. Ground water information was greatly enhanced. Ground water was mapped and essential ground water data was greatly increased.

Stine: A lot of hydrogeologists were hired within the state agencies, and they began talking to each other, so now we have a very solid technical community.

Q: MGWA contribution?

Stine: The conversation during the Spring and Fall MGWA conferences has been the source of innovation and these conversations are some of the seeds of change. In the government, it is difficult to have these conversations, and the current Administration / Governor causes some impact on them. In fact, it takes some time for agency culture to change after an administration changes.

Q: What issues did we have to ignore or were difficulties?

Stine: Emerging contaminants is a difficult task. The program crosses several agencies and it is difficult to move forward. No one agency wishes to charge ahead and be clipped by another agency. We tend to ignore those things that are hard to implement. This problem is not with the Act but with the implementation of the rules.

Q: Emerging Issues?

Stine: We should look at issues that are people-health-focused first, or separately children's health. If we talk about the environment, the audience tends to lose focus. Trust in experts is low.

Q: Issues important now but not discussed in 1989?

Stine: Climate change is the big issue--and affects precipitation, river flows, statistical validity. Agricultural chemical impacts are increasing. Our understanding of the pathways for nitrate contamination is improving. Drainage, manure management, and so on are other topics.

Q: Education? Are we getting traction?

Stine: There is no very good measure for that. A benchmark is needed and the Clean Water Council is working toward this measure. It helps to make the topic local.

6.1.7 Interview #7: Roger Renner and Dave Kill

Date: April 30, 2020
Location: Zoom
Attendees: Gretchen Sabel, Jim Stark, Laurel Reeves, Jim Lundy, David Crisman

Roger Renner is the owner of a well-known Minnesota drilling company. Dave Kill has worked many years for companies that support drilling and drinking water supply.

Q: What events in the 1980s led to the Act?

Renner: The Well Code was adopted in 1984 and pulled into the Act. Tony Rupert was instrumental for the Well Code development. Ron Thompson (MDH) wrote the well code section.

Q: What changes were made to the Well Code during 1988-1989? Well disclosures?

Renner: Yes, a change required property owners to disclose information about wells present at the site during real estate transactions. A more significant change increased the grouting depth from 30 to 50 feet. It may not have been enough of a change--full length grouting of casing failed. As a consequence, water mixing in the well causes iron problems, especially in Anoka county, and elsewhere too. As a result, we are seeing poor water quality in domestic wells and municipal wells.

Kill: Another factor driving the Act was the focus on underground storage tank (UST) contamination sites. As a result, ground water issues became elevated in the public arena.

Renner: Add the visibility of Superfund sites like TCAAP and FMC to the mix. New Brighton's situation of pulling contamination into supply wells was part of the story.

Q: If we open up the well code, what kind of support exists for changes?

Renner: There is good support, and we always have topics on the table to change. MDH controls the code, and the council is either a proposer or group to offer suggestions. MDH is a good listener when the Council has suggestions.

Q: Multi-aquifer wells?

Renner: Multi-aquifer wells have been banned since 1989, but many that were drilled earlier still exist. Our thinking is formation-focused rather than on where the water actually moves or how the chemistry is changing. The issue lacks importance with the general public. In some areas, it is difficult to prevent hydraulic connection between bedrock aquifers and the glacial material. These water-bearing units do differ in chemistry even if acting as one hydraulic unit. DNR has been talking to municipalities with multi-aquifer wells and owners are often surprised by this information.

Kill: We need to consider the formation, hydraulics and chemical changes within water bearing zones. This is different thinking than formation-oriented aquifer thinking or naming.

Q: "Multi-chemistry wells" may be the new term or way to evaluate water supply.

Kill: These are dynamic systems, whether it is hydraulics and chemistry causing the mixing and resulting water quality issues. With pumping we see mixing, and sometimes this is an improvement. Pumped systems can also complicate the mixing or water quality issue.

Q: Old wells that still exist that may not have been sealed?

Renner: The well owner usually isn't motivated unless the DNR uses the appropriation permit as the driver. There is no cycle for review. The well condition could drive a review if work is needed on the well and a permit is required. Water quality can push the issue also as it would involve a driller/pump professional. They may identify the problem.

Renner: An example of how the general public views this situation is highlighted by a story in Anoka. The City identified about fifty or sixty private wells that were or could be multi-aquifer. Anoka offered well owners a ninety percent reimbursement of the grouting cost if they paid the $125 permit fee and ten percent of the grouting changes. Basically, the cost share was $325 for the owner and $1800 for the City. Only ten wells were sealed under this program. Property owners don't see the value of sealing wells.

Kill: Another water quality problem to consider: two City of Ramsey municipal wells are off-line for elevated naturally-sourced manganese. The City considered the Mississippi River as a water source, but assessed it to be an unreliable water source and so rejected it. Instead they are drilling additional wells, planning to blend water as means of reducing the manganese concentrations.

Q: How did well setbacks change?

Renner: There are charts for determining distances from sources of pollution, septic and drain fields. These have been consistent since the 1980s. Wisconsin and Michigan are updating these distances, but no change is necessary to Minnesota setbacks.

Q: Is there new municipal water supply well work?

Renner: Municipalities control the production of water and the driving factor is money. Water conservation has reduced the need for new wells within municipal water systems. Often, changing the pump capacity is more economical than drilling a new well. But it can also cause new problems.

Kill: We can install variable-frequency drives for pumps to improve the well capacity. One customer added transducers and a variable speed pump with program logic control to slow the pump down as well water level drops. This strategy avoids dewatering the aquifer and improved the yield. A good metric is to look at kilowatt-hour per 100 gallons or 1000 gallons

pumped. This is being implemented at TCAAP to improve contaminant capture and pump less water.

Q: Are there other strategies for monitoring water-supply wells in real time? Water levels, chemical constituents, and so on.

Kill: There has been a lot of work on the sensors (vibration, water levels and quality) to improve real monitoring. Sensor environment is being adopted to streams more than in wells. Access to wells is less convenient than streams. The achilles' heel is always the sensor.

Renner: Water use is down. This affects the drilling business--fewer drillers can stay employed, and the older ones are dying off.

6.1.8 Interview #8: Jeff Broberg and Bruce Olsen

Date: May 7, 2020
Location: Zoom
Attendees: Gretchen Sabel, Jim Stark, Laurel Reeves, Jim Lundy, David Crisman

Jeff Broberg is founder and board member at-large for Minnesota Well Owners Organization (MNWOO), and lives in Elba, Minnesota. Bruce Olsen is a retired hydrogeologist (MGS, MDH).

Q: Talk about source water protection for private wells and the Act?

Olsen: I worked at MGS in 1989. I was excited the Legislature wanted to work on the Act, and that it was driven by contamination and other water-related issues. It ended up consolidating the sometimes conflicting existing laws. And with Superfund, the Act highlighted ground water issues and gave them more visibility. It gave the MDH the power to do wellhead protection. Sometimes the Act is known as the "hydrologist full-employment act".

Broberg: Or the "Ag is Off the Hook" Act. I had just returned to Minnesota, and Steve Morse was my representative. He was starting his involvement with political topics. And living near agricultural areas, he became interested in some Ag rules. He just reread the Act and there are areas of excellent requirements, Atlas program, non-degradation/prevention goal. And other things like the well code and the well index. And then there are escape clauses--the word "practicably". This allows us to claim it is 'practical' to remove trees and roots to plant row crops. After one year of corn growing, we can detect nitrates in ground water. BMPs are supposed to be an assessment and include environmental review. We don't include any cost-benefit analysis to measure the environmental impact in economic terms.

Q: Private Wells?

Olsen: For a new well, the well code can help you out. For owners of old wells, there is nothing.

Broberg: Private wells are missing in the Act. Most (eighty-five percent) of the land area is served by private wells, but it's only twenty-five percent of the population. That's why we need to protect sensitive areas. We are missing a significant issue, especially when it comes to nitrate contamination. Well disclosure helps in real estate transactions, but not if you are just a property (well) owner.

We are blessed to have the Act, but there are gaps. At Wadena, there is a large number of shallow, sand point wells, mostly free of nitrates for now. These wells are absent in the well records. So if a feedlot or fertilizer operation moved in, they could be contaminated, but without testing the owners would never know.

Olsen: The education standards have improved, so there is an opportunity there. The MGWA White Paper on education covers this ground. There is hope for elevating awareness of ground water and sharing concerns about regional contamination.

Q: Is there effective outreach?

Broberg: Most people cannot read a map. If you start the conversation with a geologic map or map of contamination, audience attention decreases and only twenty-five percent or less will continue to be interested. Same for some of the fact sheets on topics relevant to well ownership or contaminants in the water.

Olsen: Public water suppliers can manage land use, but only within their own jurisdiction.

Q: How to move forward?

Broberg: We are in a shifting paradigm between "the water should be perfect" and "we need to test to be sure". Focus on testing and make the test and any followup easy for private well owners. We should develop an interactive tool for learning how to treat for detected contaminants or to implement other remedies. Vermont has a tool for treatment approaches. And it should be county based. We recognize there is a significant variation in county abilities to address well issues ranging from finding unsealed, no-longer used wells, to dealing with contamination.

Olsen: The testing should include multiple contaminants and this could be broken down into zones or counties so you know what should be tested in your area. This may not be simple or low cost, because we need to consider such things as radium, arsenic, lead, pesticides, and maybe others.

Broberg: A good suggestion is to test at 'point of property sale' and then provide interactive tools, county-level support, or other information to support private well owners, for instance if a remedy is needed after a positive contaminant detection. And we need to reduce the fear of high treatment costs when a remedy is the appropriate action.

Broberg: At the County level there is an interesting contrast between well management and septic management. In Olmsted County, upgrading a septic system is regulated, but a similar level of regulation doesn't exist for wells. In MNWOO well classes, they try to communicate how to find problems or maintain a well, yet most owners don't know how to move upstream from the kitchen sink to a cause. A good point was well owners need to know how to assess neighboring activities that could impact the well. They don't understand they have legal remedies when the well water is contaminated or the levels change.

Q: Single test versus monitoring?

Olsen: Arsenic and some other contaminants could be addressed through a single test. Coliform and nitrate need to be monitored over time, which becomes costly. Well owners are very interested in the age of their water, which is measured using tritium. 'Vintage' versus recent water designation may help in southeastern Minnesota.

Olsen: In the source water protection program, MDH has the authority to protect all public water-supply wells. A good thing but the actions are significant.

Broberg: What's the value of water? In Minnesota, it's cheap. We should strike the word 'practicable' from the Act.

6.1.9 Interview #9: Kelton Barr, Bob Karls, Ray Wuolo

Date: May 14, 2020
Location: Zoom
Attendees: Gretchen Sabel, Jim Stark, Laurel Reeves, Jim Lundy, David Crisman

Kelton Barr is a ground water professional with nationwide consulting experience. He is a founding member of MGWA, and served several times as Association President. Bob Karls, MGWA president when the Act passed in 1989, is a ground water professional with international consulting experience. Ray Wuolo is Vice President and Senior Hydrogeologist with Barr Engineering, and has more than three decades of experience in the investigation of ground water flow and contamination.

Q: Where were you and how involved were you in the Act?

Karls: I was MGWA President that year, and John Helland wrote a column in the newsletter. I also wrote a President's Column on the topic, I'll send it. We have accomplished significant progress in public education. People are directly impacted by issues related to ground water.

Q: Was the Act a big deal?

Karls: The things leading up to it were a big deal. Superfund and UST laws were bringing focus to ground water. Droughts and wet years were also recent events. Then the work on ground water sensitivity.

Wuolo: I don't recall the Act so much, but I do remember some of the high profile contamination sites in the Twin Cities, Reilly Tar, General Mills...these were metro area focus, and there were also water quantity issues in the rural parts of the state. There was funding for ground water studies through the LCMR. The focus then was on water quality. Now it's more on water quantity: calcareous fens, source water protection. When the analytical element model failed, that was very significant. The Act was a "launch pad" for what came in the 1990s.

Barr: I was not in Minnesota at the time of the Act's passage. I worked for a national environmental consulting firm at the time, so my awareness of the Act was low. For this interview I did review materials, and am impressed with breadth of the Act--MPCA and MDA silos, the geological atlas program, and more. Was the MDA-MPCA "bifurcation" traced back to the passage of the Act? There seems to be evidence of MDA in setting the rules.

Q: What is missing or may have come to light since the passage of the Act?

Wuolo: The Act recognized ground water and surface water interaction. Minneapolis came close to fixing (needing to lower) their Mississippi River intakes in the 1988 drought. The area of ground water, and especially ground water and surface water interaction, is mostly out of public view, but the public gets concerned when the interaction causes something really visible like a drought. The focus of ground water and surface water interaction has evolved a bit since passage of the Act, but it is still important, and may need more regulation or consideration.

Karls: It's important to see the impact on society. Woodbury is bringing a treatment plant online for perfluorochemicals and there is concern with water supply shortages in terms of lawn watering bans. Northeast Metro groundwater protection area….but we still need to touch the third rail of Agriculture. The agriculture buffer zones issue showed there is opposition to any change to agricultural practice. (Same for) industry with high volumes of water use, like the bottling industry. These stories need to be told but we need to expect it will cause blowback.

Q: Monetary value of water? The provision of safe, plentiful drinking water is an engineering triumph, but as a result, drinking water is undervalued.

Barr: Water is viewed as plentiful. There is a protection and education issue here. How do you add cost to increase the value of water?

Karls: It can be a sliding scale based on use. You can't tell people what to not to do--leave it as a choice. Industry and municipalities are tracking water use and you could structure a model around it.

Wuolo: There is a better chance of grants to cities to improve irrigation systems. This allows us to avoid a policing issue.

Q: Exportation of Water?

Barr: And export of water has to be seen in the context of potential future scarcity. Where will that occur? What is the long term finite water supply? No one seems to have their eye on the horizon.

Wuolo: Climate needs to be factored in. Perhaps there is a staggeringly high cost to exporting water.

Q: "Yield" in the Act, versus "sustainability" in the CWLA.

Wuolo: "Sustainability" is the better term, which implies value. Hard to quantify, though. "Yield" has problems, and is a dangerous path to go down.

Barr and Karls: Agreed.

Wuolo: Yield is so specific and sustainability can be different in different locations.

Q: "Sustainability" is defined in statute.

Barr: Where can we increase the recharge of ground water? There are only a few locations where this can happen. There are areas of Dakota County where recharge could be protected from irrigation, but these lands are likely to be developed in the next ten to twenty years, so why do it?

Karls: Met Council has tried to do this and they are attacked for this work. The timeframe for ground water is decades, and the timeframe for legislators is weeks or months. We lack perfect knowledge. You could spend a huge sum protecting recharge, then lose all you gain in a few decades.

Q: Emerging Contaminants?

Barr: More locations will have water quality concerns, so emerging contaminants need to be added to the list.

Wuolo: If you look, you will find them. But we don't have the dollars to find all of them. How do you manage this effort? When the Act was passed, ground water was seen as essentially clean--so keep it clean. There was also a dependence on "cleanup", but this approach has often been disappointing in practice since that time.

Barr: It starts with public health. How do we define the scope of the problem, where is it going--but hydrogeologists don't determine what is a contaminant.

Wuolo: Legacy. Have agriculture become a part of the solution. Soil health, nutrients, moisture, tillage practice, and so on. This will be hard to do--but helpful.

Karls: Communication and education are key. Conflicting timeframes are important too.

6.2 Appendix B: Master Table, Minnesota 1989 Ground Water Protection Act

Summary of the Ground Water Protection Act of 1989 (SF 262, CHAPTER LAW)

Includes citation to current law, history of changes in law, implementation status and whether Clean Water Fund funding has been used in implementation.

Article 1: Groundwater Protection

Section	Summary of the Section	Citation to Current Law	Status	Clean Water Legacy Funding
1	States a goal that groundwater be maintained in its natural condition, free from degradation	https://www.revisor.mn.gov/statutes/cite/103H.001 History: *1989 c 326 art 1 s 1*	Established in law: no further action needed	
2	Definitions are provided for the purpose of the chapter created by Article 1 (MN Statutes 103H). Terms defined are: agricultural chemical, health risk limits, best management practices, common detection, degradation, fertilizer, groundwater, pesticide, plant amendment, pollutant, pollution, registered use, registrant, sensitive area, soil amendment, water resources protection requirements.	https://www.revisor.mn.gov/statutes/cite/103H.005 History: *1989 c 326 art 1 s 2*	Established in law: no further action needed	
3	A process is established for the commissioner of natural resources and the Minnesota Geological Society to designate sensitive areas. Sensitive areas are those areas where because of natural features where there is significant risk of contamination of groundwater from activities at or near the surface.	https://www.revisor.mn.gov/statutes/cite/103H.101 History: *1989 c 326 art 1 s 3; 1990 c 391 art 10 s 3; 1991 c 345 art 2 s 16; 2009 c 101 art 2 s 107*	Ongoing	Nitrogen fertilizer study - CWF is supporting implementation of GWProt rule. Local advisory teams, mapping, identification of DWSMAs.
4	Conservation easements are allowed for areas designated as sensitive areas and land in or immediately surrounding a sink hole.	https://www.revisor.mn.gov/statutes/cite/103H.105 History:	Established in law: no further action needed	Fund supports $13M for easement programs in 2021. Wetland restoration easements for denitrification.

		1989 c 326 art 1 s 4; 1990 c 391 art 10 s 3; 2009 c 176 art 1 s 50		Working lands/floodplain easement, critical shoreland easement, and CREP. BWSR estimates 10% directly affects GW.
5	A provision for a defense to liability is provided for a person who implements and maintains projects and practices from an adopted soil and water conservation plan that applies to the person's property and protection of groundwater.	https://www.revisor.mn.gov/statutes/cite/103H.111 History: 1989 c 326 art 1 s 5	Established in law: no further action needed	MN Ag Water Q Cert Prog provides10 years of regulatory certainty for certified farms. CWF provides $6M/biennium.
6	The commissioner of agriculture for agricultural chemicals and the pollution control agency for other pollutants must develop best management practices (BMPs) for the prevention of groundwater degradation. BMPs are by definition voluntary practices.	https://www.revisor.mn.gov/statutes/cite/103H.151 History: 1989 c 326 art 1 s 6; 1995 c 220 s 94; 2019 c 50 art 1 s 30	Ongoing, Incomplete. slow progress, when does it change from O to I. Increased requirements for Cl- in MS4 permit will be BMP's from MPCA.	Paul will send a list of programs. MDA Assistance to farmers, irrigation mgmt assist, U of MN nitrogen recs, etc. MS4 assistance to municipalities, smart salt, etc.
7	All monitoring of groundwater quality by state agencies and political subdivisions must be submitted to the environmental quality board. The board will assess the quality of the data and maintain a computerized database of groundwater data submitted.	https://www.revisor.mn.gov/statutes/cite/103H.175 History: 1989 c 326 art 1 s 7; 1991 c 345 art 2 s 17,18; 1994 c 557 s 16; 1999 c 86 art 3 s 11; 2009 c 101 art 2 s 107; 2010 c 392 art 1 s 12; 2012 c 272 s 59; 2013 c 134 s 30; 2013 c 142 art 3 s 36	Now with Minnesota Geospatial Information Office	CWF supports creation of data sets and MNWRL.
8	The commissioner of health is required to promulgate health risk limits for substances degrading groundwater. The commissioner must review and revise, if necessary, the limits every four years.	https://www.revisor.mn.gov/statutes/cite/103H.201 History:	Complete and Ongoing. HRLs have been promulgated, it's a regular ongoing process.	CEC program is funded by CWF. $2.4M.

	Existing recommended allowable limits for drinking water may be adopted by the commissioner of health as health risk limits.	*1989 c 326 art 1 s 8*; *1994 c 557 s 17*,*18*		
9	The commissioner of agriculture for agricultural chemicals and the pollution control agency for other pollutants are required to evaluate the detection of pollutants in groundwater. The commissioner or the agency must evaluate whether the pollution results from common detection and continue monitoring and evaluation to determine the pollution frequency and concentration trend.	https://www.revisor.mn.gov/statutes/cite/103H.251 History: *1989 c 326 art 1 s 9*	Ongoing	Township testing program is funded by CWF. $700K for MDA lab to make possible lower detection and greater range of pesticides..
10	The commissioner of agriculture for agricultural chemicals and the pollution control agency for other pollutants are required to manage pollutants where groundwater degradation is detected. Where degradation is detected, the commissioner of agriculture or the pollution control agency must promote the implementation of BMPs. If the BMPs are not effective, the commissioner of agriculture or the pollution control agency must adopt water resource protection requirements (WRPRs) that prevent and minimize pollution. The WRPRs can be for the whole state or a portion designated by order of the commissioner of agriculture or the pollution control agency.	https://www.revisor.mn.gov/statutes/cite/103H.275 History: *1989 c 326 art 1 s 10*; *1999 c 86 art 3 s 12*	Ongoing	See Agricultural Chemical Monitoring and Assessment | Minnesota Department of Agriculture (state.mn.us) and Pesticide Best Management Practices | Minnesota Department of Agriculture (state.mn.us)
11	The pollution control agency and the department of agriculture, in consultation with the board of water and soil resources, are required to conduct a study on nitrogen compounds in groundwater. The study will be submitted to the legislative water commission by July 12, 1991. The commissioner must provide recommendations to the legislature by November 15, 1991.	No longer in statute.		The CWF supported development of the Nitrogen Fertilizer Management Plan Nitrogen Fertilizer Management Plan, March 2015 (state.mn.us) and supports implementation of the new Groundwater Protection Rule.

Article 2: Water Research Information and Education

Section	Summary of the Section	Citation to Current Law	Status	
1	A legislative water committee is created to review state water policy and make recommendations to the legislature. The committee will consist of five members each from the house and the senate. The committee will sunset June 30, 1995.	https://www.revisor.mn.gov/statutes/cite/3.886 History: *2014 c 312 art 4 s 3*	Ongoing LWC was disbanded, now reconstituted as the Subcommittee on Minnesota Water Policy	
2	The commissioner of agriculture must establish a clearinghouse and other assistance to agricultural producers on sustainable agriculture and promote the use of integrated pest management.	https://www.revisor.mn.gov/statutes/cite/17.114 History: *1989 c 326 art 2 s 2; 1994 c 557 s 4-7; 1999 c 86 art 3 s 1,2; 2009 c 94 art 1 s 10; 2012 c 244 art 1 s 2,3*	Ongoing https://www.mda.state.mn.us/organic https://www.mda.state.mn.us/pesticide-fertilizer/integrated-pest-management	
3	An environmental agriculture program is established. The board of water and soil resources, after review by the legislative committee on water and the Minnesota future resources commission, must award contracts for the program.	Recoded as 103F.460 (Laws 1990, c 391, art 6, sec 69); then repealed (Laws 1994, c 557, s 27)	Ongoing	
4-6	Conservation easements under the reinvest in Minnesota resources program are allowed for sensitive area and hillsides used for pasture.	https://www.revisor.mn.gov/statutes/cite/103H.105 History: *1989 c 326 art 1 s 4; 1990 c 391 art 10 s 3; 2009 c 176 art 1 s 50*	Established in law: no further action needed	RIM Grassland Reserve--not funded by the CWF: RIM Grassland Reserve | MN Board of Water, Soil Resources (state.mn.us)
7	The environmental quality board must prepare and submit a report on water research needs to the joint legislative committee on water and the Minnesota future resources commission by September 15 of each odd-numbered year.	https://www.revisor.mn.gov/statutes/cite/103A.43 History: *1989 c 326 art 2 s 7;1989 c 335 art 1 s 269; 1994 c 557 s 12; 1995 c 220 s 91; 1999 c 86 art 3 s 7; 2006 c 243 s 21; 2008 c 363 art 5 s 15; 2012 c 272 s 27*	Complete and Ongoing	

8-10	The local water resources protection and management program is established under the board of water and soil resources to provide assistance to counties to develop comprehensive local water plans or to carry out water resource protection programs identified in the water plans.	https://www.revisor.mn.gov/statutes/cite/103B.3369 History: *1989 c 326 art 2 s 10; 1990 c 391 art 10 s 3; 1990 c 597 s 15; 1990 c 604 art 3 s 1,2; 1995 c 184 s 26,27; 2003 c 128 art 1 s 102-105; 2009 c 176 art 1 s 26; 2012 c 272 s 37; 2013 c 143 art 4 s 3; 1Sp2019 c 4 art 5 s 1,2*	Complete and Ongoing	
11	Sensitive areas and wellhead protection areas are added as components for which the comprehensive local water plans under statue must address	https://www.revisor.mn.gov/statutes/cite/103H.101 History: *1989 c 326 art 1 s 3; 1990 c 391 art 10 s 3; 1991 c 345 art 2 s 16; 2009 c 101 art 2 s 107*	Complete and Ongoing	Source water protection areas
12	The University of Minnesota is added as an ex official, nonvoting member of the board of water and soil resources.	Recoded as 103B.101, subd 3 (Laws 1990, c 391, art 2, sec 2); then repealed (Laws 1997, c 28, s 4)	Established in law: no further action needed	
13	Additional water planning duties are added to the duties of the environmental quality board and the board must have a new plan and strategy by November 15, 1990, and every five years thereafter.	https://www.revisor.mn.gov/statutes/cite/103B.151 (Laws 1990, c 391 art 2 s 3); subsequently amended (see History note in statute)	Established in law: no further action needed	

Article 3: Wells, Borings and Underground Uses

Section	Summary of the Section	Citation to Current Law	Status	Clean Water Legacy Funding
1	The current wells, borings and underground uses provisions in Minnesota Statutes, chapters 156A, 145A, 105, 84, 469 and 471 are recodified in chapter 103I.		Established in law: no further action needed	
9, subd. 1-3	A permit is required for all non-drive point wells constructed. Emergency permit exemptions are provided to protect public health or welfare, or to allow a well contractor to begin construction prior to obtaining a permit. Drive point wells are exempt from the permit requirement but after December 31, 1989, the owner of the well must notify the commissioner of health of the installation and location. A maintenance permit is required for a well that is not in use, inoperable and unsealed.	https://www.revisor.mn.gov/statutes/cite/103I.205 This summary is very detailed. The citation above includes all the points in this summary from Section 9 of the law.	Established in law: no further action needed	
9, subd. 4	A well contractor license is required to drill, construct or repair a well except: 1) a registered professional engineer, or certified hydrologist or hydrogeologist may construct a monitoring well; 2) a limited well contractor may modify well casings or screens, construct drive-point wells, or install pumps or pumping equipment; 3) an individual constructing a well on land they own or lease for farming or a place of abode; or 4)an individual performing labor or service for a contractor under the direction of the contractor.	https://www.revisor.mn.gov/statutes/cite/103I.205 History: *1989 c 326 art 3 s 9; 1990 c 597 s 28-33; 1991 c 355 s 18-23; 1992 c 507 s 22; 1994 c 557 s 20; 1999 c 153 s 7,8; 2005 c 106 s 22,23; 2013 c 108 art 12 s 108; 2013 c 114 art 4 s 74; 2014 c 312 art 23 s 1; 2015 c 54 art 1 s 1; 1Sp2017 c 6 art 10 s 15-20; 1Sp2019 c 9 art 11 s 7-9*	Established in law: no further action needed	
9, subd. 7	At grade monitoring wells are allowed for leak detection devices.	https://www.revisor.mn.gov/statutes/cite/103I.205 sub 5	Established in law: no further action needed	
9, subd. 6	Potential sources of contamination may not be placed closer to a well than isolation distances prescribed by the commissioner of health.	https://www.revisor.mn.gov/statutes/cite/103I.205 sub 6	Established in law: no further action needed	

9, subd. 7	A well identification label is required for all new wells.	https://www.revisor.mn.gov/statutes/cite/103I.205 sub 7.	Ongoing	
9, subd. 8	A report of well completion or sealing must be submitted to the commissioner of health within 30 days of completion. The commissioner of health must send a copy of the report to the commissioner of natural resources, the local soil and water conservation district, and the Minnesota Geological Survey	provision not found, but related requirements are in: https://www.revisor.mn.gov/statutes/cite/103I.301 sub 6 and https://www.revisor.mn.gov/statutes/cite/103I.325	Ongoing	
10	Permit fees are established for wells as follows: For a new well that produces less than 50 gpm, $50; For a new well that produces 50 gpm or more, $100 For an inoperable well, construction of a monitoring well or dewatering well, a groundwater thermal exchange device, or vertical heat exchanger, $50; Annually for an unsealed monitoring well, $50; Annually for a dewatering well, $25.	https://www.revisor.mn.gov/statutes/cite/103I.208 History: *1989 c 326 art 3 s 10; 1990 c 597 s 34; 1991 c 355 s 24; 1994 c 557 s 21; 1997 c 203 art 2 s 5; 1998 c 407 art 2 s 23; 1999 c 247 s 1; 1Sp2001 c 9 art 1 s 5,6; 2002 c 379 art 1 s 113; 2005 c 106 s 24,25; 1Sp2005 c 4 art 6 s 3,4; 2007 c 147 art 16 s 3,4; 2009 c 79 art 10 s 1; 1Sp2011 c 9 art 2 s 6,7; 2013 c 108 art 12 s 108; 2015 c 21 art 1 s 109; 1Sp2017 c 6 art 10 s 21,22; 1Sp2019 c 9 art 11 s 10*	Established in law: no further action needed Fees continue to fund the Well Program	
14	After July 1, 1990, a seller must disclose the location of known wells before signing an agreement to transfer real property. A seller who fails to disclose the existence of a well at the time of sale is liable to the buyer for costs and reasonable attorney fees relating to the sealing of a well.	https://www.revisor.mn.gov/statutes/cite/103I.235 History: *1989 c 326 art 3 s 14; 1990 c 597 s 35; 1991 c 292 art 2 s 2; 1991 c 355 s 26; 1992 c 544 s 6; 1994 c 557 s 22; 1997 c 7 art 1 s 23; 1999 c 11 art 3 s 6;*	Established in law: no further action needed	

		1Sp2001 c 9 art 1 s 7; *2002 c 379 art 1 s 113*; *1Sp2005 c 4 art 6 s 5*; *2007 c 147 art 16 s 5*; *2008 c 277 art 1 s 6*; *1Sp2011 c 9 art 2 s 8*; *1Sp2017 c 6 art 10 s 23*; *1Sp2019 c 9 art 11 s 11*		
15	The statute of limitations for a landowner's cause of action against a person whose action or inaction cause contamination of a well is established at six years after the owner discovers the contamination.	https://www.revisor.mn.gov/statutes/cite/103I.241 History: *1989 c 326 art 3 s 15*	Established in law: no further action needed	
16	Well sealing requirements are established for a well that: is contaminated was not sealed according to the provisions of this chapter; or endangers groundwater or is a safety or health hazard. Monitoring wells and dewatering wells must be sealed when no longer in use.	https://www.revisor.mn.gov/statutes/cite/103I.301 History: *1989 c 326 art 3 s 16*; *1990 c 597 s 36*; *1991 c 355 s 27,28*; *1992 c 544 s 7,8*; *1999 c 153 s 9,10*; *1Sp2017 c 6 art 10 s 24,25*; *1Sp2019 c 9 art 11 s 12,13*	Ongoing	Well sealing cost share is funded through CWF PG-Correct--although well sealing is now funded from CWF through BWSR and not MDH
17	The state is prohibited from purchasing or selling land without identifying the location of all wells.	https://www.revisor.mn.gov/statutes/cite/103I.311 History: *1989 c 326 art 3 s 17*; *1990 c 597 s 37*; *1991 c 355 s 29*; *2008 c 277 art 1 s 7*	Established in law: no further action needed	
18	The commissioner of health may order a well sealed that is: an imminent threat to public health and safety; required to be sealed under section 16, or a monitoring or dewatering well for which a maintenance permit is not renewed or obtained within 14 months after construction.	https://www.revisor.mn.gov/statutes/cite/103I.315 History: *1989 c 326 art 3 s 18*; *1992 c 544 s 9*; *1Sp2017 c 6 art 10 s 26*	Established in law: no further action needed	
19	Counties must issue sealed well certificates for wells properly sealed.	Repealed in 1990 https://www.revisor.mn.gov/statutes/cite/103I.321		

20	The landowner liability for a sealed well is removed for contamination of groundwater from the well that occurs after the well is sealed, on wells that have properly recorded sealed well certificates.	https://www.revisor.mn.gov/statutes/cite/103I.325 History: *1989 c 326 art 3 s 20; 1990 c 597 s 38; 2005 c 106 s 27*	Established in law: no further action needed	
21	A well-sealing cost-share program is established in the board of water and soil resources to provide grants to counties. The program sunsets June 30, 1995. Grants will be targeted to counties based on: the diversity of well construction, geologic conditions and land use; current use of affected aquifers; and aquifer susceptibility of contamination by unsealed wells. The state cost share is up to 76% or $2000. After July 1, 1991, only a well sealing that is a priority action identified in approved local water plans will be eligible for assistance.	Repealed, 1989 c 326 art 3 s 21, subd 6; 1994 c 557 s 23	Complete and Ongoing	Well sealing cost share is funded through CWF
22	A property owner may apply to the board of water and soil resources for funding to seal wells.	https://www.revisor.mn.gov/statutes/cite/103I.335 History: *1989 c 326 art 3 s 22*	Ongoing	Well sealing cost share is funded through CWF
23	The commissioner of health and the board of water and soul resources have a governmental services lien for the cost of wells sealed under contract.	https://www.revisor.mn.gov/statutes/cite/103I.341 History: *1989 c 326 art 3 s 23; 1992 c 544 s 10,11; 1997 c 7 art 1 s 24; 2005 c 4 s 27,28*	Established in law: no further action needed	
New in 1992	Well boring and sealing account established	https://www.revisor.mn.gov/statutes/cite/103I.345 History: *1992 c 544 s 12; 1993 c 206 s 1; 2005 c 106 s 28*	Established in law: no further action needed	
24	Elevator shaft borings may not be made without a permit from the commissioner of health.	https://www.revisor.mn.gov/statutes/cite/103I.401 History: *1989 c 326 art 3 s 24; 1994 c 557 s 24; 1997 c 203 art 2 s 6; 2005 c 106 s 29*	Established in law: no further action needed	

25	https://www.revisor.mn.gov/statutes/cite/103I.541	https://www.revisor.mn.gov/statutes/cite/103I.541 History: *1989 c 326 art 3 s 34; 1990 c 597 s 44-46; 1991 c 355 s 40,41; 1996 c 305 art 3 s 17,18; 1999 c 250 art 3 s 13; 1Sp2001 c 9 art 1 s 20-22; 2002 c 379 art 1 s 113; 2005 c 106 s 52; 1Sp2011 c 9 art 2 s 12; 1Sp2017 c 6 art 10 s 40-48*	Established in law: no further action needed	
30 and 33	The license fee for a well contractor's license of $250, and an elevator shaft contractor's license is $50. An application fee for each of $50 is also required. A statewide surety bond of $10,000 in lieu of license bonds required by political subdivisions is required.	https://www.revisor.mn.gov/statutes/cite/103I.525 History: *1989 c 326 art 3 s 30; 1990 c 597 s 40-42; 1991 c 355 s 31-34; 1996 c 305 art 3 s 12,13; 1999 c 250 art 3 s 10; 1Sp2001 c 9 art 1 s 8-11; 2002 c 379 art 1 s 113; 2005 c 106 s 32-37; 2007 c 124 s 1; 1Sp2011 c 9 art 2 s 9; 1Sp2017 c 6 art 10 s 31-35*	Established in law: no further action needed	
32	A limited well contractor's license and a limited well sealing contractor's license, with a license fee of $50 each, are provided for.	https://www.revisor.mn.gov/statutes/cite/103I.550 History: *1Sp2017 c 6 art 10 s 50*	Established in law: no further action needed	
35	After December 31, 1990, monitoring well contractors must meet examination and experience requirements of the commissioner of health. A statewide surety bond of $10,000 in lieu of license bonds required by political subdivisions is required. Application fees will be set by the commissioner of health.	https://www.revisor.mn.gov/statutes/cite/103I.541 History: *1989 c 326 art 3 s 34; 1990 c 597 s 44-46; 1991 c 355 s 40,41; 1996 c 305 art 3 s 17,18; 1999 c 250 art 3 s 13; 1Sp2001 c 9 art 1 s 20-22; 2002 c 379*	Complete	

		art 1 s 113; 2005 c 106 s 52; 1Sp2011 c 9 art 2 s 12; 1Sp2017 c 6 art 10 s 40-48		
44 and 45	Administrative remedies including denial, suspension, or revocation of licensure and administrative penalties are provided.	https://www.revisor.mn.gov/statutes/cite/103I.715 History: 1989 c 326 art 3 s 47; 1Sp2017 c 6 art 10 s 54	Established in law: no further action needed	

Article 4: Water Conservation

Section	Summary of the Section	Citation to Current Law	Status	Clean Water Legacy Funding
1	Provisions on agricultural irrigation permits and consistency of permits with state, regional and local water plans, deleted in section 2, are recodified.		Complete	CWF supports an Irrigation Specialist Position | Minnesota Department of Agriculture (state.mn.us)
2	The water allocation priorities are amended to place power production that meets contingency planning provisions within the first priority. Power production in excess of a contingency plan remains at fourth priority.	https://www.revisor.mn.gov/statutes/cite/103G.261 History: 1989 c 326 art 4 s 1; 1990 c 391 art 7 s 25; 1990 c 426 art 1 s 13; 1993 c 186 s 1; 2012 c 272 s 48	Established in law: no further action needed	
4	No new appropriation permits may be issued for once-through cooling systems using in excess of five million gallons annually.	https://www.revisor.mn.gov/statutes/cite/103G.271 Recoded as 103G.271, subd 5 (Laws 1990, c 391, a 7, s 27); subsequently amended	Complete	
5	A water-use processing fee is established for each water-use permit, replacing the current statutory system. Except for once-through cooling systems, the water use permit fee is .05 cents per	https://www.revisor.mn.gov/statutes/cite/103G.271 History:	Complete	

	10000 gallons for the first 50 million gallons and 0.1 cents per 1000 gallons for amounts about 50 million gallons. The maximum is $2000. The fee for once-through cooling systems is set at 5 cents per 1000 gallons until December 31, 1991, 10 cents per 1000 gallons during calendar years 1992-1996, and 15 cents per 1000 gallons thereafter. The fees are based on permitted capacity and a fee must be $25 or more.	*1990 c 391 art 7 s 27; 1990 c 594 art 1 s 49; 1990 c 597 s 63-65; 1991 c 214 s 6; 1991 c 234 s 1; 1991 c 354 art 10 s 5; 1992 c 366 s 1; 1992 c 601 s 1; 1993 c 186 s 3-5; 1994 c 557 s 15; 1995 c 218 s 10; 1997 c 104 s 1; 1998 c 401 s 38; 1999 c 231 s 128; 2001 c 160 s 1-3; 2003 c 128 art 1 s 116,117; 2005 c 89 s 1; 1Sp2005 c 1 art 2 s 121; 2006 c 281 art 1 s 21; 2008 c 363 art 5 s 19; 2009 c 37 art 1 s 34; 2010 c 361 art 4 s 52; 1Sp2011 c 2 art 4 s 14; 2012 c 272 s 50; 2013 c 114 art 4 s 69,70; 2014 c 312 art 13 s 20,21; 1Sp2015 c 4 art 4 s 92-94; 2017 c 93 art 2 s 116-119*		
6	Rules are authorized for conservation of public water supplies.	105.418 was repealed in Laws 1990 c 391 art 10 s 4. While other portions of 105.418 were recoded in 103G.291 by the 1990 law, the paragraph related to rules was dropped (likely duplicative of other rulemaking authority).	No rules were written	
7	Joint powers water management organizations are given authority to require water appropriation permits for nonessential uses below 10,000 gallons per day and one million gallons per year on protected watercourses in the metropolitan area with a drainage area less than 25 square miles.	https://www.revisor.mn.gov/statutes/cite/103B.211 Recoded by Laws 1990, c 391, art 2, s 7	Established in law: no further action needed	CWF supports Met Council Water Efficiency: Irrigation Efficiency - Metropolitan Council (metrocouncil.org) and Water Efficiency Grant Program - Metropolitan

				Council (metrocouncil.org) The Met Council's goal is to reduce groundwater use by 150 million gallons/year in the metro, and they are hitting that annual goal
8	The commissioner of natural resources must study and report by February 15, 1990, to the legislative water commission, on the impact of consumptive water use on existing aquifers.	This was a temporary provision, requiring no further action once the report was completed in 1990		

Article 5: Pesticide Amendments

Section	Summary of the Section	Citation to Current Law	Status	Clean Water Legacy Funding
1 – 15	New definitions are provided for collection site, container, corrective action, local unit of government, owner of real property, pesticide end user, returnable container and waste pesticides.		Established in law: no further action needed	
17	The commissioner of agriculture must develop a pesticide management plan for the prevention, evaluation, and mitigation of the occurrence of pesticides and pesticide breakdown products.	https://www.revisor.mn.gov/statutes/cite/18B.045 History: *1989 c 326 art 5 s 17; 1994 c 557 s 8; 1999 c 86 art 3 s 5*	Complete and Ongoing	
18	The state must use integrated pest management techniques on public lands.	https://www.revisor.mn.gov/statutes/cite/18B.063 History: *1989 c 326 art 5 s 18*	Complete and Ongoing	
19	Monitoring of urban and rural pesticide use must be done by the commissioner.	https://www.revisor.mn.gov/statutes/cite/18B.064 History:	Complete and Ongoing	CWF supports Pesticide Monitoring: Increased Capacity and Capability | Minnesota Department

		1989 c 326 art 5 s 19; 1990 c 391 art 10 s 3		of Agriculture (state.mn.us)
20	The commissioner of agriculture is required to establish a waste pesticide collection program to collect waste pesticides from pesticide end users. The commissioner may assess costs for disposal on the end users and use the money in the waste pesticide collection account to pay for expenses of the program.	https://www.revisor.mn.gov/statutes/cite/18B.065 History: 1989 c 326 art 5 s 20; 1993 c 367 s 3; 1Sp2001 c 2 s 35; 2007 c 45 art 1 s 22,23; 2008 c 297 art 1 s 2-5; 2009 c 94 art 1 s 48-54; 2012 c 244 art 1 s 4,5; 2015 c 44 s 4,5; 2017 c 88 art 2 s 12	Complete and Ongoing	
25-26	A chemigation permit and antisiphon device are required for applying pesticides through an irrigation system from any source of irrigation water.	https://www.revisor.mn.gov/statutes/cite/18C.205 History: 1989 c 326 art 6 s 11; 1990 c 597 s 5	Complete and Ongoing	
27	A fertilizer chemigation permit holder is exempt from the pesticide chemigation permit fee.	https://www.revisor.mn.gov/statutes/cite/18C.205 History: 1989 c 326 art 6 s 11; 1990 c 597 s 5	Established in law: no further action needed	
29	After June 30, 1994, pesticide dealers and distributors must accept waste pesticides that remain in the original container unless there is a designated place in the county to return the unused portion.	https://www.revisor.mn.gov/statutes/cite/18B.135 History: 1989 c 326 art 5 s 29; 1993 c 367 s 4; 1994 c 557 s 9	Complete and Ongoing	
31	The annual application fee for pesticide registration is increased from $125 to one-tenth of one percent of gross sales of the pesticide within the state, with a minimum fee of $150.	https://www.revisor.mn.gov/statutes/cite/18B.26 History: 1987 c 358 s 68; 1989 c 326 art 5 s 30-33; 1990 c 597 s 2; 1991 c 309 s 11; 1992 c 439 s 1; 1992 c 513 art 2 s 15; 1992 c 603 s 22; 1993 c 226 s 15; 1993 c 367 s 6,7; 1999 c 6 s 1;	Established in law: no further action needed	

		1999 c 231 s 39; 2003 c 128 art 3 s 26; 1Sp2005 c 1 art 1 s 17; 2007 c 45 art 1 s 24; 2008 c 297 art 1 s 7; 2009 c 94 art 1 s 55,56; 2013 c 114 art 2 s 32; 2016 c 189 art 2 s 9; 2017 c 88 art 2 s 13		
33	A person intending to discontinue registration of a pesticide in Minnesota must complete a total recall of the pesticide in the state within 60 days.	See above item, article 31	Established in law: no further action needed	
34	The commissioner of agriculture, in connection with the extension service, must develop innovative educational and training programs addressing pesticide concerns.	18C.511 [Repealed, 1989 c 326 art 6 s 34]		
46	The certification period for a private applicator is reduced from five years to three years.	https://www.revisor.mn.gov/statutes/cite/18B.36 History: *1987 c 358 s 78; 1989 c 326 art 5 s 45,46; 1993 c 367 s 9; 1995 c 95 s 3; 1997 c 131 s 3; 2001 c 7 s 12; 2002 c 373 s 8; 2010 c 333 art 1 s 8; 2017 c 88 art 2 s 19*	Established in law: no further action needed	
52	The department of agriculture, in consultation with the pollution control agency and the Minnesota extension service, is required to develop a pesticide container collection and recycling pilot project. The department is required to report to the legislature by November 30, 1991, on recommendations for managing pesticide containers.	https://www.revisor.mn.gov/statutes/cite/18B.135 History: *1989 c 326 art 5 s 29; 1993 c 367 s 4; 1994 c 557 s 9*	Complete and Ongoing	

Article 6: Fertilizers, Soil Amendments and Plant Amendments

Section	Summary of the Section	Citation to Current Law	Status
-	The current provisions on fertilizers, soil amendments and plant amendments from Minnesota Statures, chapter 17 are recodified in chapter 18C.	https://www.revisor.mn.gov/statutes/cite/18C	Established in law: no further action needed

Article 7: Agricultural Chemical Liability, Incidents and Enforcement

Section	Summary of the Section	Citation to Current Law	Status
1	Definitions	https://www.revisor.mn.gov/statutes/cite/18D.01 History: *1989 c 326 art 7 s 1; 1990 c 561 s 12; 1991 c 250 s 19,20; 1995 c 95 s 4*	Established in law: no further action needed
2	Liability – landowner is not liable for costs of cleanup if they have been using chemicals in compliance with rules	https://www.revisor.mn.gov/statutes/cite/18D.101 History: *1989 c 326 art 7 s 2*	Established in law: no further action needed
3	Incidents – responsible party must report incident when discovered; commissioner may require corrective actions or undertake actions if RP cannot be identified.	https://www.revisor.mn.gov/statutes/cite/18D.103 History: *1989 c 326 art 7 s 3; 1990 c 597 s 7; 1993 c 367 s 17*	Established in law: no further action needed
4	MN Dept of Ag is lead agency		
5	RP is responsible for costs. Payments for destruciton of wildlife to be deposited in game and fish fund. Landowner is not responsible for costs unless they were responsible for the incident. Civil liabilities can be applied.	https://www.revisor.mn.gov/statutes/cite/18D.105 History: *1989 c 326 art 7 s 4; 1993 c 367 s 18; 1995 c 95 s 5*	Established in law: no further action needed
6	Apportionment of liability is described.		

7	Inspection – Commissioner may enter site for inspection. Persons with knowledge of incident may request commissioner to inspect. Samples must be taken following US EPA protocol. Cost of MDA inspection may be assessed to RP. Commissioner may subpoena records and testimony.	https://www.revisor.mn.gov/statutes/cite/18D.201 History: *1989 c 326 art 7 s 7; 2000 c 477 s 20; 2011 c 14 s 10*	Established in law: no further action needed
8	Enforcement – enforcement authorities are described. Commissioner's discretion allowed. Civil actions may be taken by Attorney General or County Attorney. MDA may take administrative actions. Permits and licenses may be revoked. Criminal penalties may be assessed if humans are endangered.	https://www.revisor.mn.gov/statutes/cite/18D.301 to https://www.revisor.mn.gov/statutes/cite/18D.40 History: see individual sections	Established in law: no further action needed

Article 8: Agricultural Chemical Incident Payment and Reimbursement

Section	Summary of the Section	Citation to Current Law	Status
1	Citation – This chapter is the Agricultural Chemical Response and Reimbursement Law	https://www.revisor.mn.gov/statutes/cite/18E History: *1989 c 326 art 8 s 1*	Established in law: no further action needed
2	Definitions	https://www.revisor.mn.gov/statutes/cite/18E.02 History: *1989 c 326 art 8 s 2; 1992 c 500 s 15; 1995 c 182 s 1; 1996 c 407 s 15; 1999 c 231 s 41; 2002 c 373 s 10,11; 2007 c 45 art 1 s 31-33*	Established in law: no further action needed
3	The Agricultural Chemical Response and Reimbursement Account (ACCRA) is established. Allowable use of funds is established. Fee (surcharge) on permits, licenses and chemicals is established.	https://www.revisor.mn.gov/statutes/cite/18E.03 History: *1989 c 326 art 8 s 3; 1990 c 597 s 10-13; 1991 c 355 s 1,2; 1993 c 367 s 19-23; 1995 c 233 art 2 s 36; 1996 c 330 s 22; 1997 c 7 art 1 s 9; 1999 c 231 s 42; 2002 c 373 s 12; 1Sp2005 c 1 art 1 s 27; 2007 c 45 art 1 s 34; 2009 c 94 art 1 s 66,67; 2011 c 14 s 11*	Established in law: no further action needed

	Funds deposited in state treasury and credited to ACRRA.		
4	Reimbursement - Commissioner to reimburse eligible persons from ACRRA pending ACRRA Board approval. Contested case hearing allowed if commissioner declines payment.	https://www.revisor.mn.gov/statutes/cite/18E.04 History: *1989 c 326 art 8 s 4; 1990 c 597 s 14; 1991 c 355 s 3,4; 1993 c 367 s 24; 1995 c 182 s 2,3; 2000 c 477 s 22; 2000 c 488 art 3 s 10; 1Sp2001 c 2 s 38-40; 2002 c 373 s 13-15; 1Sp2007 c 2 art 3 s 5; 2008 c 297 art 1 s 9*	Established in law: no further action needed
5	ACRRA Board is established.	https://www.revisor.mn.gov/statutes/cite/18E.05 History: *1989 c 326 art 8 s 5; 1991 c 355 s 5; 1996 c 305 art 2 s 3*	Established in law: no further action needed
6	Annual reports required to Legislative Water Commission.	https://www.revisor.mn.gov/statutes/cite/18E.06 History: *1989 c 326 art 8 s 6; 1993 c 4 s 13; 1994 c 557 s 10; 1999 c 86 art 3 s 6; 2002 c 373 s 16; 2009 c 94 art 1 s 68*	Established in law: no further action needed
7	Commissioner of Finance to manage ACCRA. Purposes for which money may be spent is established, mirroring use of funds in the Environmental Response, Compensation and Compliance Fund (MPCA).	https://www.revisor.mn.gov/statutes/cite/115B.20 History: *1983 c 121 s 20; 1987 c 186 s 15; 1989 c 325 s 31; 1989 c 326 art 8 s 7; 1989 c 335 art 1 s 269; art 4 s 37-39,106; 1990 c 597 s 55; 1993 c 4 s 14; 1994 c 557 s 25; 1995 c 220 s 98; 1995 c 247 art 2 s 54; 1996 c 470 s 27; 1997 c 7 art 1 s 31,32; 1999 c 86 art 1 s 22; art 3 s 13; 2002 c 379 art 1 s 32-34; 2003 c 128 art 2 s 12; 2005 c 10 art 1 s 23; 2013 c 114 art 4 s 80*	
8	Commissioner to work the MPCA to create a priorities list for cleanup	Temporary provision; no further action required after report submitted in 1990	
9	MDA to conduct study on health and response risks of ag chemicals, due to legislature by Jan 15, 1990. Study must include a plan for assessing surcharges.	Temporary provision; no further action required after report submitted in 1990	

Article 9: Watershed Districts – Not addressed in this White Paper
Article 10: Appropriations – Not addressed in this White Paper

https://www.revisor.mn.gov/laws/1989/0/Session+Law/Chapter/326/

6.3 Appendix C: Review of Minnesota's Water Governance

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Supplemental Information:

Introduction

For many years, concerns have been expressed that Minnesota's water governance needs reform (EQB, 2015 Clean Water Roadmap and the Minnesota 25 by 25 Water Quality Goals; MPCA,2013; University of Minnesota, 2011). Recent bills, introduced in the legislature, reflect those concerns. Two papers in particular offer suggestions for reforming water governance. One report focused on water sustainability and recommendations for improved water governance (University of Minnesota, 2011). In 2013, the Minnesota Pollution Control Agency (MPCA, 2013), developed recommendations for improving water governance. These papers provide the background for the consideration in this appendix and the Minnesota Ground Water Association's White Paper review of the 1989 Ground Water Protection Act (Act).

Water Governance in Minnesota

Water dominates Minnesota's landscape. Our state is at the head of four continental-scale river basins, so almost all the state's water falls on lands of the state. This also means that Minnesotans are solely responsible for the quality and quantity of the state's water (University of Minnesota, 2011). In Minnesota, water is a public resource, and the State has the right to regulate the use of water within its boundaries, and to determine the scope of private water rights. The State holds title to public waters and the lands beneath them in trust for the general public. Private rights to water are governed by a "riparian doctrine" where the traditional common law doctrine of riparian rights apply. This doctrine implies that owners of the adjacent

land, and the groundwater beneath it, have use rights to the water bodies touching that land. However, the riparian doctrine has been modified through legislatively enacted regulations, and riparian rights to water are not absolute. Rather, they give adjacent landowners the right to reasonably use and can enjoy a water body as long as that use does not interfere with the public's rights or the rights of other riparian owners. (University of Minnesota, 2015; MPCA, 2013).

To understand water governance in Minnesota, it is important to know how water policy, regulation, and management have evolved and changed. This evolution involved transition from the draining of excess water for agricultural improvement, to the protection and restoration of our waters; from farming practices that did not recognize adverse impacts on natural resources and natural systems to statewide adoption of soil and water conservation practices; and from discharge of raw sewage and pollutants into water bodies to implementation of water quality standards. Water policy changes also reflect decisions and actions made in other areas that include energy, land use, transportation, public health, and economic development (University of Minnesota, 2011, 2015; MPCA, 2013). A detailed history of the evolution of water governance in Minnesota is presented in the Supplemental Information Section of this paper. Agencies, boards, and organizations involved with Minnesota's water management also are described in the Supplemental Information Section.

Background on the Need for Reforming Water Governance

This appendix considers "water governance" to be structures and processes used to protect and utilize Minnesota's water resource. Recurring proposals to change the structure of Minnesota's water governance have been made. Despite criticisms, it is important to recognize that many of Minnesota's water programs are well designed and managed, and are considered among the best in the nation. Minnesota's water related agencies are coordinated, due in part to the required activities of the Clean Water Fund's Interagency Coordinating Teams. Agencies have also created working groups to address specific aspects of the Clean Water Fund and some emerging problems (Helland, 1986; Brand and Finley, 1990; University of Minnesota, 2011, 2015; MPCA, 2013). However, there remains a need for improvement.

Although water governance in Minnesota is considered exemplary, many of Minnesota's water resources remain impaired or are trending toward impairment. Non-point source pollution, drainage, and over-use of groundwater supplies continue to be major problems. There remains the need for greater coordination across the different levels of governance, from the local to statewide. Because governing policies have developed over time, and in response to specific issues, water governance structure remains somewhat fragmented and diffuse. Certain aspects of Minnesota's water management system are confusing and frustrating to local units of government and citizens, resulting in continued calls for reform (Clean Water Roadmap and the Minnesota 25 by 25 Water Quality Goals, Helland, 1986; Brand and Finley, 1990; University of Minnesota, 2011, 2015; MPCA, 2013).

The issue of reforming water governance, and reviews of water governance in Minnesota are not new. The fundamental question is whether water governance needs to be changed. Proactively addressing concerns about water governance could present unnecessary obstacles to groundwater sustainability efforts. There have been several reviews of water governance over the past twenty years. They all offer recommendations regarding greater cooperation and efficiencies that should be considered for implementation. The reviews generally agree that water management is not as efficient as it could be. However, these evaluations do not present a clear vision for a better or more efficient organizational structure or for the need for a major change in governance.

Minnesota's waters are governed by hundreds of laws, regulations, rules, and ordinances involving more than twenty federal agencies, more than six state agencies, and many local units of government. These agencies have individual and specific missions and are bound by individual federal and state laws. These constraints have created silos, overlaps, conflicts, and contradictions in implementation. Water governance is not as adaptive, flexible, or resilient as it could be. Over time, a multiplicity of state, regional and local water-management organizations have been created that contribute to the challenging patchwork of entities (Helland, 1986; Brand and Finley, 1990; University of Minnesota, 2011, 2015; MPCA, 2013). A short description of the local, State and federal agencies involved in water governance in Minnesota is included in the Supplemental Information Section of this appendix.

Two governance review papers are fundamental. In 2011, the University of Minnesota published a report on water sustainability (University of Minnesota, 2011). That report, which involved many of the state's water experts, was conducted at the request of the Minnesota Legislature, in response to the passage of the Clean Water, Land and Legacy Amendment. The legislature directed the University of Minnesota to construct a framework to describe needs to accomplish goals that drove the passage of the amendment. The result was the publication of the Minnesota Water Sustainability Framework, which laid out pressing issues needed to ensure sustainable water as well as strategies, and recommendations for how to meet these challenges. Suggestions for revised water governance were included. Most of the suggestions in that report have not been accomplished.

More recently, the Minnesota Pollution Control Agency (MPCA, 2013), in cooperation with other state water-management agencies, the Metropolitan Council, and the University of Minnesota, developed recommendations for improving Minnesota's water governance. This evaluation was authorized by the Minnesota Legislature in 2011 (Laws 2011, 1st Special Session, Chapter 2, Article 4, and Section 33). The legislation asked the MPCA to evaluate water-related statutes, rules, and governing structures to streamline, strengthen, and improve sustainable water management.

Two different views of water Governance have evolved from these reports (University of Minnesota, 2011: MPCA 2013) and from other important publications (Helland, 1986: Brand and Finley, 1990). Collectively, they address obstacles resulting from the existing water

governance structure and policy and offer suggestions for improvement (Brand and others, 1990; University of Minnesota, 2011; Helland, 2001; MPCA, 2013; MPCA, 2014a). One view suggests that state and local water governance is too complicated and involves too many state, local, regional, and federal agencies that do not cooperate and are not well-integrated. This view also suggests that the existing network of water programs discourages coordinated long-term water planning and policy. The resulting recommendation is that the shortcomings should be addressed by combining state-level governance and management into a single "Department of Water" to improve efficiency and simplify services to citizens.

However, combining water-related governance into one agency could risk diluting existing agency objectives and some protective features could be lost. For example, a combined "Department of Water" would house functions currently within MDH (safe drinking water) with the functions currently at MDA (water and agriculture), forcing them to compete within a single agency. Large-scale changes to water governance and policy also risks interrupting existing federal funding mechanisms and individual state agency mission goals. This scale of reform would be significant and would involve major changes to organizational structure and resources. The restructuring of large government agencies often involves significant realignment of personnel, each having unique program expertise and institutional memory. A change of this magnitude should involve considerable study and evaluation (Helland, 1986; Brand and Finley, 1990; University of Minnesota, 2011, 2015; MPCA, 2013).

A second school of thought recognizes the strengths of the current system of cooperation among individual agencies. The Clean Water Land and Legacy Act has resulted in more and better coordination among staff across agencies. Advocates argue that the current system of strong, competing agencies, with specific duties and specific goals, promotes coordination as well as healthy competition among agencies. It also focuses on the importance of specific agency missions and goals and allows for legislative, rather than administrative, resolutions of priorities, tradeoffs, and conflicts. The current system results in healthy competition among the various agencies. Although the agencies cooperate better than ever before, there remains the need for a specific and greater coordination (Brand and Findley, 1990; University of Minnesota, 2011; Helland, 2001; MPCA, 2013; MPCA, 2014a).

Based on recommendations from existing reports, and because the natural environment continues to change, considerations for changes to water governance need to be carefully evaluated. There is an increasing need to better coordinate water policy across agencies in the face of uncertain future conditions, emerging contaminants, emerging technology, changing demographics, changing land use, changing climate, economic uncertainty, and aging infrastructure, while avoiding unintended consequences are issues that also need to be considered. Funding priorities need to be evaluated, within established grant programs, that involve technological uncertainty. In order to create an improved process, there also is a need to strengthen communication between the legislature and state agencies (Helland, 1986; Brand and Finley, 1990; University of Minnesota, 2011, 2015; MPCA, 2013). In order to ensure adequate and clean water for the future, we need to balance long-term plans for conserving

and protecting our natural resources with those for ensuring a healthy public and healthy economy.

There are several good suggestions, described in the reports referenced in this appendix, that provide recommendations for improved agency cooperation. They provide a strategy for a desired future for managing groundwater sustainably. Some of those recommendations, in the following section, are offered for consideration by decision makers. They provide an approach for protecting our water for future generations and a first step in a process to address an uncertain future for state waters.

Specific Suggestions for Improving Inter-Agency Water Governance

The ICT and its teams and sub-teams are well-positioned to address issues regarding water governance and policy, including improved coordination of groundwater efforts among the state water agencies. The cooperation of the ICT, and its sub-teams in cooperation with the CWC, have developed the Minnesota Water Management Framework, which lays out state agency and local partner roles for managing surface water and groundwater.

To improve coordination between water agencies, the expansion for stable, transparent interagency cooperation is needed that is accountable, responsive, inclusive, and empowered. ICT roles could be expanded beyond coordinating CWLLA funding. In so doing, the ICT could provide needed and expanded coordination for all groundwater programs across the agencies. The Interagency Groundwater/Drinking Water and Interagency Watershed Management/Implementation Teams could optimize the work on groundwater issues and coordinate water resource management through a watershed approach.

A collaborative approach that promotes groundwater protection through numerous activities should be considered. Slight changes would allow water agencies to collaborate to offer assistance in integrating prevention activities into state and local plans that include local water management plans, wellhead protection plans, groundwater management area plans, surface water protection plans as well as a nutrient reduction strategy.

To support efforts toward groundwater sustainability, reducing barriers to existing enforcement authorities, including those related to groundwater protection are needed. As an example, the DNR has authority to adjust appropriations in support of groundwater sustainability. However, there is no enforcement portion of MS 103G.287, Subd. 5. for DNR to pursue violations of permit conditions. Reducing barriers to existing enforcement authorities across the water agencies could be a fundamental step toward ensuring groundwater sustainability.

Other governmental changes would also make governance more efficient. Using existing successful organizations as an example, the Metropolitan Council relies on the Metropolitan Area Water Supply Advisory Committee and the associated Technical Advisory Committee to

prepare the Twin Cities Master Water Supply Plan (Metropolitan Council, 2010, updated 2015), a regional framework for long-term water supply planning supported by regional groundwater flow modeling.

In summary, further development of water governance in Minnesota will benefit groundwater sustainability. Two reports (University of Minnesota, 2011; MPCA, 2013) document the Governance issues that need attention and provide specific recommendations for improving Minnesota's system of water governance. Proposed actions to promote groundwater sustainability are:

- Continuation of the existing state agency water-governance structure
- Allowing existing groups, like the Interagency Coordination Teams, to continue and to strengthen their coordinating roles that would include greater transparency and possibly broader membership
- Following and expanding successful water policy and governance models--using the Metropolitan Council's Technical Advisory Team's approach as an example.

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Minnesota. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/98976. Associated WRC archived White papers as follows:

- Water Use in Minnesota
- Water Availability in Minnesota
- Water Quality in Minnesota
- Agricultural Water Use Technical Work Team Report
- Domestic Water Use Technical Work Team Report
- Manufacturing and Energy Water Use Technical Work Team Report
- Recreational, Spiritual, and Cultural Uses of Water
- Technical Work Team Report Ecosystem Services Technical Work Team Report
- Policy Technical Work Team Report
- Water Education Technical Work Team Report
- Water Valuation Technical Work Team Report Public Water
- Infrastructure Needs Report Citizen Stakeholder Outreach Efforts Report

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