Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August 2005

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August, 2005

To: The Citizens of Wisconsin
The Honorable Governor Jim Doyle
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State Geologist James Robertson - Geological and Natural History Survey

The Groundwater Coordinating Council (GCC) is pleased to release its 2005 Report to the Legislature. The GCC was formed in 1984 to help state agencies coordinate non-regulatory activities and exchange information on groundwater. For the past 20 years, the GCC has served as a model for interagency coordination and cooperation among state agencies, the Governor, local and federal government, and the university. It is one of the few groups in the nation to effectively coordinate groundwater activities in its state from an advisory position.

This report summarizes GCC and agency activities related to groundwater protection and management in FY 05 (July 1, 2004 to June 30, 2005) and provides an overview of the condition of the groundwater resource. See the *Executive Summary* for highlights and the GCC's recommendations in *Future Directions for Groundwater Protection*. The full report is available online at *http://dnr.wi.gov/org/water/dwg/gcc/rtl/gccreport.htm*.

Highlights of the State's groundwater protection activities this past year include:

- Organizing the first meetings of the Groundwater Advisory Committee and taking other steps to begin implementation of the new groundwater legislation 2003 Wisconsin Act 310;
- Completion of source water assessments for all 11,500 public water supply systems in Wisconsin;
- Incorporation of Wisconsin's groundwater monitoring strategy, including both quantity and quality needs, into the state's water monitoring plan;
- Developing a Groundwater Information Network email list to share information with a broad range of agencies and organizations interested or involved in groundwater education.
- Continued efforts through participation in teacher workshops, a groundwater festival for students, Farm Technology Days, county groundwater programs and other opportunities to share with others the importance of protecting groundwater.

We hope you will find this report to be a useful reference in protecting Wisconsin's valuable groundwater resource.

Sincerely,

Todd Ambs, Chair
Groundwater Coordinating Council

The GCC is an interagency group that is directed by law to assist State agencies in the coordination and exchange of information related to groundwater programs. See the GCC web site for more information (http://dnr.wi.gov/org/water/dwg/GCC/).

EXECUTIVE SUMMARY

This is the Executive Summary of the annual Report to the Legislature by the Groundwater Coordinating Council (GCC) as required by s. 15.347, Wisconsin Statutes. The report describes the condition and management of the groundwater resource and summarizes the GCC's activities for fiscal year (FY) 2005. The full report along with several appendices can be accessed online at *http://dnr.wi.gov/org/water/dwg/gcc/rtl/gccreport.htm*.

In 1984, the Legislature enacted 1983 Wisconsin Act 410 to improve the management of the state's groundwater. The GCC is directed by s. 160.50, Wis. Stats., to "serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management. The Groundwater Coordinating Council shall advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research."

Membership of the GCC includes the Secretaries of the Departments of Natural Resources (DNR); Commerce; Agriculture, Trade and Consumer Protection (DATCP); Health and Family Services (DHFS); Transportation (DOT); the President of the University of Wisconsin System (UWS); the State Geologist; and a representative of the Governor. Agency designees are listed on the inside of the front cover. More information about the GCC and its activities can be found on the GCC web pages: (*http://dnr.wi.gov/org/water/dwg/gcc/index.htm*).

Highlights from each of the major parts of the Report are summarized below.

GROUNDWATER COORDINATION

The GCC, its Subcommittees, and member agencies worked together to address groundwater management issues and coordinate groundwater activities in FY 05. Examples include:

1. *The first steps were taken to begin implementation of the Groundwater Protection Act, 2003 Wisconsin Act 310.* The Groundwater Advisory Committee (GAC), required by Act 310, was formed in the spring of 2005 and the first two meetings were held. Two work groups were created to assist the GAC in addressing technical issues.

2. *The GCC Monitoring and Data Management Subcommittee worked with DNR Groundwater staff and interested groups to integrate the statewide groundwater monitoring strategy into a statewide water monitoring strategy*. The Subcommittee modified the groundwater monitoring strategy developed in 2004 to integrate it into a statewide water monitoring strategy. The groundwater monitoring strategy is a comprehensive effort establishing a framework to gather both groundwater quality and quantity data. There are now 8 subteams working on implementation of the DNR water strategy, including one for groundwater.

3. *The Education Subcommittee developed a Groundwater Information Network to make linkages to a broader base of people involved in groundwater education.* In response to one of the recommendations of the Groundwater Summit, the subcommittee focused on expanding its membership to increase access to other groups that work on groundwater education issues in the state. The Subcommittee decided to create an email advisory group, called the Groundwater Information Network (GIN), with which to share information. A total of 14 groups were interested and joined the GIN.

4. *The third annual "Wisconsin Groundwater Festival" was held in Eau Claire on May 6, 2005*. The Statewide Groundwater Guardian Coordinator and the Eau Claire Groundwater Guardian Team organized this event, with planning and participation from many state agencies, the USGS, and UW Extension. The event attracted some 530 5th and 6th graders plus teachers from around the State and offered a host of hands-on learning activities about various groundwater topics. Next year's festival is planned for northeast Wisconsin.

5. *For the fifth year in a row, three groundwater workshops for teachers were taught jointly by staff from the DNR, WGNHS and the Center for Watershed Science and Education at UW Stevens Point.* The workshop leaders taught the teachers how to use a groundwater sand tank model and gave them additional resources to incorporate groundwater concepts into their classroom. Teachers from eight different schools attended each workshop and took a groundwater model back to their school free of charge. With funding from an EPA grant, 120 groundwater models have been given to schools since 2001.

6. *The GCC and the UWS Groundwater Research Advisory Council (GRAC) continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies*. The GCC approved the FY 06 solicitation for groundwater research and monitoring proposals, which was sent out in September 2004 (see *Appendix D*). A total of 29 project proposals were received. A comprehensive review process resulted in the selection of 16 new projects for funding for FY 06, eight by UWS and 8 by the DNR. The GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 06 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 05.

7. *The GCC approved reorganization of its Subcommittees.* In FY 05, the GCC approved a reorganization of the GCC Subcommittees to more effectively meet current needs. The functions and members of the Planning and Mapping Subcommittee were merged with the Local Government Subcommittee and Monitoring and Data Management Subcommittee. The Planning and Mapping Subcommittee no longer exists. In addition, the Monitoring and Data Management Subcommittee was maintained as one Subcommittee, but the tasks will be divided between two workgroups.

SUMMARY OF AGENCY GROUNDWATER ACTIVITIES

State agencies and the University of Wisconsin System addressed a number of issues related to groundwater protection and management and implementation of Chapter 160 in FY 05:

1. *Groundwater Protection Act Implementation* – In May of 2004, the statutes regarding high capacity wells were expanded to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Other statutory changes include notification and fees to be collected along with all new well construction and requirements for reporting water use on an annual basis for new and existing high capacity wells. The DNR established procedures for and began requiring notification of any new water supply well prior to drilling. As of May 1, 2005, the DNR must be notified before any new well is installed and a notification fee of $500 paid to the DNR for any high capacity well and $50 for all other wells. The DNR also facilitated the organization and first two meetings of the Groundwater Advisory Committee (GAC) as required by Act 310. The GAC is to recommend management approaches in two Groundwater Management Areas and further statutory changes. The DNR is currently working through a separate appropriation process to obtain the necessary staff positions and funding to implement the new programs created by the law.

2. *Source Water Assessments* - The DNR completed assessments for all, approximately 11,500, public water supply systems in the State by the end of 2004. Regional Source Water Assessment Program (SWAP) staff hand-delivered completed assessments to municipal systems. Smaller systems were notified when their assessment was available. The results of all of the assessments are available on the Internet. Visit the DNR's web page to see the assessment results: *http://dnr.wi.gov/org/water/dwg/swap/index.htm*.

3. *Start-up Site Assessment Grants for Brownfields* - In FY 05, the DNR Remediation and Redevelopment Program awarded 45 Site Assessment Grants totaling approximately $1.7 million to assist 31 communities across the state. Small grants up to $30,000 make up 36 of the awards, while nine are large grants between $30,000 and $100,000. Local governments have also pledged more than $900,000 in additional funds for the projects, well beyond the 20 percent match required through the application process.

The grants will provide funds for environmental activities on 107 acres of land. Activities include 128 site assessments and investigations, the demolition of 63 buildings or structures and the removal of 87 tanks, drums and other abandoned containers. Since 2000, 257 grants have been awarded to 134 communities around the state for work on 850 acres of land.

4. *Partnering for $400,000 brownfield grant for 30th St. Corridor Work in Milwaukee* - The DNR, in partnership with the city of Milwaukee and the 30th Street Industrial Corridor Corporation, applied for and received two EPA brownfield site assessment grants – a $200,000 grant for hazardous substances and another $200,000 for petroleum contamination. The partnership group is the first created by Wisconsin's Reinvestment Initiative, which will assist with redevelopment in economically and environmentally distressed areas of the state.

5. *Nutrient management plans* - DATCP, through its land and water resource management program, provides funding primarily to counties to assist in the protection of water resources through farmer adoption of nutrient management planning. In FY 05 approximately $100,000 was provided to develop tools for nutrient management plans on farms to maximize profitability and to minimize excessive runoff of nutrients to surface and groundwater. Additionally, staff worked to train farmers, consultants, and local agencies on the principles of sound nutrient management and how to comply with performance standards.

6. *Environmental Health Tracking Network* - DHFS has begun work on developing environmental public health tracking modules for childhood cancer, multiple sclerosis (MS) and amyotrophic lateral sclerosis (ALS) to create data systems that link information on relevant hazards, exposures and health outcomes. In support of this CDC-funded initiative, DHFS is working with DNR to access groundwater and drinking water data to improve the tools available to state and local health officials to investigate reports of disease clusters and respond to other environmental health inquiries. Other partners in this project include DATCP, the University of Wisconsin - Madison's School of Medicine and Division of Information Technology (DoIT), and the Wisconsin State Laboratory of Hygiene.

7. *Groundwater project reports online* - The UW Water Resources Library disseminates the results of more than 120 groundwater research projects funded since 1989 by itself, DNR, DATCP and the state Department of Commerce through its Web site devoted to the Wisconsin Groundwater Research and Monitoring Program at *http://www.wri.wisc.edu/wgrmp/wgrmp.htm*. Many of the final reports are available online in full text.

8. *Wisconsin Water Policies Inventory (WWPI)* - This Web-based online tool for researching the state's major policies pertaining to water was developed by the WRI in cooperation with a UW-Madison graduate seminar. This project, undertaken for the 2003 Year of Water observance, enables Wisconsinites to browse state water policies by category or to search the database by using key words. The URL is *www.aqua.wisc.edu/waterpolicy*. This public resource provides Wisconsin citizens with easy access to state laws, rules and programs governing Wisconsin's water resources.

9. *New groundwater use project* - In FY 04, the WGNHS was awarded funding for a two-year project investigating changes in groundwater pumping. The project began in FY 05 and will focus on determining the cause of exponential growth in groundwater pumping that has occurred in Waukesha County over the last several decades, and compare this to changes in groundwater pumping that have occurred in a predominantly rural area (Sauk County). This study, funded by the USGS and the Water Resources Institute, will also evaluate methods for tracking groundwater pumping in Wisconsin.

10. *Great Lakes Water Availability Study* - The USGS received funding to undertake a water availability study in the Great Lakes. This will be a valuable effort in light of the groundwater quantity concerns in eastern Wisconsin. This will be a 5-year study and will build on modeling work by the USGS and WGNHS in southeast Wisconsin. More details at *http://www.usgs.gov/budget/2006/wateravail021405.pdf.*

CONDITION OF THE GROUNDWATER RESOURCE

Major groundwater quality and quantity concerns in Wisconsin include:

1. *Volatile Organic Compounds (VOCs):* Sources of VOCs in Wisconsin's groundwater include landfills, underground storage tanks, and hazardous substance spills. Thousands of wells have been sampled for VOCs. Fifty-nine different VOCs have been found in Wisconsin groundwater. Trichloroethylene is the VOC found most often in Wisconsin's groundwater.

2. *Pesticides*: Pesticide contamination in groundwater results from field applications, pesticide spills, misuse, or improper storage and disposal. The most commonly detected pesticides in Wisconsin groundwater are: metabolites of alachlor (Lasso) and metolachlor (Dual); atrazine and its metabolites; metribuzin (Sencor); and a metabolite of cyanazine (Bladex). DATCP databases show that about 40% of private wells tested have atrazine detections, while about 1% have atrazine over the groundwater enforcement standard of 3 µg/L. A recent DATCP survey of 336 private drinking water supplies showed that 38% of wells contain a detectable level of a herbicide or herbicide metabolite.

3. *Nitrate*: Nitrate-nitrogen is the most common contaminant found in Wisconsin's groundwater. Nitrate can enter groundwater and surface water from a variety of sources including farm fields, animal feedlots, septic tanks, urban storm water, and decaying vegetation. Concentrations of nitrate in private water supplies frequently exceed the state drinking water standard of 10 mg/L. In 2005, DNR aggregated and analyzed data from three extensive statewide groundwater databases as part of a "Condition of the Resource" paper focused on the contamination of nitrate in Wisconsin groundwater. This combined dataset from DNR's Groundwater Retrieval Network (GRN) database (25,894 samples), the Center for Watershed Science and Education database (21,525 samples) and DATCP's groundwater database (1,399 samples), includes only the most recent nitrate result for each sampled private well. Out of the 48,818 samples, 5686 (11.6 %) equaled or exceeded the ES of 10 mg/L.

4. *Microbial agents*: Microbiological contamination often occurs in areas where the depth to groundwater or the depth of soil cover is shallow, or in areas of fractured bedrock. Microbial agents include bacteria, viruses, and parasites. These agents can cause acute illness and result in life-threatening conditions for some population groups. In one assessment, approximately 23% of private well water samples statewide tested positive for total coliform bacteria, an indicator species of other biological agents. Approximately 3% tested positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract. Viruses are increasingly becoming a concern as new analytical techniques have detected viral material in private wells and public water supplies.

5. *Radionuclides*: Naturally-occurring radionuclides, including uranium, radium, radon, and gross alpha are becoming an increasing concern for groundwater quality, particularly in the Cambro-Ordovician aquifer system in eastern Wisconsin. The water produced from this aquifer often contains combined radium activities in excess of 5 pCi/L, in some cases in excess of 30 pCi/L. Nearly 60 public water systems exceed the drinking water standard of 15 pCi/L for gross alpha activity. New federal standards are causing many communities to search for alternative water supplies.

6. *Arsenic*: Naturally occurring arsenic has been detected in wells throughout the State of Wisconsin. DNR historic data show that 3,830 public wells and 3,013 private wells have detectable levels of arsenic. About 10% of these wells exceed the new Federal drinking water standard of 10 µg/L. The highest concentration of arsenic detected in a private well in Wisconsin is 15,000 µg/L. Arsenic has been detected in well water samples in every county in Wisconsin. However, the problem is especially prevalent in northeastern Wisconsin where increased water use has likely mobilized arsenic into the groundwater. The State continues to proactively address arsenic concerns through well drilling advisories, health studies, well testing campaigns, and studies aimed at improving geological understanding and developing innovative treatment technologies.

7. *Groundwater quantity*. Despite a general abundance of groundwater in Wisconsin, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural, and domestic use and for adequate baseflow to our lakes, streams, and wetlands. Groundwater use grew from 570 to 804 million gallons per day (Mgal/d) from 1985 to 2000. Groundwater quantity problems have occurred naturally

and from human activities, and often affect groundwater quality. Regional effects of groundwater withdrawals are well documented in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. Localized effects of groundwater pumping on trout streams, springs, and wetlands have been documented throughout the state. The groundwater quantity legislation passed by the Legislature and signed in law on Earth Day 2004 represents a first step at managing groundwater quantity on a comprehensive basis.

BENEFITS OF MONITORING AND RESEARCH PROJECTS

Pharmaceuticals and personal care products - There has been increasing interest in recent years about the potential for pharmaceuticals and personal care products (PCPs) to contaminate Wisconsin's groundwater resources. Pharmaceuticals such as antibiotics, birth control pills and various prescription medicines may be present in wastewater effluents. PCPs, including shampoos, detergents and "over the counter" medications, are found in both treated wastewater discharges and the municipal solid waste stream. Some pharmaceutical/PCP compounds may act as endocrine disruptors, adversely affecting the behavior of natural hormones in humans and other animals. New analytical methods, allowing detection of very small quantities of a substance, have helped improve investigations into the occurrence of pharmaceuticals and PCPs in the environment.

Discharges of treated wastewater through land treatment systems, leachate leaking from solid waste landfills, and agricultural/municipal biosolids landspreading activities can potentially contaminate groundwater aquifers. Recent studies in other states, assessing the occurrence of pharmaceuticals and PCPs, have shown the presence of these substances in groundwater at sites where treated wastewater is used to recharge groundwater.

In Wisconsin, research has been done evaluating the occurrence, and movement in the subsurface, of pharmaceuticals and PCPs. A 2003 University of Wisconsin (UW) study, conducted by K.G. Karthikeyan and William F. Bleam, investigated the presence of antibiotics in treated wastewater effluents, and their potential fate in the subsurface. Two antibiotics, tetracycline and sulfamethoxazole, were found in all of the wastewater effluents tested for the study and other antibiotics were also detected. A second UW study, conducted by Joel Pedersen and K.G. Karthikeyan, found that under the right soil conditions some antibiotics, such as the sulfonamide antibiotics, have the potential to be fairly mobile in the subsurface. Several other pharmaceuticals/PCP studies are currently in progress.

Studies comparing the levels of pharmaceutical and PCP substances in wastewater influent with those present in treatment system effluents will be useful in assessing the removal effectiveness of currently approved wastewater treatment processes. Research into the behavior of pharmaceutical and PCP substances in soil and groundwater will help the Department develop effective monitoring strategies, and studies evaluating new sampling techniques and analytical methods assures that the Department is utilizing the best available tools to assess the occurrence of these substances in the environment.

FUTURE DIRECTIONS FOR GROUNDWATER PROTECTION

The GCC recommends the following priorities for future groundwater protection and management:

1. **Restore adequate funding for groundwater monitoring and research**: State budget cuts have severely limited the number and scope of groundwater research and monitoring projects that were funded in the past three fiscal years (see Table 3 in Chapter 2). Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC encourages its member agencies and the Legislature to restore adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

2. **Address groundwater quantity management issues at both statewide and regional levels:** Groundwater quantity issues came to the forefront of public discussion in FY 04, with the development and passage of landmark groundwater quantity legislation, 2003 Wisconsin Act 310. This legislation has the potential to address needs identified by two recent forums, the 2001 Groundwater Summit and the Waters of Wisconsin

Initiative. Common themes included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues. The GCC will continue to serve as a resource for addressing scientific and technical questions related to groundwater quantity and facilitate further dialogue among all parties on potential approaches and solutions.

3. **Support implementation of a Statewide Groundwater Monitoring Strategy:** Chapter 160 of the Wisconsin Statutes requires the DNR to work with other agencies and GCC to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present. In 2004, several agencies worked together to develop a Statewide Groundwater Monitoring Strategy to guide agency monitoring efforts for the next ten years to address both groundwater quality and quantity needs. This strategy recognizes the importance of long-term data collection to be able to make informed decisions based on science. The GCC encourages agencies, the university, and federal and local partners to implement the various components of the strategy and to seek funding to support its implementation.

4. **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited from the consistent educational messages that have been endorsed by the GCC. In 2005, the GCC's Education Subcommittee launched a "Groundwater Information Network" with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection. Priorities include promoting water stewardship and awareness of water quantity issues, finding innovative ways to encourage testing of private water supplies, and providing materials for local communities to support comprehensive planning activities. It is important that this effort continue to make sure that the public gets consistent messages about groundwater protection.

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Chapter 1 -- INTRODUCTION

PURPOSE OF THE REPORT

The Groundwater Coordinating Council (GCC) is required by s. 15.347, Wis. Stats., to prepare a report which "summarizes the operations and activities of the council..., describes the state of the groundwater resource and its management and sets forth the recommendations of the council. The annual report shall include a description of the current groundwater quality of the state, an assessment of groundwater management programs, information on the implementation of ch. 160, Wis. Stats., and a list and description of current and anticipated groundwater problems." This report is due each August. The purpose of this report is to fulfill this requirement for fiscal year 2005 (FY 05).

The activities of the Council and its subcommittees, including coordination of groundwater monitoring and research programs, are described in the chapter titled *Groundwater Coordination*. The chapter *Summary of Agency Groundwater Activities* describes groundwater management programs and implementation of ch. 160, Wis. Stats., by the individual state agencies in FY 05. *Condition of the Groundwater Resource* provides an assessment of Wisconsin's groundwater quality and quantity, as well as current and anticipated groundwater problems. The *Benefits from Monitoring and Research Projects* chapter describes how research and monitoring findings are used to better manage groundwater resources in Wisconsin. The recommendations of the Council are contained in *Future Directions for Groundwater Protection*.

SUMMARY OF WISCONSIN'S GROUNDWATER LEGISLATION

1983 Wisconsin Act 410, Wisconsin's Comprehensive Groundwater Protection Act

Wisconsin has a long history of groundwater protection. The first major milestone in this effort was adoption and implementation of 1983 Wisconsin Act 410, Wisconsin's Comprehensive Groundwater Protection Act, which was signed into law on May 4, 1984. The law expanded Wisconsin's legal, organizational, and financial capacity for controlling groundwater pollution. 1983 Wisconsin Act 410 created Chapter 160, Wisconsin Statutes, which serves as the backbone of Wisconsin's program. Chapter 160 provides a multi-agency comprehensive regulatory approach, using two-tiered numerical standards, based on the premise that all groundwater aquifers in Wisconsin are entitled to equal protection. There are a number of major components to Wisconsin's groundwater quality protection program:

1) Standards. Under chapter 160, Wis. Stats., the Department of Natural Resources (DNR) must establish state groundwater quality standards based on recommendations from the Department of Health and Family Services (DHFS). Standard setting is a continuing process based on a priority list of substances detected in groundwater or having a high possibility of being detected, established by the DNR in conjunction with other state agencies. The state groundwater standards are contained in chapter NR 140, Wisconsin Administrative Code. For each substance there is an enforcement standard (ES) which determines when a violation has occurred and a preventive action limit (PAL) which is set at a percentage of the ES. The PAL serves as a trigger for possible remedial action.

2) Regulatory Programs. Once groundwater quality standards are established, all state agencies must manage their regulatory programs to comply. Each state regulatory agency must promulgate rules to assure that the groundwater standards are met and to require appropriate

responses when the standards are not met. The state regulatory agencies are the DNR (solid and hazardous waste, industrial and municipal wastewater, remediation and redevelopment, wetlands and water supply); the Department of Commerce (private sewage systems, petroleum product storage tanks and petroleum environmental clean-up fund); the Department of Agriculture, Trade and Consumer Protection (DATCP) (pesticide use and storage and fertilizer storage); and the Department of Transportation (DOT) (salt storage).

3) Aquifer Classification. One of the most important features of Wisconsin's groundwater law is an item that was omitted. When Wisconsin was debating the groundwater protection legislation, the U. S. Environmental Protection Agency (EPA) tried to develop a nationwide groundwater approach. A keystone of EPA's proposal was aquifer classification - a scheme whereby each aquifer would be classified according to its potential use, value or vulnerability, and then would be protected to that classification level. This entails "writing off" certain aquifers as industrial aquifers not entitled to protection and never again usable for human water supply. Wisconsin said "no" to aquifer classification. The philosophical underpinning of Wisconsin's groundwater law is the belief that all groundwater in Wisconsin must be protected equally to assure that it can be used for people to drink today and in the future.

4) Monitoring and Data Management. At the time the groundwater legislation was created, there was concern that Wisconsin needed a groundwater monitoring program to determine whether the groundwater standards were being met. Therefore, a groundwater monitoring program was created under s. 160.27, Wis. Stats. Money from the Groundwater Account of the Environmental Fund has been used for problem-assessment monitoring, regulatory monitoring, at-risk monitoring, and management-practice monitoring, as well as establishment of a data management system for collection and management of the groundwater data.

5) Research. Although all state agencies must comply with the groundwater standards, the processes by which groundwater becomes contaminated, the technology for cleanup, the mechanisms to prevent contamination, and the environmental and health effects of the contamination are often not well understood. In addition, the basic data on geology, soils, and groundwater hydrology is often not available. The UWS and the state agencies have recognized that additional efforts in these research areas are badly needed. The Governor and the Legislature included a new groundwater research appropriation for the UWS beginning with the 1989-1991 biennial budget. Since 1992, the UWS, DATCP, DNR and Commerce have participated in a joint solicitation for groundwater-related research and monitoring proposals.

6) Coordination. In establishing the groundwater law, the Legislature recognized that management of the state's groundwater resources was a responsibility divided among a number of state agencies. Therefore, the GCC was created to advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater. The Council has been meeting since 1984.

7) Local Groundwater Management. The Groundwater Protection Act clarified the powers and responsibilities of local governments to protect groundwater in partnership and consistent with state law.

   a. Zoning authority for cities, villages, towns and counties was expanded to "encourage the protection of groundwater."

b. Counties can adopt ordinances regulating disposal of septage on land (consistent with DNR requirements); cities, villages, or towns may do so, if the county does not.

c. Counties can regulate (under DNR supervision) well construction and pump installation for certain private wells.

d. Property assessors must consider the time and expense of repairing or replacing a contaminated well or water supply when assessing the market value of real property; they must consider the "environmental impairment" of the property value due to the presence of a solid or hazardous waste disposal facility.

Wisconsin's Groundwater Protection Act, 2003 Wisconsin Act 310

After several years of discussion on groundwater quantity issues in the state, Governor Doyle issued a challenge to legislators on Earth Day 2003 to have groundwater quantity legislation for him to sign on Earth Day 2004. Senator Neal Kedzie and Rep. DuWayne Johnsrud took up this challenge and convened a group of stakeholders to draft legislation. In March of 2004, a bill was passed in both houses with only one dissenting vote.

On Earth Day, April 22, 2004, Governor Doyle signed a new groundwater protection law, 2003 Wisconsin Act 310, that expands the State's authority to consider environmental impacts of high capacity wells and institutes a framework for addressing water quantity issues in rapidly growing areas of the state.[1] This legislation recognizes the link between surface water and groundwater, and that all wells have an impact on groundwater quality and quantity. The law applies many principles of adaptive management, allowing for changes in the regulation of high capacity wells as relevant information becomes available or groundwater conditions change.

Major components of the legislation include:

1) *Tracking well construction and water use.* As of May 1st, 2005, well owners are required to obtain approval of a high capacity well (pumping more than 100,000 gallons per day) by the DNR prior to construction, pay a fee of $500, and submit an annual pumping report to DNR. For any new well that is not a high capacity well, the owner must notify DNR of the well location prior to construction and pay a fee of $50. The fees directly support the administration of this Act, including tracking well construction, review of high capacity well applications, and collection of groundwater data. In addition, fees will support increased inspections and enforcement of well construction activities, helping to ensure a safe drinking water supply. The law requires all high capacity well owners to report water use on an annual basis, including ones with existing approvals. Previously, only municipal water supply wells were required to submit pumping reports, along with some high capacity wells that required reporting as part of their approval. The collection of this information will assist in evaluating proposed new wells, monitoring approval conditions, identifying trends, calibrating groundwater flow models, and improving water use estimates, all contributing to better understanding and management of groundwater resources.

2*) Expanded regulation of high capacity wells.* The Act requires DNR to undertake an environmental review (under ch. NR 150, Wis. Adm. Code), for the following proposed high capacity wells:

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1 More details can be found at the Wisconsin State Legislature website:
Text of Act 310: *http://www.legis.state.wi.us/2003/data/acts/03Act310.pdf*
Legislative Council memo: http://www.legis.state.wi.us/lc/act_memo/2003/act310-ab926.pdf

- Wells located in a “groundwater protection area” (an area within 1,200 feet of an Outstanding or Exceptional Resource Water or any Class I, II, or III trout stream).
- Wells that may have a significant environmental impact on a spring with a flow of at least one cubic foot per second for at least 80% of the time.
- Wells where more than 95% of the amount of water withdrawn will be lost from the basin.

In these cases, DNR may deny or limit an approval to assure that these wells do not cause significant environmental impact. There are also protections and exceptions for public water utility wells. For example, the DNR must weigh the public health and safety benefits of a proposed well in a groundwater protection area or near a spring if it is to be used for a public water supply. In these cases, the DNR must balance the well’s environmental impact and its public health and safety benefits. Some of the criteria that might be used for this "balance test" include provisions for water conservation, appropriate use (drinking water vs. lawn watering or car washing), and long range water supply planning. The DNR must also ensure that a public utility's water supply is not impaired by another high capacity well, maintaining a long-standing requirement from previous statutes.

3) *Designation of groundwater management areas.* The Act directs the DNR to establish two groundwater management areas in Southeastern Wisconsin and the Lower Fox River Valley. These areas will include Waukesha and Brown Counties, and surrounding cities, villages and towns where the water level of the deep sandstone aquifer has been drawn down more than 150 feet since pre-development. In the Lower Fox River Valley, this could include portions of Outagamie and Calumet Counties, while in Southeastern Wisconsin it could include Kenosha, Racine, Milwaukee, and Ozaukee Counties, and portions of Washington and Walworth Counties. The intention of the groundwater management area is to encourage a coordinated management strategy among the state, local government units, regional planning commissions, and public and private users of groundwater to address problems caused by over-pumping of the deep aquifer, including increased levels of radium, arsenic and salinity. The DNR will assist local government units and regional planning commissions in those areas as they undertake research and planning related to groundwater management.

4) *Creation of a Groundwater Advisory Committee.* The Act establishes a Groundwater Advisory Committee. The Committee is to make recommendations regarding:

- the regulation of wells in groundwater protection areas, that have a water loss of 95 percent or more, or that have a significant environmental impact on a spring;
- the definition of springs;
- adaptive management approaches;
- the potential for the use of general permits; and
- factors to be considered in determining whether a high capacity well causes significant environmental impact.

The Act also directs the Groundwater Advisory Committee (GAC) to recommend legislation that addresses the management of groundwater within groundwater management areas and any other areas of the state where a coordinated strategy is needed. The Committee may identify other parts of the state that should be designated as groundwater management areas, and will recommend how and when this designation may be removed. The Committee is to issue reports to the legislature no later than December 31, 2006 regarding groundwater management areas, and December 31, 2007 regarding its review of the implementation of the new regulations. If the committee fails to submit these reports, the DNR may adopt rules to address management of groundwater in the groundwater management areas.

In the Spring of 2005, GAC members were appointed by the Governor and Legislature to represent municipal, environmental, agricultural and industrial interests. The Groundwater Advisory Committee has already met twice. The DNR received appropriations and positions to begin implementing the new legislation in the 2005-2007 biennial budget. The GCC will track progress of the implementation and provide assistance on education, research, monitoring, planning, and data management needs related to the new legislation.

Chapter 2 -- GROUNDWATER COORDINATION

The Groundwater Coordinating Council (GCC) is directed by s. 160.50, Wis. Stats., to "advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research." To assist in this work, the GCC is authorized to create subcommittees on "the subjects within the scope of its general duties…and other subjects deemed appropriate by the Council." Additionally, the GCC is directed to "advise the Secretary of Administration on the allocation of funds appropriated to the Board of Regents of the University of Wisconsin under s. 20.285(1)(a) for groundwater research."

The purpose of this chapter is to describe the activities of the Council and its Subcommittees during FY 05, as well as the coordination of the Wisconsin Groundwater Research and Monitoring Program. Through these activities, the GCC continues to play an important role in ensuring agency coordination, increasing efficiency and facilitating the effective functioning of state agencies in activities related to groundwater protection and management. Ultimately groundwater is better protected, which protects public health and preserves Wisconsin's natural resources for future generations.

GROUNDWATER COORDINATING COUNCIL

The GCC consists of the heads of all state agencies with some responsibility for groundwater management plus a Governor's representative. The agency heads have appointed high-level administrators with groundwater responsibilities to sit on the Council. The state agencies include the DNR, Commerce, DHFS, DATCP, DOT, WGNHS, and the UW System. The GCC has created four subcommittees to assist in its work. The subcommittees are composed of approximately 60 people including members of the GCC, employees of state and federal agencies, university researchers and educators, representatives of counties and municipalities and public members. Through FY 05, the DNR has had one permanent position with half of its responsibilities related to coordination of the GCC.

The GCC took an active role in many groundwater issues and activities during FY 05, several of which are highlighted and summarized here.

Addressing Long-Term Groundwater Management Needs

In October 2001, the GCC facilitated an event called "Wisconsin's Groundwater Summit." The Summit brought together a broad spectrum of groundwater users and stakeholders to discuss issues facing groundwater protection and management and develop solutions to better protect Wisconsin's groundwater. Representatives from over 50 organizations, agencies, and other groups with a stake in safe and adequate groundwater supplies attended the meeting. These included environmental, conservation, and agricultural groups, industrial users, water utilities, local and tribal government, planning agencies, state and federal agencies, and university researchers and educators. Findings and recommendations from the Summit are contained in the document *Sharing Our Buried Treasure: A Summary of the 2001 Groundwater Summit* available at http://dnr.wi.gov/org/water/dwg/gcc/SOBT.pdf.

Summit participants identified 9 "Key Themes" to guide groundwater management activities over the next decade:

1) Clarifying "Whose Water is it?"
2) Recognizing the Connections Between Groundwater and Surface Water
3) Evaluating and Managing Threats to Groundwater Quality
4) Linking Land Use Planning and Groundwater Protection
5) Developing a Comprehensive Approach to Groundwater Quantity
6) Addressing Water Use and Conservation Issues
7) Exploring Options for Regionalization of Water Management
8) Building a Groundwater Constituency through Public Education and Involvement
9) Collecting Long-Term Groundwater Data to Address Long-term Problems

During the past year, the GCC and its Subcommittees continued to address strategies suggested by these Key Themes. The Education Subcommittee developed a Groundwater Information Network to make linkages to a broader base of people involved in groundwater education, including non-profit groups, consultants, well drillers, and water utilities (*Key Theme 8)*. The Monitoring and Data Management Subcommittee developed a long term groundwater monitoring strategy (*Key Theme 9)*. Several research priorities identified at the Summit were incorporated into the FY 06 Solicitation for Proposals, particularly those related to implementation of the groundwater monitoring strategy and the groundwater quantity law *(Key Themes 2, 6 and 9).*

There have been a number of collaborative efforts to promote groundwater protection in the comprehensive planning process by local governments (*Key Theme 4*). In 2002, representatives from three GCC Subcommittees prepared and distributed three Comprehensive Planning and Groundwater Fact Sheets to promote inclusion of groundwater information in comprehensive plans. The fact sheets were reviewed and updated in 2005. Through the Wisconsin groundwater research and monitoring program, two projects have been funded to address how to make groundwater information available to local governments for use in comprehensive plans. In addition, the DNR's Land Use Team is providing training in the use of computer tools that would be useful for planning purposes.

The historic groundwater quantity law signed by Governor Doyle on Earth Day 2004 (see *Introduction* and groundwater quantity discussion in *Condition of the Resource* chapter) addressed several key themes of the Groundwater Summit. The law recognizes that groundwater quantity issues need a more comprehensive approach (*Key Theme 5).* For the first time, impacts of groundwater withdrawals on surface waters were acknowledged in statutory language *(Key Theme 2).* Provisions requiring reporting of water use for high capacity wells *(Key Theme 6)* and the creation of Groundwater Management Areas *(Key Theme 7*) also reflect a more comprehensive approach.

The GCC was an active participant in the process that led to the creation of the groundwater quantity law through the creation of a Quantity Subcommittee and discussions at its quarterly meetings. Many subcommittee members and agency representatives contributed data, research findings, maps, modeling scenarios, and technical expertise to help answer questions and ensure that the legislation was based on sound scientific principles. The GCC will continue to play a role in the implementation of the legislation, through its research and monitoring oversight, as well as making technical information and expertise available to the Department of Natural Resources and the Groundwater Advisory Committee created by the legislation.

Implementing a Statewide Groundwater Monitoring Strategy

A new statewide groundwater monitoring strategy was completed in FY 05 with the help of representatives from the DNR, DATCP, USGS, WGNHS, UW Stevens Point, and the Wisconsin Academy of Sciences, Arts, and Letters. The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in the state.

Over the next ten years, components of the strategy will be integrated into DNR's overall water monitoring plan which was adopted in FY 05. Other agencies will also continue to make improvements in their monitoring efforts based on the comprehensive strategy. The components of the strategy may change over time according to needs of the different agencies.

Information and Outreach Activities

Through the efforts of the Education Subcommittee, a Groundwater Information Network was created to communicate with groups and organizations working on groundwater education. This group of 14 organizations is emailed Subcommittee minutes and other relevant information. See Education Subcommittee summary for more information.

The third annual "Wisconsin Groundwater Festival" was held in Eau Claire on May 6, 2005. The event was organized by the Statewide Groundwater Guardian Coordinator and the Eau Claire Groundwater Guardian Team, with planning and participation from many state agencies, the USGS, and UW Extension. The event attracted over 500 5th and 6th graders plus teachers from around the State and offered a host of hands-on learning activities about various groundwater topics. Next year's festival is planned for northeast Wisconsin.

For the fifth year in a row, three groundwater workshops for teachers were taught jointly by staff from the DNR, WGNHS and the Center for Watershed Science and Education at UW Stevens Point. The workshop leaders taught the teachers how to use a groundwater sand tank model and gave them additional resources to incorporate groundwater concepts into their classroom. Teachers from eight different schools attended each workshop and took a groundwater model back to their school free of charge. With funding from an EPA grant, 120 groundwater models have been given to schools since 2001.

Coordination of Groundwater Research and Monitoring Program

The GCC, the UW System, and the Groundwater Research Advisory Council (GRAC) continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies, as specified in a November 2002 Memorandum of Understanding (MOU). (Details are found in the section on *Wisconsin's Groundwater Research and Monitoring Program*). The GCC approved the FY 06 Solicitation for Proposals in August of 2004 (see *Appendix D*). In January 2005, members of 2 GCC Subcommittees reviewed the proposals that were submitted and made their recommendations to the agencies and GRAC. The GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats., at its February meeting and a letter was sent to the UW System president and the Department of Administration to this effect.

Through these coordination activities, the GCC helps create efficiencies in the proposal submittal process and help ensure that taxpayer dollars are directed at the most pressing needs for groundwater information.

Other Coordination Activities
The GCC continued to promote communication, coordination and cooperation between the state agencies through its quarterly meetings. The meeting minutes are included in Appendix B. In addition to the activities listed above, the GCC received briefings and heard presentations on:

- Subcommittee activities (see below)
- 2004 and 2005 GCC Report to the Legislature
- UWS FY 05 groundwater research plan
- FY 06 and 07 joint solicitation for groundwater proposals
- Agency updates
- Groundwater Advisory Committee formation and progress
- Nitrate in Wisconsin's Groundwater: Status of the Resource
- Penetration of Nitrate and Pesticides into Wisconsin's Aquifers
- Straddling the Divide: Water Supply Planning in the Lake Michigan Region
- USGS Great Lakes Water Availability Pilot Study
- Groundwater in the Great Lakes Basin
- Diamino-atrazine ELISA Evaluation Study
- DNR Water Monitoring Strategy
- Groundwater Monitoring Strategy
- Monitoring and Predictive Modeling of Subdivision Impacts on Groundwater
- Status of the Quantity Subcommittee
- Southern Lake Michigan Water Supply Planning Consortium
- Occurrence and Fate of Antibiotics in Soils and Wastewater
- Interaction of Sulfonamide Antibiotics with Soil Constituents
- Aquifer Storage and Recovery (ASR) Pilot Studies

SUBCOMMITTEE SUMMARIES

The GCC is directed to "serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management." The Subcommittees of the GCC carry out this charge by regularly bringing together staff from over 15 different agencies, institutions and organizations to communicate and work together on a variety of research, monitoring and data management, planning and mapping, educational and local government issues.

In FY 05, the GCC approved a reorganization of the GCC Subcommittees to more effectively meet current needs. The functions and members of the Planning and Mapping Subcommittee were merged with the Local Government Subcommittee and Monitoring and Data Management Subcommittee. The Planning and Mapping Subcommittee no longer exists. In addition, the Monitoring and Data Management Subcommittee was maintained as one Subcommittee, but the tasks will be divided between two workgroups. With the enactment of the groundwater quantity legislation, the need for the Groundwater Quantity Subcommittee no longer exists so it has been dissolved. See further details on the Subcommittee restructuring below.

In addition, numerous contacts and informal conversations are generated both at meetings and through email communications among Subcommittee members, leading to better communication across agency lines on a variety of issues. These activities are related to participation of agency staff on GCC Subcommittees and create efficiencies and provide intangible benefits to Wisconsin's taxpayers.

Research Subcommittee

The purpose of the Research Subcommittee is to assist the GCC in establishing priorities for groundwater research and monitoring activities and to review proposals submitted through the Wisconsin Groundwater Research and Monitoring Program. The subcommittee met with the Monitoring and Data Management Subcommittee in January 2005 to review proposals that were submitted in response to the FY 06 solicitation. Subcommittee members made recommendations that were used by the UWS in deciding which groundwater-related proposals to fund for FY 06. The projects to be funded in FY 06 are listed in Table 2.

The Research Subcommittee discussed the need for more access and dissemination of research and monitoring findings, as well as ensuring that future proposals address pressing state needs, especially in light of reduced state funds for research. Two ideas were advanced. One idea was to hold periodic meetings of the subcommittee to discuss recently completed reports and findings generated by state funded projects. Another idea is to require that future proposals explicitly make reference to past funded projects on similar topics. Both of these ideas would help to ensure that past research projects are consulted before embarking on new projects, eliminating duplication of efforts and maximizing use of state dollars.

Monitoring & Data Management Subcommittee

The goal of the Monitoring & Data Management Subcommittee (MDMS) is to coordinate groundwater monitoring and data management activities of state agencies to maximize value and efficiency. Subcommittee members continued to work collectively, individually, and in small groups on GCC activities or action items targeted by the subcommittee. Several key issues were addressed in FY 05:

- **Revised charge, functions and membership** – The GCC approved changes to several of its subcommittees in FY 05. The changes resulted in an expanded scope for the MDMS and placed increased emphasis on monitoring. Several members of the now-defunct Planning and Mapping Subcommittee have joined the MDMS to add the mapping component to the subcommittee's charge. These changes will help improve communication about groundwater data management, GIS, and mapping topics. Towards the end of FY 2005, the structure of the MDMS also changed. Two "work groups" were formed - one with a Data Management and Mapping focus and one with a Monitoring focus. This change is to improve focus on the disparate issues the group faces. In practice, the focus of the quarterly MDMS meetings will alternate between these 2 work groups or topics with each member to attend the meetings that pertain to their work group, but have the option to attend the other meetings. To keep each work group informed of the activities and discussion of the other group there will be one meeting a year where both work groups meet together.
- **FY06 Joint Solicitation –** Subcommittee members evaluated and discussed the 29 proposals received in this year's solicitation at their annual meeting with the Research Subcommittee. Subcommittee members made recommendations that were used by the UWS in deciding which groundwater-related proposals to fund for FY 06.
- **Monitoring Strategy** - The Groundwater Monitoring strategy drafted in 2004 was updated, and enhanced and integrated into the DNR's Water Division strategy (http://dnr.wi.gov/org/water/MonitoringStrategy_13_V1WEB_2-4-05.pdf). The DNR strategy is an opportunity to pull together all water monitoring activities from throughout the agency. There are now 8 subteams working on implementation of the DNR water strategy, including one for

groundwater.

- **Data sharing**. Increasing the use of Wisconsin Unique Well Numbers (WUWN) to identify well samples compiled in databases has been a long-standing effort of the Subcommittee. This year the focus shifted to what could be done *from now on* to improve data sharing, rather than spend more time trying to deal with data that has already been collected. Also, other means of uniquely identifying a well, such as GPS locations, were discussed.
- **Synergistic effects and health advisory letters** – A workgroup of the subcommittee worked on clarifying the process for determining if a health advisory should be issued due to the potential additive health risks in cases where multiple contaminants are detected in a private well below groundwater standards.
- **Nitrate** – Several subcommittee members were involved in helping the DNR's Groundwater Section compile data for a "Condition of the Resource Report" on nitrate. The Subcommittee made a number of suggestions for analyzing and presenting the data, such as dividing the state by water basin or legislative boundaries, looking at trends in exceedance rates over time by township, and doing a categorical analysis of concentration rather than treating it as a continuous variable.
- **Updates** – The subcommittee continued to be a forum for information exchange to prevent duplication of efforts and increase the utility of monitoring data. In FY 05 the MDMS met regularly to update one another on their agencies' activities. This year's topics included: DATCP Diamino-atrazine ELISA study follow-up sampling; DNR implementation of groundwater quantity legislation; Commerce's new tracking system for identifying sites with occurrences of VOCs, MTBE, and other oxygenates; changes to DNR and DATCP groundwater monitoring databases; the USGS groundwater monitoring network and water use reporting programs; Groundwater Center county drinking water programs; and new digital products from WGNHS.

Education Subcommittee

The Education Subcommittee met four times during the past year. Its mission is to review public information and education materials, coordinate educational messages among agencies, and serve as a forum to identify groundwater education needs, ideas and concerns. At each meeting, representatives share information about current agency activities related to groundwater.

The subcommittee worked to expand its membership over the last year to attempt to increase access to other groups that work on groundwater education issues in the state. After careful consideration, it was decided that having an email advisory group, which is called the Groundwater Information Network (GIN), would be the most effective method to reach the largest audience. Groups were identified that work on a variety of water quality issues. Invitations were sent out and 14 groups replied with interest to join the GIN. This group receives meeting minutes, can share their thoughts and ideas via email, and request to be on meeting agendas. After only the second meeting to include the GIN, one of the members contacted the subcommittee and will be on the agenda for their fall meeting to discuss possible ways for these organizations to work together.
The fourteen members of the Groundwater Information Network are:

1. Wisconsin Environmental Health Association, Inc.
2. Wisconsin Association of Lakes

3. Wisconsin Rural Water Association
4. Wisconsin Water Well Association
5. Biodiversity Project
6. Clean Wisconsin
7. Wisconsin Land and Water Conservation Association
8. Wisconsin Water Association
9. Wisconsin DNR, Watershed Management Bureau
10. Wisconsin Environmental Lab Association
11. Wisconsin Stewardship Network
12. Wisconsin Groundwater Association
13. River Alliance
14. USEPA, Groundwater & Drinking Water Program

Many members of the subcommittee participated in the Third Annual Wisconsin Groundwater Festival. This year the event was held at the Eau Claire County Expo Center on May 6th. Over 500 fifth and sixth grade students who attended the event learned about groundwater and their role in protecting the resource. Volunteer instructors included groups from area high schools, UW-Eau Claire students, citizen groups and several state agencies and University of Wisconsin Extension staff.

The members of the subcommittee continue to work together when writing a new publication or updating existing documents. This year, subcommittee members provided assistance to the DNR when they updated their Bacteriological Contamination of Drinking Water brochure. The DNR also re-released a publication originally published by the Stevens Point-Whiting-Plover Wellhead Protection Project called Better Homes and Groundwater.

Local Government and Planning Subcommittee

The Local Government Subcommittee was formed in 1993 to promote communication between local governments and the state government regarding groundwater issues. At its February meeting, the GCC combined the Local Government Subcommittee with the planning function of the former Planning and Mapping Subcommittee to create the Local Government and Planning Subcommittee (LGPS). Both Subcommittees have been addressing planning issues for some time, so it made sense to combine these two subcommittees.

The new LGPS met for the first time April 26, 2005 in Madison. The Subcommittee heard summaries of some of the efforts to assist the comprehensive planning effort by local governments. The DNR Land Use Team has developed a number of computer tools to assist local communities with comprehensive planning. The Team is now organizing workshops to provide training in the use of these tools. The UW Stevens Point Center for Land Use Education has been looking at how groundwater is being incorporated into comprehensive plans. The LGPS also learned that the Comprehensive Planning and Groundwater fact sheets prepared in 2002 have been updated.

The LGPS will continue to follow the comprehensive planning and groundwater quantity law implementation initiatives.

WISCONSIN'S GROUNDWATER RESEARCH AND MONITORING PROGRAM

The GCC provides consistency and coordination among state agencies in funding groundwater monitoring and research to meet state agency needs. Approximately $12.7 million has been spent

through FY 05 on 319 different projects dealing with groundwater or related topics (see *Appendix C* for a complete listing). The four programs, collectively called the Wisconsin Groundwater Research and Monitoring Program, have different sources of money and purposes, which are summarized as follows: include:

1. DNR Management Practice Monitoring – Except for FY 05, the DNR has had at least $125,000 available each year since FY 86 to support groundwater monitoring studies evaluating existing design and/or management practices associated with potential sources of groundwater contamination. The intent of these studies is to identify appropriate management practices to reduce the impacts of potential sources of contamination. The money comes from the Groundwater Account of the Environmental Fund (which is funded by various fees). Additional funds have been available in some years through various Federal and State sources, enabling the DNR to fund additional projects. Through FY 05, the DNR has spent approximately $5.7 million on 173 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS.

2. UWS Groundwater Research - The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. Projects may be of a fundamental or applied nature on any aspect of groundwater research in the natural sciences, engineering, social sciences or law. Through FY 05, the UWS has spent $4.7 million on 130 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and eleven were co-funded with WRI through the US Geological Survey.

3. DATCP Pesticide Research - Since 1989, DATCP has had up to $135,000 available annually to fund research on pesticide issues of regulatory importance. The money comes from fees paid by pesticide manufacturers to sell their products in Wisconsin. Starting in FY 03, these funds have not been available for new research. Through FY 05, DATCP has spent about $1.8 million on 42 pesticide projects. Several of these projects have been co-funded with DNR and/or UWS.

4. Department of Commerce Private Onsite Wastewater Treatment System (POWTS) Research – Due to budget shortfalls, Commerce has not been able to fund research projects since FY02. Through FY 05, DILHR/Commerce has spent approximately $600,000 on eight projects. Two projects were co-funded with DNR and UWS.

Solicitation and Selection of Proposals

The UWS, DNR, DATCP, and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems.

In 1988, the GCC requested that the UWS create a Groundwater Research Advisory Council (GRAC) to establish a long-range groundwater research plan and develop a groundwater research decision item narrative (DIN) for inclusion in the University's biennial budget. The GRAC consists of university, state agency, and public representatives. During the summer of 1990, the GRAC and GCC developed and endorsed a plan to coordinate the solicitation of projects for funding in FY 92 and subsequent years. The joint solicitation provides for only one submittal of project proposals, rather than four as had been the case. The intent of the joint solicitation is to determine the most appropriate funding source for a particular project.

Statutory language requires that there be agreement between the UWS and the GCC on the use of the UWS research funds before the funds can be released by the Department of Administration (s. 160.50(1m), Wis. Stats). To expedite this agreement, a Memorandum of Understanding (MOU) was signed in 1989 and 1991 by representatives of the GCC, the GRAC, and the UWS on use of the UWS groundwater research funds. This MOU was reviewed and updated in November 2002. The MOU spells out the procedures for establishing priorities and selection of projects for funding of UW groundwater research. The MOU recognizes that the GCC has a substantive role in establishing research priorities and an advisory role in project selection to minimize overlap and duplication.

FY 05 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 05 was distributed in September 2003. A total of 15 project proposals were submitted in response to the SFP. To assist in the review process, a joint meeting of the Monitoring & Data Management and Research Subcommittees of the GCC was held in January 2004 to review and rank the projects that were submitted for funding. As a result of the subcommittee meeting, the GRAC meeting in March, and review of the proposals by agency staff, 8 new projects were selected for funding in FY 04, all by the UWS. Nine on-going projects were carried over into FY 05. A total of 17 projects were funded through the joint solicitation at a cost of approximately $387,000 (see Table 1).

FY 06 Proposal Solicitation. The SFP was distributed in September 2004 for funding in FY 06. The SFP package (see *Appendix D*) contained a listing of the monitoring and research priorities for each of the agencies, as determined by agency staff, the GRAC, and members of the GCC Monitoring & Data Management and Research Subcommittees. The deadline for proposals was November 15, 2004.

The entire submission and review process was conducted online through a secure web site administered by the WRI. Investigators could upload and modify contact information, proposal narratives, and budget information at any time up to the deadline. Reviewers were able to simply log on to the site to review proposals at their convenience. A total of 29 proposals were submitted, requesting a total of $740,703 in funding. A minimum of 3 external peer reviews was solicited for each proposal from experts within the field. GCC Subcommittee members and agency staff also reviewed the proposals and met in January to rank the proposals. In addition, the GRAC met in February to select projects to recommend to the GCC for UWS funding.

The DNR and UWS will each fund eight proposals and they will share the cost of another proposal. DATCP and Commerce will not be funding new projects in FY 06. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 05 will be funded through FY 06. The projects to be funded in FY 06 are listed in Table 2.

State budget shortfalls have severely limited the number of new projects that were selected for funding during the past three fiscal years. DNR's funding for projects has been cut by over two-thirds since FY 02 (see Table 3). The UWS budget was cut by 10% in FY 04 and again in FY 05. DATCP and Commerce have been unable to fund new projects in the last three fiscal years. Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC will continue to encourage its member agencies to maintain adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

Coordination with Other Research Programs

The GCC attempts to compile information about other groundwater research programs within Wisconsin. For example, many groundwater-related research projects are funded through the Wisconsin Fertilizer Research Council (http://www.soils.wisc.edu/frc/). Staff from the GCC also work with the Research Committee of the Wisconsin Water Association (WWA), the state affiliate of the American Water Works Association (AWWA).

Also, the GCC is actively involved in efforts to use state funded research projects to leverage Federal funds, through the USGS, EPA, and the Centers for Disease Control (CDC). Proposals submitted to Wisconsin's Groundwater Research and Monitoring Program are occasionally forwarded to these federal partners, or re-worked to meet the specific needs of the funding source.

Distributing Project Results

Final reports are required for each project funded through Wisconsin's Groundwater Research and Monitoring Program. Reports from UWS funded projects are kept in the Water Resources Library. DATCP, Commerce, and DNR funded reports are kept on file with the respective agencies, but many are provided to the Water Resources Library for public distribution as well. All project investigators must submit a 2-page Project Summary upon completion of the final report. These summaries are made available on the WRI web site (http://www.wri.wisc.edu/wgrmp/wgrmp.htm). Over 130 summaries are currently provided. Summaries from older reports are printed in *Wisconsin Groundwater Research and Monitoring Project Summaries* (DNR PUBL-WR-423-95 and DNR PUBL-WR-205-90) both of which are available from the Water Resources Library or the DNR.

Previously, only summaries of the funded projects were available online. During the past year, the Water Resources Library partnered with UW Libraries' Digital Collections Center to digitize and put online most WRI and selected DNR final project reports. The WRI Groundwater Research and Monitoring Program Web site now links to the full-text reports, which are included in the University of Wisconsin Ecology and Natural Resources Digital Collection at http://digital.library.wisc.edu/1711dl/EdoNatRes. Inclusion in the UW Ecology and Natural Resources online collection should make a wider audience aware of this important groundwater research.

Projects funded through Wisconsin's Groundwater Research and Monitoring Program have provided valuable information regarding the Wisconsin's groundwater resources, helped evaluate existing regulatory programs, increased the knowledge of the movement of contaminants in the subsurface, and developed new methods for groundwater evaluation and protection. Chapter 6, *Benefits from Monitoring and Research Projects*, highlights some of these projects and illustrates how agencies have used the project results to improve the management of the state's groundwater resources.

Table 1: Groundwater Research and Monitoring Projects Funded in FY 05

Agency	*Title*	*Author(s)*	*Affiliation*	*FY 05 Budget*
DNR				
	*Monitoring and Predictive Modeling of Subdivision Impacts on Groundwater in Wisconsin	K. Bradbury & J. Bahr	WGNHS & UW-Madison	$43,719
	*Development of a Groundwater Flow Model for the Mukwonago River Watershed, Southeastern Wisconsin	J. Bahr	UW-Madison	$21,511
	*Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	G. Kraft & B. Browne	UW-Stevens Point	$27,350

The total cost for all projects funded by DNR in FY 05 is $92,580. No new projects were funded in FY 05.

UWS				
	*Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	K. Potter	UW-Madison	$36,242#
	*Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide and Tetracycline Antibiotics in Subsurface Environments	K. Karthikeyan and J. Pedersen	UW-Madison	$24,715 (+$31,592#)
	*Evaluation of Contamination of Groundwater around Landfills	T. Edil, C. Benson and J. Connelly	UW-Madison & WDNR	$25,625
	*Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Z. Li	UW-Parkside	$20,121
	*Providing Communities with the Groundwater Information Needed for Comprehensive Planning	D. Cherkauer	UW-Milwaukee	$33,717
	*A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI	T. Grundl, K. Bradbury, D. Feinstein & D. Hart	UW-Milwaukee, WGNHS & USGS	$39,209
	Mercury Speciation along a Groundwater Flowpath	D. Armstrong and C. Babiarz	UW-Madison	$25,425
	Delineation of Flow Paths, Capture Zones, and Source Areas, Allequash Basin, Vilas County, Wisconsin	Mary Anderson	UW-Madison	$24,065
	A comparison of USEPA approved enzyme-based total coliform/E. coli tests for microbiological groundwater monitoring and laboratory consultation	J. Schauer, J. Olstadt, J. Standridge, and S. Kluender	WSLH	$16,260
	Occurrence of Estrogenic Endocrine Disruptors in Groundwater	W. Sonzogni, J. Hemming, M. Barman and S. Geis	WSLH	$13,800
	Development of tools to address groundwater in comprehensive planning	L. Markham, Charles Dunning and C. Tang	UW-Stevens Point & USGS	$5,873
	Hydrostratigraphy of west-central Wisconsin: A new approach to groundwater management	D. LePain and K. Bradbury	WGNHS	$23,615
	Monitoring Environmental Effects at an Established Phytoremediation Site	W. DeVita and M. Dawson	UW-Stevens Point	$17,820
	Foundry Slag for Treating Arsenic in Ground Water and Drinking Water	C. Benson and D. Blowes	UW-Madison	$3,644

The total cost for all new projects funded by the UWS through the FY 05 solicitation for

proposals is $130,502. The total cost for all projects funded by the UWS in FY 05 is $294,202 (including fringe benefits and 6% administration costs and excluding USGS co-funding).

funded by USGS base funding of WRI
* denotes continuing project from FY 04

Table 2: Groundwater Research and Monitoring Projects to be Funded in FY 06

Agency	*Title*	*Author(s)*	*Affiliation*	*FY 06 Budget*
DNR				
	Mechanisms of Groundwater Flow across Aquitards	David Hart, Kenneth Bradbury, Daniel Feinstein and Basil Yikoff	WGNHS, USGS & UW-Madison	$37,615
	Centralizing Access to Groundwater Information for Use in Comprehensive Planning	Lynn Markham, Chin-Chun Tang and Charles Dunning	UW-Stevens Point & USGS	$22,884
	A Survey of Baseflow for Groundwater Protection Areas Western Fox-Wolf Watershed	G. Kraft	UW-Stevens Point	$35,438
	Groundwater Mounding and Contaminant Transport Beneath Stormwater Infiltration Basins	Anita Thompson	UW-Madison	$34,840
	Mapping and Characterization of Springs in Brown and Calumet Counties	Kevin Fermanich Ron Stieglitz and Michael Zorn	UW-Green Bay	$13,800
	Identification and characterization of springs in west-central Wisconsin	Katherine Grote	UW-Eau Claire	$21,686
	Evaluating drinking-well vulnerability to viruses	Randall Hunt and Mark Borchardt	USGS, Marshfield Clinic	$36,485
	Disinfection of Enteric Viruses in Wisconsin Municipal Groundwater Systems	Gregory Harrington, Mark Borchardt and Irene Xagoraraki	UW-Madison, Marshfield Clinic	$31,615
	+Assessing the Ecological Status and Vulnerability of Springs in Wisconsin	David Zaber, Susan Swanson, Kenneth Bradbury & Dave Hart	UW-Extension, Beloit College	$12,000

The total cost for all new projects to be funded by DNR through the FY 06 solicitation for proposals is $246,363. There are no continuing projects to be funded by the DNR in FY 06.

UWS				
	*Mercury Speciation along a Groundwater Flowpath	D. Armstrong and C. Babiarz	UW-Madison	$25,595
	*Occurrence of Estrogenic Endocrine Disruptors in Groundwater	W. Sonzogni, J. Hemming, M. Barman and S. Geis	WSLH	$0#

*Monitoring Environmental Effects at an Established Phytoremediation Site	W. DeVita and M. Dawson	UW-Stevens Point	$17,890
*Foundry Slag for Treating Arsenic in Ground Water and Drinking Water	C. Benson and D. Blowes	UW-Madison	$0#
Transient Functioning of a Groundwater Wetland Complex, Allequash Basin, Wisconsin	M. Anderson	UW-Madison	$23,633
Measuring and Modeling Macroporous Soil Water And Solute Flux Below the Root Zone of a Plano Silt-Loam Soil	B. Lowery, J. Norman & B. Lepore	UW-Madison	$31,121
Evaluation of On-site Wastewater Treatment as a Source of Antibiotic Resistance Genes in Groundwater	K. McMahon	UW-Madison	$39,190
Arsenic Species (III,V) Distribution in Wisconsin's Groundwaters: Field Measurements and Prediction Using Multivariate Analysis of Geochemical Data	M. Shafer, K. Ellickson and J. Schauer	UW-Madison	$28,026
Validation of Transport of VOCs from Composite Liners	T. Edil & C. Benson	UW-Madison	$25,821
Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer	G. Kraft and B. Browne	UW-Stevens Point	$30,562
Climate Signals in Groundwater and Surface Water System: Spectral Analysis of Hydrologic Processes	H. Bravo	UW-Milwaukee	$33,717
+Assessing the Ecological Status and Vulnerability of Springs in Wisconsin	David Zaber, Susan Swanson, Kenneth Bradbury & Dave Hart	UW-Extension, Beloit College	$24,038

The total cost for all new projects to be funded by the UWS in 06 is $236,108. The total cost for all projects to be funded by the UWS in FY 06 is $279,593 (including fringe benefits and 6% administration costs and excluding USGS co-funding).

funded by USGS base funding of WRI
+ denotes joint funding between the DNR and UWS
* denotes continuing project from FY 05

Table 3: Groundwater Research and Monitoring Projects Funded from FY 1999 through FY 2005

Fiscal Year	Total		DNR		UWS		DATCP		Commerce	
	#	$	#	$	#	$	#	$	#	$
New projects										
1999	**16**	**438,689**	5	186,766	8	160,333	4	91,590	0	0
2000	**14**	**327,338**	6	115,321	9	196,266	1	15,751	0	0
2001	**19**	**[1]578,895**	8	276,090	7	165,924	4	78,881	1	58,000
2002	**21**	**626,068**	9	281,259	10	252,619	3	92,190	0	0
2003	**7**	**180,621**	2	17,864	6	162,757	0	0	0	0
2004	**13**	**347,835**	4	124,495	9	251,423	0	0	0	0
2005	**8**	**130,502**	0	0	8	130,502	0	0	0	0
Continuing Projects										
1999	**8**	**237,900**	3	102,360	5	121,647	1	13,893	0	0
2000	**11**	**321,171**	5	186,221	4	87,000	2	47,950	0	0
2001	**8**	**179,441**	2	60,623	7	[2]118,818	0	0	0	0
2002	**11**	**234,913**	5	155,026	4	[2]37,077	3	42,810	0	0
2003	**13**	**311,237**	4	110,198	7	[2]121,039	3	80,000	0	0
2004	**3**	**15,170**	0	0	3	[2]15,170	0	0	0	0
2005	**9**	**256, 280**	3	92,580	6	[2]163,700	0	0	0	0
All Projects										
1999	**24**	**676,589**	**8**	**289,126**	**13**	**281,980**	**5**	**105,483**	**0**	**0**
2000	**25**	**648,509**	**11**	**301,542**	**13**	**283,266**	**3**	**63,701**	**0**	**0**
2001	**27**	**758,336**	**10**	**336,713**	**14**	**284,742**	**4**	**78,881**	**1**	**58,000**
2002	**32**	**860,981**	**14**	**436,285**	**14**	**289,696**	**6**	**135,000**	**0**	**0**
2003	**20**	**491,858**	**6**	**128,062**	**13**	**283,796**	**3**	**80,000**	**0**	**0**
2004	**16**	**391,088**	**4**	**124,495**	**12**	**266,593**	**0**	**0**	**0**	**0**
2005	**17**	**386,782**	**3**	**92,580**	**14**	**294,202**	**0**	**0**	**0**	**0**

[1]2001 DNR figures do not include 71K from Federal 106 funds applied toward FY02 projects
[2]2001-2005 UWS figures do not include matching USGS funds (approximately 46K per year)

Chapter 3 -- SUMMARY OF AGENCY GROUNDWATER ACTIVITIES

The 1983 Groundwater Protection Act created Chapter 160, Wis. Stats., which serves as the backbone of Wisconsin's groundwater protection program. Chapter 160 provides a multi-agency comprehensive regulatory approach, using two-tiered numerical standards, based on the premise that all groundwater aquifers in Wisconsin are entitled to equal protection. Each state regulatory agency must promulgate rules to assure that the groundwater standards are met and to require appropriate responses when the standards are not met.

The state regulatory agencies are the Department of Natural Resources (DNR) (solid and hazardous waste, industrial and municipal wastewater, remediation and redevelopment, wetlands and water supply); the Department of Commerce (private sewage systems, petroleum product storage tanks); the Department of Agriculture, Trade and Consumer Protection (DATCP) (pesticide use and storage and fertilizer storage); and the Department of Transportation (DOT) (salt storage). In addition, Chapter 160 directs the Department of Health and Family Services (DHFS) to recommend health-based enforcement standards for substances found in groundwater and specifies the protocol for developing the recommended standards.

The purpose of this chapter is to describe groundwater management programs and implementation of ch. 160, Wis. Stats., by the individual state agencies in FY 05. In addition, the University of Wisconsin System, UW Extension and the Wisconsin Geological and Natural History Survey (WGNHS) carry out numerous educational, research, monitoring, and outreach activities related to groundwater protection that are described here. The groundwater management efforts undertaken by the member agencies of the Groundwater Coordinating Council during the past year show that Wisconsin continues to have a strong commitment to protection of its groundwater resource.

DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources (DNR) has statutory authority as the central unit of state government to protect, maintain and improve the quality and management of the waters of the state, ground and surface, public and private (s. 281.11 Wis. Stats.). The DNR establishes the groundwater quality standards for the state under authority of ch. 160, Wis. Stats. DNR regulatory activities to protect groundwater are the responsibility of four programs:

1. *Drinking Water and Groundwater (DG)* – Regulates public water systems, private drinking water supply wells, well abandonment and high capacity wells. DG is responsible for adoption and implementation of groundwater standards contained in ch. NR 140, Wis. Adm. Code, and works closely with other programs and agencies to implement Chapter 160, Wis. Stats., including groundwater monitoring, database management, and staffing the Groundwater Coordinating Council. The new provisions under 2003 Wisconsin Act 310 are also being implemented by DG. The program also coordinates the state's Wellhead Protection program and the Source Water Protection Programs. http://dnr.wi.gov/org/water/dwg/index.htm

2. *Waste Management (WA)* – Regulates and monitors groundwater at proposed, active, and inactive solid waste facilities and landfills. WA reviews investigations of groundwater contamination and implementation of remedial actions at active solid waste facilities and

landfills. WA also maintains a Groundwater and Environmental Monitoring System (GEMS) database of groundwater quality data from over 600 solid waste facilities and landfills and uses reports from GEMS to evaluate whether sites are impacting groundwater quality. http://dnr.wi.gov/org/aw/wm/index.htm

3. *Remediation and Redevelopment (RR)* – Oversees response actions at spills, hazardous substance release sites, abandoned containers, drycleaners, brownfields (including the Site Assessment Grant program), "high priority" leaking underground storage tanks, closed wastewater and solid waste facilities, hazardous waste corrective action and generator closures, and sediment cleanup actions. A significant amount of the RR's work relates to groundwater contamination. http://dnr.wi.gov/org/aw/rr/index.htm

4. *Watershed Management (WT)* – Regulates the discharge of municipal and industrial wastewater, by-product solids and sludge disposal from wastewater treatment systems and wastewater land treatment/disposal systems. WT also issues permits for discharges associated with clean-up sites regulated by WT for the RR program. WT also has primary responsibility for regulating stormwater and agricultural runoff as well as managing waste from large animal feeding operations. http://dnr.wi.gov/org/water/wm/index.htm

The Department made significant strides in protecting groundwater in FY05

1. *Source Water Assessments* – In FY 05 the DNR finished source water assessments for all (approximately 11,500) active public water supply systems in the State. DNR staff hand-delivered completed assessments to municipal systems. Smaller systems were notified when their assessment was available. Assessments consisted of delineating source water areas, identifying potential contaminant sources within those areas, and determining the susceptibility to contamination for each public water system. Summaries of all of the assessments are available on the Internet. Visit the DNR's web page to see the assessment results: *http://dnr.wi.gov/org/water/dwg/swap/index.htm*.

2. *Groundwater Protection Act Implementation* – In May of 2004, the statutes regarding high capacity wells were expanded to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Other statutory changes include notification and fees to be collected along with all new well construction and requirements for reporting water use on an annual basis for new and existing high capacity wells. Further provisions in the Groundwater Protection Act include designation of two Groundwater Management Areas to address regional groundwater issues and the creation of a Groundwater Advisory Committee to recommend management approaches in these areas and further statutory changes.

   In FY 05 DNR sought funding and approval to hire staff to implement the new law. Additionally, progress was made on the following components of the new law:
   - Implementing an automated Internet well construction notification and fee collection system.
   - Assessing the availability of data and evaluation tools needed for evaluating potential significant adverse impacts of high-capacity wells on sensitive surface waters.
   - Contracting with researchers to collect streamflow and springs data.
   - Staffing Groundwater Advisory Committee meetings in April and June, 2005.

3. *Groundwater monitoring strategy* - In FY 05, DNR staff completed a new statewide groundwater monitoring strategy with representatives from the DATCP, USGS, WGNHS,

and UW Stevens Point and the Wisconsin Academy of Sciences, Arts, and Letters. The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in the state. The statewide groundwater monitoring strategy will help DNR meet the prerequisites of the Clean Water Act Section 106(e)(1) as described in the EPA's "Elements of a State Water Monitoring and Assessment Programs" guidance document. Over the next ten years, components of the strategy will be integrated into DNR's overall water monitoring plan.

4. *Use of Conservation Reserve Program in wellhead protection areas* - DG staff worked with staff from the federal Farm Service Agency to identify a process for identifying cropland in wellhead protection areas. Farmers that use cropland in wellhead protection areas could be eligible for cost-sharing and annual rental payments as part of the federal Conservation Reserve Program (CRP).

5. *Groundwater water workshops for teachers* - For the fifth year in a row, DNR staff worked with the Wisconsin Geological and Natural History Survey and Center for Watershed Science and Education to sponsor three groundwater workshops for teachers in January 2005. Teachers from 24 school districts were given training in the use the groundwater sand tank model and given models to take back to their schools. The intent is to provide information for teachers to educate students – and their parents – to protect groundwater.

6. *Approved 467 Cleanups of Contaminated Properties* - That number raised the total of approved cleanups to more than 13,500. Program staff also:
   - helped 95 percent or more of the cleanups undertaken by responsible parties proceed without enforcement.
   - responded to nearly 100 requests for detailed, fee-based technical reviews.
   - worked with hundreds of inactive responsible parties resuming site investigation and cleanup activities.

7. *Provided Assistance Through Start-up Site Assessment Grants For Brownfields* - In FY 05, the RR Program awarded 45 Site Assessment Grants totaling approximately $1.7 million to 31 communities across the state. Small grants up to $30,000 make up 36 of the awards, while nine are large grants between $30,000 and $100,000. Local governments have also pledged more than $900,000 in additional funds for the projects, well beyond the 20 percent match required through the application process.

   The grants will provide funds for environmental activities on 107 acres of land. Activities include 128 site assessments and investigations, the demolition of 63 buildings or structures and the removal of 87 tanks, drums and other abandoned containers. Since 2000, 257 grants have been awarded to 134 communities around the state for work on 850 acres of land.

8. *Helped Prevent and Control Toxic Spills* - The RR Program partnered with state and local emergency responders at more than 300 hazardous substance spills and helped avoid hundreds of other spills through education and prevention efforts.

9. *Provided State-Funded Response at Orphan Site* - When a responsible party is unknown, unable or unwilling to conduct environmental restoration, the RR Program protects human health and the environment with a state-funded cleanup. In 2005, the Program spent $3.5 million in Environmental Fund dollars to initiate or continue environmental cleanup actions at approximately 62 locations where groundwater contamination is known or suspected. The

Program also recovered $2.1 million in state expenses that had been used to address contamination, where responsible parties would not proceed with investigation or cleanup.

10. *Partnered with local officials to net $400,000 brownfield grant for 30th St. Corridor Work in Milwaukee* - The DNR, in partnership with the city of Milwaukee and the 30th Street Industrial Corridor Corporation, applied for and received two EPA brownfield site assessment grants – a $200,000 grant for hazardous substances and another $200,000 for petroleum contamination. The partnership group is the first created by Wisconsin's Reinvestment Initiative, which will assist with redevelopment in economically and environmentally distressed areas of the state.

11. *Provided Accessible and In-Depth Public Information* - Program staff continued to improve one of the nation's most comprehensive web sites on environmental contamination, investigation, cleanup, liability, redevelopment and financial aid, averaging approximately 90,000 web hits every month. The RR Program also maintains records on thousands of active investigations and cleanups of contaminated properties in an Internet-accessible format. In addition, Program staff attended more than 100 meetings with local officials to provide assistance on cleanup and redevelopment of contaminated properties.

12. *Storm water* - DNR completed the revision of its storm water regulations under ch. NR 216, Wis. Adm. Code, in order to comply with federal storm water regulations that took effect on March 10, 2003. The revised rules became effective on August 1, 2004. The rules require nearly 200 municipal storm sewer systems to obtain permit coverage statewide and also require construction sites down to one acre of land disturbance to have permit coverage to control erosion during construction. Permit holders will also be required to install post-construction practices to limit pollutant discharge after construction is completed (storm water management). The DNR has developed performance standards (i.e. 80% sediment control, infiltration, peak flow, buffer requirements, etc.) that will protect groundwater quality and promote recharge.

More information about the groundwater programs and activities of the DNR is detailed in the following pages.

Drinking Water and Groundwater Program

Groundwater standards. Chapter 160, Wis. Stats., requires the DNR to develop numerical groundwater quality standards, consisting of enforcement standards and preventive action limits, for substances detected in, or having a reasonable probability of entering, the groundwater resources of the state. Chapter NR 140, Wis. Adm. Code, establishes these groundwater standards and creates a framework for their implementation. There are currently groundwater quality standards for 122 substances of public health concern, 8 substances of public welfare concern and 15 indicator parameter substances in ch. NR 140.

DG maintains a table listing NR 140 groundwater quality standards, NR 809 state drinking water standards, and established health advisory levels (HALs) for substances in water (http://dnr.wi.gov/org/water/dwg/health/hal.htm). This table of regulatory standards and advisory levels provides a useful source of information to members of the public concerned about the safety of their drinking water and also is a valuable resource for DNR staff involved with groundwater contamination and remediation cases. Links in this table allow users to obtain additional toxicological and health related information on many of the substances listed.

DG staff work closely with the RR program to identify policy issues, develop guidance, and provide training regarding the implementation of chs. NR 720, 722, 724 and 726 dealing with soil cleanup standards, selecting and implementing remedial actions, and case closures. DG staff also provide advice and assistance on site investigations, soil and groundwater remediation, and general case closure decisions. This coordination is critical in obtaining statewide consistency on how the DNR evaluates, addresses and closes soil and groundwater contamination sites.

DG staff work with Runoff Management staff to ensure that new performance standards for stormwater infiltration (NR 151) comply with groundwater standards specified in NR 140. DG is also participating on a team writing guidance for developers, land use planners and government agencies regarding stormwater practices that will meet the performance standards while preserving groundwater quality.

Public hearings have been held on proposed amendments to NR 140 that revise existing groundwater quality standards for butylate, dacthal and naphthalene, and establish new NR 140 groundwater quality standards for molybdenum and alachlor ethane sulfonic acid (alachlor-ESA), a breakdown product of the pesticide alachlor. Staff at the Department of Health & Family Services have completed review of the results of a new alachlor ESA toxicological study and have finalized their recommendations for alachlor-ESA groundwater standards. The Department is currently planning to request that the Natural Resources Board approve adoption of proposed revisions to butylate, dacthal and naphthalene NR 140 groundwater quality standards and new proposed molybdenum and alachlor-ESA NR 140 groundwater quality standards at the Board's September 2005 meeting.

Groundwater Protection Act Implementation. The DNR is authorized under statute to regulate wells on each property where the combined capacity of all wells on the property, pumped or flowing, is greater than about 70 gallons per minute (100,000 gallons per day over a 30-day period). Such wells are defined as high capacity wells. When the operation of a high capacity well is anticipated to have an adverse impact on the quality or quantity of water available to a public utility well, the DNR is obligated to deny approval or to limit operation of the high capacity well so that their operation does not adversely impact a public utility well.

In May of 2004, the statutes regarding high capacity wells were expanded through Wisconsin Act 310 to give the DNR the authority to consider environmental impacts of wells in order to protect critical surface water resources. Specifically, the DNR is mandated to complete an environmental review under ch. NR 150, Wis. Adm. Code, for the following proposed high capacity wells:

- Wells located within 1,200 feet of an outstanding or exceptional resource water or a trout stream
- Wells that may have a significant environmental impact on a high volume spring
- Wells where more than 95% of the water will be lost from the basin

In these cases, DNR may allow, deny or limit an approval to assure that these wells do not cause significant environmental impact.

Other statutory changes affecting high capacity wells include a new fee to be collected along with the application for approval and requirements for reporting water use on an annual basis for new and existing high capacity wells. Beginning May 1, 2005, the DNR requires notification for all water supply wells prior to construction. A fee of $500 is required for all new high capacity wells and $50 for private wells.

The DNR is currently working through a separate appropriation process to obtain the necessary staff positions and funding to implement the new programs created by the law. In the meantime

DNR is providing support to the Groundwater Advisory Committee which began meeting in April.

Well construction and abandonment. DG sets and enforces minimum standards for well construction, pump installation and well abandonment through ch. NR 812, Wis. Adm. Code. The standards are intended not only to provide health protection but also to protect groundwater. DG also licenses and educates well drillers under ch. NR 146, Wis. Adm. Code, so that they are qualified to construct wells in a way that won't contaminate groundwater. Drillers submit reports to the DNR describing the construction of each well drilled. Field staff in the program conduct surveillance and inspections to enforce the minimum well construction standards.

DG continues to promote electronic management of well construction and other information through its website at http://dnr.wi.gov/org/water/dwg/gw/software.htm and through semiannual releases of a Water Well Data CD.

Groundwater monitoring well requirements, as specified under NR 141, are administered by DG staff. Activities include consultation on well construction with Remediation and Redevelopment, Waste Management, Watershed Management and Department of Commerce staff, consultants and drillers. Random inspections of environmental drilling operations provide an opportunity for DNR hydrogeologists to update drillers and consultants about NR 141 requirements and enhance compliance with the code. Review of new technologies and their application also continue to be a priority.

A significant program activity for the past fiscal year involved the surveillance and referral of several grouting violators to the Department of Justice for prosecution. Failure to grout or failure to properly grout is a threat to groundwater because the empty space around the well casing pipe provides an easy conduit for contamination to enter the groundwater and contaminate lower aquifers.

Another activity involved the designation and enforcement of special well construction requirements in areas where arsenic is known to exist. These requirements, if not followed, could allow naturally occurring arsenic to enter groundwater at higher levels. The DNR has designated a special casing area that covers all of Outagamie and Winnebago Counties. In these areas wells must be constructed to avoid the arsenic rich St. Peter and Prairie du Chein formations. Wells can be constructed to draw water from the overlying Galena/Platteville dolomite or they must be cased and grouted into the Cambrian sandstone. The special casing area in the Town of Algoma has led to the construction of a municipal water system (currently 2 wells and water mains).

Aquifer Storage & Recovery (ASR) pilot testing. Aquifer storage and recovery (ASR) is a water supply management technique involving the injection of water into an underground aquifer for storage and later recovery. The technique has been proposed in Wisconsin to address the problem of peak seasonal water supply demand. A water utility may not have the storage reservoir volume or water treatment plant capacity to provide enough water to users during summer high, "peak", water demand periods. Using ASR a utility might store "surplus water", water treated during periods of "low" demand, underground for later recovery during peak demand periods. ASR has been proposed as a lower cost alternative to address peak seasonal water demand, than construction of additional "above ground" water storage structures, or upgrading to increase existing water treatment facility capacity.

Rules have been established by the DNR to regulate the use of ASR technology in Wisconsin. These regulations, in ch. NR 811, Wis. Adm. Code, limit use of ASR to municipal water systems

and require that any water, placed underground for ASR storage, meet state drinking water (ch. 809, Wis. Adm. Code) and groundwater quality (ch. NR 140, Wis. Adm. Code) standards. Chapter NR 811 also requires that water recovered from ASR storage meet drinking water standards prior to being placed in a municipal water distribution system and that operation of an ASR system not cause exceedances of state NR 140 groundwater quality standards in the aquifer used for ASR water storage. Before "long term" operational approval of an ASR system is granted in Wisconsin, pilot testing of the system is required.

To date, two municipalities in Wisconsin, Oak Creek and Green Bay, have conducted ASR pilot tests. Both pilots have tested the viability of storing treated Lake Michigan surface water in the Ordovician - Cambrian carbonate/sandstone aquifer ("deep sandstone aquifer") system. Both tests were designed to inject and recover ASR water through a single test site ASR well, and both pilot tests have included monitoring to assess ASR impacts on ambient groundwater quality.

Both ASR pilot tests conducted to date have resulted in trace elements, from aquifer matrix material, being mobilized in groundwater to levels above state groundwater quality standards. This appears to have been caused by the injection of highly oxidized, "reactive" Lake Michigan surface water into the relatively reduced redox environment of the deep sandstone aquifer system. It also appears that some trihalomethane (THM) disinfection byproducts present in the disinfected Lake Michigan surface water, and also generated in the aquifer during ASR storage, are not degrading as readily as originally suggested. Because the proposed operation of the ASR systems pilot tested results in some of the stored ASR water remaining in the aquifer after each ASR pumpout cycle is completed, there is the potential for THM disinfection byproducts to accumulate over time in the aquifer used for ASR storage. The increasing accumulation of THM disinfection byproducts in an ASR storage zone over time is likely to result in exceedances of state groundwater quality standards for these substances at the ASR system compliance boundary.

Green Bay decided after the second smaller injection to abandon further plans to test ASR. Oak Creek is in conditional operational mode. They have injected a 5th full-scale volume of 42 million gallons this year. Recovery should begin in August 2005. While they have been granted a conditional operational permit they must still closely monitor the geochemistry of the system until stability is achieved.

Public water systems. DG oversees monitoring and operation of public water systems through ch. NR 809 (Safe Drinking Water), Wis. Adm. Code, to ensure all public water systems are safe to drink and use. Working in cooperation with owners and operators of water systems DG ensures that samples are collected and analyses completed to determine if the water meets federal Safe Drinking Water Act (SDWA) standards. Also, through ch. NR 811 (Requirements for the Operation and Design of Community Water Systems), DG regulates the general operation, design and construction of public water systems. DG also works to educate water system owners and operators concerning proper operation and maintenance of water systems to ensure safe drinking water for Wisconsin consumers.

DG developed and continues to maintain data about Wisconsin’s drinking water and groundwater quality through the Drinking Water System database. The Drinking Water System is an important tool used to efficiently enforce SDWA regulations for public water systems. It contains the monitoring and reporting requirements for each public water system and their drinking water sampling results. It also includes violations for any missing requirements and exceedances of the maximum contaminant levels (MCLs).

This fiscal year, DG has been working with private laboratories to allow electronic submission of

data to continuously improve the process in which water quality sampling results are received. Additionally, DG has been working on implementing new federal rules and updates to existing rules dealing with arsenic and disinfection byproducts.

Wellhead protection. The DNR is the lead state agency for developing and implementing the Wisconsin Wellhead Protection (WHP) Plan. The specific goal of Wisconsin's plan is to achieve groundwater pollution prevention in public water supply wellhead areas consistent with the state's overall goal of groundwater protection. A WHP plan is required for new municipal wells and must be approved by the DNR before the new well can be used. A WHP plan is voluntary for any public water supply well approved prior to May 1, 1992; the DNR promotes and encourages but does not require wellhead protection planning for these older wells.

The DNR coordinates a statewide public information effort aimed at encouraging water utilities to protect their water supplies from potential sources of contamination through wellhead protection planning. Wellhead protection staff responded to over 60 requests for information during FY 05. Staff answered questions, sent publications, reviewed draft plans and ordinances and visited communities to assist in their WHP efforts. The DNR has prepared a video and several publications to assist communities in their wellhead protection efforts. The DNR also works with the Wisconsin Rural Water Association in providing assistance to local water utilities. Information is shared with local communities through a spring and fall wellhead protection newsletter. The DNR also maintains a web page (http://dnr.wi.gov/org/water/dwg/gw/wellhead.htm) with a variety of relevant information. In addition, the DNR has developed a tracking system for both wellhead protection and source water assessment activities in the DNR's Drinking Water System database. The DNR uses this information to report annually to EPA on WHP and source water assessment progress.

Other highlights include:

- *New wellhead protection plans*. In FY 05, 49 communities received DNR approval of required WHP plans (for new wells) or submitted voluntary plans to the DNR. (There were 18 communities with approved plans and 31 communities with voluntary plans.) There are now nearly 270 communities who have a WHP plan for at least one of their wells.

- *CRP in wellhead protection areas*. The DNR worked with the federal Farm Service Agency to identify a process for identifying cropland in wellhead protection areas. Farmers that use cropland in wellhead protection areas could be eligible for cost-sharing and annual rental payments as part of the federal Conservation Reserve Program (CRP). The CRP program is designed to protect the environment by taking agricultural cropland out of production and installing conservation practices. The DNR has identified cropland within WHP areas in 47 counties to date.

- *Teacher training*. For the fifth year in a row, DNR staff worked with the Groundwater Center at the Center for Watershed Science and Education (CWSE) and the Wisconsin Geological and Natural History Survey (WGNHS) to sponsor three groundwater workshops for teachers in January. Teachers from 24 school districts were given training in the use of the groundwater sand tank model and given the models to take back to their schools. Forty-six teachers took part in the workshops held in Madison, Waukesha and Eau Claire. Teachers were also given a variety of educational materials and an assignment to report how they used the model in their classroom. The intent is to provide information for teachers to educate students –and their parents – to protect groundwater in their own communities.

- *Promoting the Groundwater Guardian Program*. The DNR continued its contract with the Center for Watershed Science and Education for a statewide Groundwater Guardian Coordinator to promote the Groundwater Guardian (GG) program in Wisconsin. This position prepares materials, makes presentations to encourage local governments to become Groundwater Guardian communities, works with existing GG communities and organizes an annual Groundwater Festival and the annual statewide meeting of GG communities. Several new communities have become Groundwater Guardian communities and three organizations have become Groundwater Guardian Affiliates.

Source water assessments. The DNR received USEPA approval of Wisconsin's Source Water Assessment Program (SWAP) Plan in November 1999. The plan was submitted to meet the requirements of the 1996 Safe Drinking Water Act Amendments. The purpose of the program is to assess the risks that potential sources of contamination pose to public drinking water supplies, both groundwater and surface water. The goal of Wisconsin's SWAP is to provide information that will assist communities in preparing WHP and Source Water Protection plans. The SWAP required the DNR to: 1) delineate source water assessment areas for all public water systems in the state; 2) conduct inventories of significant potential sources of contamination within those areas; 3) determine the susceptibility for each system; and 4) make the results of the assessments available to the public.

In FY 05 the DNR completed assessments for all active public water supply systems in the State. Each assessment contains a delineated source water area, identification of potential contaminant sources and a susceptibility determination for each system. Staff hand-delivered completed assessments to most municipal systems. Smaller systems were notified when their assessment was available. The results of all of the assessments are available on the Internet. However, security concerns resulting from the 2001 terrorist attacks curtailed the program's initial goal of making all aspects of the assessment available to the public. Visit the DNR's web page to see the assessment results: *http://dnr.wi.gov/org/water/dwg/swap/index.htm*.

Groundwater monitoring and research. Chapter 160 of the Wisconsin Statues requires the DNR to work with other agencies and the Groundwater Coordinating Council (GCC), to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). The DNR has also supported groundwater monitoring studies evaluating existing design and/or management practices associated with potential sources of groundwater contamination. The intent of these studies is to reduce the impacts of potential sources of contamination by changing the way land activities that may impact groundwater are conducted. Final reports and 2-page research summaries are available for most projects from the Water Resources Institute website: http://wri.wisc.edu/wgrmp/wgrmp.htm.

In FY 05, DG staff completed a new statewide groundwater monitoring strategy with representatives from the DATCP, USGS, WGNHS, UW Stevens Point, and the Wisconsin Academy of Sciences, Arts, and Letters. The objective of the new monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in the state. The statewide groundwater monitoring strategy will help DNR meet the prerequisites of the Clean Water Act Section 106(e)(1) as described in the EPA's "Elements of a State Water Monitoring and Assessment Programs" guidance document. Specific goals include:

- Documenting status and trends in groundwater quality, quantity and use;
- Improving of understanding of groundwater systems and groundwater/surface water interactions; and

- Communicating groundwater information to citizens, policy makers and resource managers.

Over the next ten years, components of the strategy will be integrated into DNR's overall water monitoring plan. Other agencies will also continue to make improvements in their monitoring efforts based on the comprehensive strategy. The components of the strategy may change over time according to needs of the different agencies. The requirements of Chapter 160, Wis. Stats., will continue to be met under the strategy.

During FY 05, $92,580 was spent on three continuing projects which were started in FY 04. Due to limited funds, no new projects were selected for funding in FY 05. More details on the DNR's groundwater monitoring and research activities can be found at http://dnr.wi.gov/org/water/dwg/gw/research.htm.

Final reports received by the DNR in FY 05 include:

Anderson, Mark, 2004, Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters.

Braatz, L., 2004, A Study of Fecal Indicators and Other Factors Impacting Water Quality in Private Wells in Door County, Wisconsin.

O'Connor, K., M. McGrath and K. Lauridsen, 2004, An Analysis of Arsenic Replacement Wells to Determine Validity of Current DNR Well Construction Guidance.

Groundwater data management. Groundwater data from the DNR's consolidated Groundwater Retrieval Network (GRN) system is available on the following website: *http://dnr.wi.gov/org/water/dwg/data.htm*. GRN accesses groundwater data from three database systems in the Waste Management and Drinking Water and Groundwater programs including information on over 293,500 wells. These wells represent public and private water supply wells, piezometers, monitoring wells, non-potable wells, and groundwater extraction wells. In FY 05, DG staff improved the locational data associated with GRN's wells. Around 300,000 well records were added in this project by bringing in historical well construction report information to GRN. Staff also added data from the WT database system to include locational data from monitoring wells associated with wastewater discharge permits. Because GRN receives its data from many different sources, it was necessary to develop a system to enable customers to always identify the best location for a particular well. A process was developed to make sure that each well in GRN had the most accurate location regardless of its origin.

The DNR continued to make progress on several groundwater-related data initiatives in FY 05 through the State's Source Water Assessment Program (SWAP). DG continued to improve its public water supply well data and coordinated efforts with the RR, WA, and WT programs to improve the DNR's data on significant potential sources of contamination that may threaten these wells. Additionally the WGNHS and DNR continue to improve their searchable index of scanned images of more than 350,000 well construction reports (see WGNHS section) for SWAP and other program uses.

Numerous data management tools were been developed and implemented to complete the source water assessments. The SWAP Assessment Form and Mapping Application are two such tools.

The Mapping Application is a Geographic Information System that maps locations of public wells, source water areas, and potential contaminant sources in a format consistent with SWAP, vulnerability assessment program, WHP, and other DNR needs. The Assessment Form uses the mapped potential contaminant sources along with well construction, monitoring, and geologic information to help DNR staff determine susceptibility of public wells to contamination. These applications are at the leading edge of DNR's efforts in integrating spatial and tabular data toward the goal of public health protection.

Waste Management Program

The Bureau of Waste Management (WA) implements the DNR's Groundwater Standards Program in several ways during the life of a landfill. Whenever staff review an applicant's "Feasibility Report," which proposes to site a landfill in a particular location, they review baseline data submitted by the applicant to determine whether exemptions and alternative concentration limits are needed for the public health and welfare parameters listed under NR 140. In addition, the reviewers establish preventive action limits for indicator parameters based on calculations submitted by the applicant. During the active life of a landfill and after closure, staff evaluate groundwater conditions at the landfill site to determine compliance with NR 140 Standards. Should conditions warrant, staff require groundwater investigation reports that include proposals for further evaluations and recommendations for remediation at landfills that exceed groundwater standards. Staff review results of site investigations triggered by the exceedances of groundwater standards and evaluate the effectiveness of remedial actions at active solid waste facilities and at closed landfills.

As of July 1, 2002, WA only accepts electronic submittal (via diskette or CD) of environmental monitoring data from landfill owners, labs and consultants. Using an interface developed in the last year, WA plans to provide facilities and the public access to the environmental monitoring data contained in its Groundwater and Environmental Monitoring System (GEMS) database within the next six months. Within the next 2 years, we hope to provide a web interface, possibly using the Department's Data Portal and/or Web Access Management System, to allow facilities to upload environmental monitoring data into GEMS, if funding is available to do the necessary programming.

WA has been concerned that staff might not be aware of some old, closed landfills that may be impacting groundwater. Program staff used several reports from the Groundwater and Environmental Monitoring System to do a rough screening of old, closed town, city and village landfills with monitoring wells. In July 2003 we sent the screening reports, identifying landfills that need further attention to each of the regions for follow-up evaluations. Program staff have since reviewed many of the identified sites.

Between July 2000 and July 2001 WA studied 31 landfills that accept municipal solid waste, to try to determine whether VOC contamination in groundwater at these landfills is increasing, decreasing or remaining stable. We chose sites with 10 years of data and summarized the trends over this period of time. One purpose of this study was to determine whether natural attenuation is occurring in groundwater near leaking landfills. The study showed that natural attenuation processes were occurring at most of the landfills as evidenced by the large number of stable or decreasing concentration trends. However, the concentrations took longer to stabilize and stabilized at higher levels than at other types of VOC contamination sites described in the literature.

WA and the UW Stevens Point received funding from July 1999 to July 2001 to evaluate the effectiveness of chemical oxygen demand (COD) as an indicator parameter at landfills. One reason for evaluating COD is that mercury waste is generated when COD is analyzed in the laboratory. The DNR's overall goal is to reduce the amount of mercury that gets into the environment so eliminating COD sampling at the 400+ landfills that currently sample for it would help us meet that goal. Findings from the first year of the study indicated that there was potential to eliminate COD monitoring at some types of landfills. The second year of the study evaluated possible alternatives to sampling for COD. Dissolved organic carbon (DOC) appears to be an acceptable alternative in certain circumstances. WA staff have incorporated the recommendations of this study into code changes that should go into effect by the end of this year.

WA received funding for the period October 2002 to October 2003 to study groundwater quality at solid waste landfills to determine whether they are a source of pesticide contamination. We sampled 11 sites the spring and summer of 2003 and summarized the findings in a 2005 GEMS Newsletter article. Groundwater samples were analyzed for 14 common Wisconsin pesticides using immunoassays and additional GC/MS methods. Preliminary findings indicated that leaking landfills may be contributing alachlor, aldicarb, atrazine and 2,4-D to groundwater. The study researchers believed a follow-up study was needed to provide more evidence to help make concrete recommendations about which pesticides to sample for. However, staff and funding are not currently available for this.

Remediation and Redevelopment Program

The Bureau for Remediation and Redevelopment (RR) has primary responsibility for implementing and aiding cleanups under the Spill Law, the Environmental Repair Law, federal programs (Superfund, Hazardous Waste Corrective Action, LUST, Brownfields), the Land Recycling Law and State Brownfield Initiatives, the Drycleaner Environmental Response Fund and at closed landfills. The RR program provides technical assistance, helps to clarify legal liability, provides financial assistance primarily to local governmental units and provides technical project oversight of cleanup projects.

All cleanups are conducted according to the NR 700 rule series, Wis. Adm. Code, Investigation and Remediation of Environmental Contamination, and NR 140, Groundwater Quality. The majority of cleanups are done by persons responsible under the laws, or persons or groups involved in the redevelopment of potentially contaminated properties. Program staff provide technical assistance on cleanups conducted by consultants at the direction of responsible parties. In addition, RR staff contract and direct consultants on state-funded cleanups.

<u>Cleanup of groundwater contamination</u>. The program used $3.5 million in Environmental Fund dollars to initiate or continue environmental cleanup actions at approximately 62 locations where groundwater contamination is known or suspected. The Environmental Fund is used when contamination is significant but private parties do not undertake the cleanup because no one has legal responsibility for the contamination, the person(s) legally responsible do not have the financial ability to proceed, or the responsible person simply refuses to proceed. Private contractors conduct these cleanups with oversight by DNR staff. The program spends an average of $5 million per year from the fund to address contamination at new and continuing project sites. Whenever feasible, the RR program and legal staff attempt to recover costs from responsible persons after the cleanups are undertaken.

Investigation, cleanup and redevelopment of brownfields. Brownfields are abandoned, idle or underused industrial or commercial facilities or sites whose expansion or development is adversely affected by actual or perceived environmental contamination. The RR program coordinates several efforts to encourage local governments and private businesses to cleanup and redevelop brownfield properties. At many brownfields sites, the release of hazardous substance threaten groundwater quality.

One of the financial assistance programs implemented by the DNR is the Brownfields Site Assessment Grant (SAG) program. The SAG program benefits groundwater by serving as a funding source for (1) the removal of potential sources of groundwater contamination, and (2) site investigations to determine whether groundwater is contaminated, including the determination of the extent and degree of contamination.

This program provides grants to local governmental units to conduct environmental site assessments and other eligible activities at contaminated properties. Eligible activities include site assessment and investigation, demolition, asbestos abatement, removal of petroleum and hazardous substance storage tanks and removal of abandoned containers. Although the SAG program does not fund remediation activities, it funds preliminary activities to determine whether remediation is necessary. Sites are eligible for funding only if the persons responsible for the contamination are unknown, cannot be located, or cannot pay for the activities for which grant funding is requested.

In FY 05, DNR awarded 45 Site Assessment Grants totaling approximately $1.7 million to 31 communities across the state. Small grants up to $30,000 make up 36 of the awards, while nine are large grants between $30,000 and $100,000. Local governments have also pledged more than $900,000 in additional funds for the projects, well beyond the 20 percent match required through the application process.

The grants will provide funds for environmental activities on 107 acres of land. Activities include 128 site assessments and investigations, the demolition of 63 buildings or structures and the removal of 87 tanks, drums and other abandoned containers. Since 2000, 257 grants have been awarded to 134 communities around the state for work on 850 acres of land.

The RR program also provides redevelopment assistance at brownfield sites with groundwater contamination. Program staff assist local governments and private businesses with the cleanup and redevelopment of brownfields by providing technical assistance. In many cases, these properties have groundwater contamination or soil contamination that poses a threat to groundwater.

The RR program also provides a number of different assurance, comfort or general liability clarification letters related to properties with groundwater contamination. Collectively, these letters facilitate the reuse and development of properties. The RR program provided 106 redevelopment assistant reviews – which can include liability clarification letters, off-site exemption letters, cleanup agreements for tax delinquent properties, etc. – at brownfield properties throughout the state in FY 05.

The RR program also continues to provide technical assistance and assist parties with voluntary investigations and cleanups of Brownfield properties through the Voluntary Party Liability Exemption (VPLE) process. Many sites that follow the VPLE process have contaminated groundwater.

After a person has conducted an environmental investigation of the property, and cleaned up soil and groundwater contamination, the DNR will issue a "Certificate of Completion" which provides a release from future liability for any contamination that occurred on the property prior to issuance of the certificate. In FY 05, DNR issued a Certificate of Completion at nine properties for completed cleanups and 15 new sites began the voluntary cleanup process.

Drycleaner Environmental Response Fund (DERF) Program. The DERF program reimburses drycleaner owners and operators for eligible costs associated with the cleanup of soil and groundwater at sites contaminated by drycleaning solvents. Fees paid by the drycleaning industry provide program funding. Environmental cleanups at dry cleaner sites are conducted following the NR 700 rule series. To date, there are more than 120 sites in the program, at various stages of investigation and cleanup. The program is implemented through ch. NR 169, Wis. Adm. Code.

Site closure rules for petroleum contaminated sites. Under the Petroleum Environmental Cleanup Fund Award (PECFA) Program, NR 746 – and its Department of Commerce counterpart, Comm 46 – was promulgated in February 2001. The bulk of NR 746 establishes risk and closure criteria to determine whether petroleum contaminated sites can be closed using natural attenuation as a final remedy for groundwater contamination. The rule also defines which petroleum-contaminated sites DNR and Department of Commerce have authority to administer; summarizes site investigation requirements, and delineates other administrative requirements such as when remediation and remediation funding is terminated, tracking and transfer of sites, staff training and dispute resolution.

The rule provides that sites with contamination in low permeability (clay) materials can close after a site investigation if all risk criteria are met and the groundwater contamination is stable or receding. For contamination in permeable materials, sites must meet all risk criteria and demonstrate through monitoring that groundwater contaminants are declining. Sites requesting closure with groundwater contamination above NR 140 enforcement standards are placed on the GIS Registry of Closed Remediation Sites.

NR 726 provides closure requirements for all other sites.

GIS Registry. Revisions to NR 726, 716, 749, and 811/812 implement a Geographic Information System (GIS) Registry of Closed Remediation Sites to replace the requirement to record soil and groundwater use restrictions at the County Register of Deeds Office. The GIS Registry currently includes locational information on sites closed with residual groundwater contamination above the NR 140 enforcement standards, as well as site specific information pertaining to where the contamination is on the property in question and at what concentration it was found at the time the closure decision was made.

The Registry is a subset of the Bureau of Remediation and Redevelopment Tracking System (BRRTS), and both of these databases can be accessed on the Internet at http://dnr.wi.gov/org/aw/rr/gis/index.htm (see below for more information on *BRRTS on the Web*). Inclusion on the GIS Registry on the Internet provides a means of notifying future owners or users of the property of the existence of soil and/or groundwater contamination.

This database is to be used with well construction requirements for private wells, and with a setback distance for new municipal wells. Beginning in July 2004, the DNR made the GIS Registry information available to well drillers through a Well Construction CD that will be updated twice a year. Before drilling, well drillers are asked to consult the CD to determine if a well is proposed for a property listed on the Registry. If the proposed well is located on a closed

remediation site, then the driller must contact regional Drinking Water and Groundwater staff prior to any well construction activities.

The RR Program continues to make improvements to the GIS Registry System. The existing application is intended to be converted to ESRI's software product, ARCIMS, so that the programming and other maintenance tasks can be accomplished more quickly and at a lower cost. In addition to the ongoing efforts, work continues on quality assurance and quality control (QA/QC) of existing data.

Five years ago, the program created *BRRTS on the Web*, making the DNR's main database for contaminated properties accessible via the Internet at http://dnr.wi.gov/org/aw/rr/brrts/index.htm. The Registry also links to *BRRTS on the Web* and both databases are useful for locating potential contamination sites when evaluating new municipal well placement.

These databases make site specific information on open and closed remediation sites much more available and accessible to the public and specific interested groups, particularly those wanting to install or replace a potable well on an affected property, as well as those buying properties. Sites regulated by the Departments of Commerce and Agriculture, Trade and Consumer Protection are also included in the GIS Registry and *BRRTS on the Web*.

Watershed Management

The Bureau of Watershed Management (WT) is responsible for statewide implementation of DNR's groundwater standards primarily through the issuance of discharge permits to facilities, operations and activities that discharge treated wastewater and residuals to groundwater. Field staff that work on integrated basin teams carry out compliance and enforcement activities using policies, codes and guidelines developed by the WT program. Integrated basin planning carried out in the field under guidelines developed by WT assess and evaluate groundwater (and surface water) and provide general and specific recommendations for the protection and enhancement of the basin's groundwater.

Wastewater discharges. WT issues Wisconsin Pollutant Discharge Elimination System (WPDES) permits to all communities, industrial facilities, and large privately owned wastewater systems which discharge treated domestic or industrial wastewater to groundwater through land treatment/disposal systems. These systems are primarily spray irrigation, seepage cell, subsurface absorption systems, and ridge & furrow treatment systems. WPDES permits issued to these facilities contain groundwater monitoring and data submittal requirements that are used to evaluate facility compliance with ch. NR 140, Wis. Adm. Code, groundwater quality standards. Groundwater monitoring systems at existing facilities are evaluated and upgraded as necessary at permit re-issuance.

WT maintains a database, designated the System for Wastewater Applications, Monitoring, and Permits (SWAMP), for holders of specific WPDES and general permits. This database system stores facility specific information such as address, contacts, location, permit requirements, monitoring results, and violations of permit requirements for private and municipal wastewater treatment facilities. The system contains current information on groundwater, wastewater, and biosolids treatment/management. Historical sampling data from groundwater monitoring wells is available through the system and current sample results are added on a monthly basis. Sampling results and site loading information are also available for land application of municipal sludge, septage and industrial sludge, by-product solids and wastewater.

WT continues to assist unsewered communities, served by failing or inadequate individual on-site treatment systems in their efforts to construct centralized wastewater treatment facilities.

In 2000, the Department of Commerce and DNR completed revision of an interagency memorandum of understanding after Commerce issued rules for private onsite wastewater treatment systems under Ch. Comm 83, Wis. Adm. Code. The DNR completed refined procedures, guidance, and rules for the review and permitting of large private onsite wastewater treatment systems (POWTS). In general, large POWTS are defined as those with a capacity of greater than 12,000 gallons per day (gpd). The DNR started issuing permits to large POWTS in early 2000. On February 1, 2005 WT issued a general permit to regulate the operation of these types of systems in a more streamlined manner.

Septage and sludge management. WT implements the regulations in chapters NR 113, NR 204 and NR 214, Wis. Adm. Code. NR 113 relates to septage management and NR 204 governs the treatment quality, use, and disposition of municipal wastewater treatment plant sludge. NR 113 and NR 204 incorporate federal septage and sludge standards. WT regulates the land application of industrial sludge, liquid wastes and by-product solids through NR 214. Chapters NR 113, NR 204 and NR 214 contain treatment quality standards and land application site requirements and restrictions that are designed to prevent runoff to surface water or leaching of nutrients and pollutants to groundwater.

WT continues to implement a new statewide computer system that records and monitors treatment and disposal of municipal sludge, septage, and industrial land applied wastes. This system includes an inventory and a history of all sites used for land application. Wisconsin became the fourth state delegated authority by EPA to implement municipal sludge regulations, through it's delegated NPDES (WPDES) permit program, in July of 2000.

Agricultural runoff. Chapter NR 243 Wis. Adm. Code covers the permitting requirements for livestock operations and currently contains provisions to protect surface water and groundwater in Wisconsin. DNR has proposed changes to ch. NR 243, Wis. Adm. Code to address revisions to federal rules that govern the operation and permitting of large confined animal feeding operations (CAFO) that were promulgated in April 2003. The proposed revisions to NR 243 improve groundwater protection from CAFOs by increasing setback requirements from community and non-community wells and karst features; and further restrict winter application of manure in areas with shallow soils over bedrock and groundwater. After consideration of testimony from public hearings in August 2005, the rules are expected to be finalized in early 2006.

Under this existing rule, there are currently 138 WPDES permits issued for livestock operations (84% dairy; 9% poultry; 7% swine & beef). In addition, there are 4 large-scale livestock operations seeking permits for the first time. Regional and central office staff have successfully maintained the permit backlog at less than 15%. The trend of growing numbers of permit applications for operations with 1,000 or more animal units is expected to continue. In early 2005, a number of livestock operations (some not regulated as larger systems) were subject to overflows that adversely impacted surface water and non-community wells. DNR investigated these incidents, initiated enforcement actions, and is currently evaluating the effectiveness of programs and procedures that are designed to protect water resources. The proposed revisions to NR 243 (see above) contain elements that address preliminary recommendations made as a part of the program evaluation.

Storm water. Final revisions to Chapter NR 216, Wis. Adm. Code were promulgated on August 1, 2004. The revisions were completed primarily to comply with federal storm water regulations that took effect on March 10, 2003. The revisions to NR 243 require nearly 200 municipal separate storm sewer systems to obtain permit coverage statewide and also requires construction sites down to one acre of land disturbance to have permit coverage to control erosion during construction. Permit holders will also are required to install post-construction practices to limit pollutant discharge after construction is completed (storm water management). The DNR has developed performance standards (i.e. 80% sediment control, infiltration, peak flow, buffer requirements, etc.) that became effective in 2002. Many of these standards will be implemented through storm water permits, especially for new development.

Nutrient management plans. One of the performance standards included as part of the Nonpoint Redesign Initiative was a nutrient management standard, NRCS Standard 590. Under the rules, the performance standard itself became effective January 1, 2005 for high priority areas in the State (source water areas, impaired waters and outstanding/exceptional resource waters). The standard will become effective for the remainder of the state in 2008. On an ongoing basis, federal, state and local agencies are working to build the necessary resources and expertise to implement NRCS Standard 590. As an example, the Department of Agriculture, Trade and Consumer Protection (DATCP) cooperatively revised the technical standard to achieve DNR's performance standards. Although the implementation of the performance standards is limited by the amount of cost share that is available to participants, NRCS has provided extensive support of nutrient standards implementation through the EQIP cost share program.

For more information, visit the following website (http://dnr.wi.gov/) or contact Todd Ambs at 608-264-6278 (Todd.Ambs@dnr.state.wi.us) or Mike Lemcke at 608-266-2104 (Michael.Lemcke@dnr.state.wi.us), DNR, P O Box 7921, Madison, WI 53707-7921.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

Protecting Wisconsin's groundwater is a priority for the Department of Agriculture, Trade and Consumer Protection (DATCP). DATCP's major activities in this area include management of pesticides and nutrients, research, and funding of local soil and water resource management projects.

In compliance with the Wisconsin Groundwater Law (1983 Wisconsin Act 410), DATCP manages pesticides and pesticide practices to assure that established groundwater standards for contaminants are not exceeded. This may include prohibition of certain activities including pesticide use. The agency also manages practices to "minimize" groundwater contamination to the extent "technically and economically feasible." DATCP regulates storage, handling, use, and disposal of pesticides, and the storage of bulk quantities of fertilizer. DATCP has authority to develop a statewide nutrient management program through section 92.05 Wis. Stats. The program includes compliance, outreach, and incentive components.

Enforcement standards have been established in Wisconsin for many known and potential groundwater contaminants, including over 30 pesticides. Standards for additional pesticides have been proposed. DATCP applies these standards and the Groundwater Law when addressing nonpoint and point sources of pesticide contamination in groundwater.

Non-Point Source Activities

Pesticides. DATCP's primary effort related to nonpoint contamination (i.e., due to general use) of groundwater from pesticides continues to involve the herbicide atrazine. In response to concerns about atrazine contamination, DATCP amended administrative rule ch. ATCP 30 in 1992 to manage the use of atrazine in an effort to reduce or eliminate the potential for further groundwater impacts. Rule revisions have been made annually in response to additional detections of atrazine in groundwater. A set of 102 maps of new or existing prohibition areas is available from the Water Quality Section covering 1.2 million acres that have been incorporated into the rule. Information suggests that atrazine use has declined from peak levels in the late 1980's and is now holding roughly constant. The decline in use may have been a result of the atrazine management rule and concern about groundwater contamination.

Nutrients. DATCP, through its land and water resource management program, provides funding primarily to counties to assist in the protection of water resources through farmer adoption of nutrient management planning. A portion of this funding is dedicated to the development and implementation of improved nutrient and pesticide management practices. In FY 05 approximately $100,000 was provided to develop tools for nutrient management plans on farms to maximize profitability and to minimize excessive runoff of nutrients to surface and groundwater. Additionally, staff worked to train farmers, consultants, and local agencies on the principles of sound nutrient management and how to comply with performance standards.

Point Source Activities

Previous work by DATCP identified pesticide and fertilizer operations as possible point sources of groundwater contamination. Past problems included improper disposal of unwanted agricultural chemicals, lack of containment for spills, out-dated product handling methods, and poor understanding by workers in the industry of how small actions when continued over time lead to large problems. DATCP has worked to address these problems through point source prevention. In cases where environmental degradation has already occurred, DATCP oversees environmental cleanup of contaminated soil and groundwater.

Point source prevention for agrichemicals includes Agricultural Clean Sweep, enforcement of product containment rules and handling regulations, and education beyond the rule requirements through the Environmental Partners program. Point source cleanup activities are performed under the Agricultural Chemical Cleanup Program (ACCP), which provides technical oversight and reimbursement to offset much of the costs for investigation and cleanup.

Since 1990, the Agricultural Clean Sweep program has helped farmers dispose of unwanted pesticides, farm chemicals, and empty pesticide containers. Beginning in 1996, the program extended collection services to small agricultural businesses. In 2003, DATCP provided $378,582 to fund Clean Sweep projects in 37 counties for collection and disposal of waste pesticides and containers. In addition, DATCP now operates and manages the state's household hazardous waste program. Approximately $710,000 was made available during 2005 for both agricultural and household programs.

DATCP's rules for minimizing environmental damage from agrichemical storage and handling were put in place in 1988. Fifteen local DATCP specialists work with facilities across the state to keep them in compliance with the ATCP rules designed to protect the environment. DATCP staff also educate facility managers and employees about how routine practices may affect the environment.

The Environmental Partners program works to reduce the amount of agrichemicals that escape into the environment. 2005 was the fifth year for this program. Participation in the program is voluntary with the agrichemical industry and Department working together to identify the problems and brainstorm ideas to reduce pollution. The ideas used to solve problems at each facility are shared so that everyone can learn and benefit from the program.

In August 1993, section 94.73 of the Wis. Stats. was created and established the Agricultural Chemical Cleanup Program (ACCP) to address point sources of contamination. The ACCP reimburses responsible parties for cleanup costs related to pesticide and fertilizer contamination at facilities and in nearby wells. The program may also handle point source contamination on farms. To date, more than 370 cases involving soil and/or groundwater remediation related to spills, misuse, and improper storage or mixing and loading have been initiated at pesticide and fertilizer facilities and on farms.

The ACCP also funds DATCP oversight of pesticide and fertilizer cleanup activities. Program staff respond to and investigate pesticide and fertilizer contaminated sites throughout the state. Investigations at these sites are prioritized based on suspected contamination levels, with the higher levels investigated first. Investigations include discussions with facility staff or farmers to determine the most likely locations of contamination at the site. Other oversight activities include, but are not limited to, sample collection, laboratory analysis, and financial auditing.

Groundwater Sampling Surveys

DATCP conducts a number of annual surveys to investigate the occurrence of pesticides in groundwater resulting from nonpoint sources. Results of these surveys are provided in the “Pesticides" section under *Condition of the Resource - Groundwater Quality*.

Research Funding

Pesticide Research - Due to budget constraints, DATCP did not have funding for new pesticide research projects in FY05.
Nutrient Research - DATCP funds fertilizer research at approximately $130,000 per year.

Groundwater Data Management

DATCP maintains two groundwater sample databases: the Drinking Water Well System and the Monitoring Well System. The Drinking Water Well System contains contact and location information, well characteristics, and pesticide and nitrate sample results for private and public drinking water wells. The Monitoring Well System contains similar information for monitoring wells, and also tracks specific pesticide use history, soils, crop history, well construction, and precipitation and irrigation at monitored sites. These data represent samples analyzed by DATCP, Wisconsin State Lab of Hygiene (WSLH), and other public and private laboratories. DATCP's Drinking Water Well System currently contains information for over 37,500 wells and nearly 240,000 pesticide and nitrate-N results.

DATCP uses geographic information system (GIS) tools to analyze groundwater data and prepare maps for public hearings, DATCP board meetings, presentations, and other uses. DATCP prepares and maintains ArcInfo and ArcView data layers of well locations, atrazine concentrations, atrazine prohibition areas, and other pesticide and nitrate-N data. These GIS layers and associated database information are used to generate maps of statewide pesticide and nitrate-N detections in wells, as well as maps for chapter ATCP 30, Wis. Adm. Code (Pesticide

Product Restrictions). For example, see the map of "Private Wells Tested for Atrazine in Wisconsin" in Chapter 4, *Condition of the Groundwater Resource*. Other GIS analyses involve identifying groundwater wells that may be impacted by point sources of pesticide and nitrate-N contamination. DATCP also uses global positioning system (GPS) receivers to locate and map wells and other features, such as agrichemical facilities and spill sites, that may affect groundwater quality.

For further information, visit the following web site (http://www.datcp.state.wi.us) or contact Kathy Pielsticker, DATCP, 2811 Agriculture Drive, PO Box 8911, Madison, Wisconsin, 53708-8911; phone: 608-224-4567; e-mail:kathy.pielsticker@datcp.state.wi.us.

DEPARTMENT OF COMMERCE

Two of the seven Divisions of the Department of Commerce regulate activities, protect or remediate Wisconsin's groundwater resources.

Within the Division of Buildings and Safety, two programs have the responsibility of safeguarding public health and the waters of the State. Graywater reuse and stormwater is regulated by the Plumbing Program (Admin. Code Comm 82) and private onsite wastewater treatment systems by the Private Onsite Wastewater Treatment Systems Program (Admin. Code Comm 83).

Within the Division of Environmental and Regulatory Services (ERS), two bureaus regulate petroleum tanks and petroleum cleanups: The Bureau of Petroleum Products and Tanks regulates flammable and combustible liquids and hazardous substance liquids (Admin. Code Comm 10). The Bureau of PECFA reimburses owners and operators of leaking petroleum storage tanks (Admin Code Comm 47) and has regulatory jurisdiction of petroleum sites determined to be a low or medium risk to the environment (Admin Code Comm 46).

Plumbing – Reuse, Stormwater and Private Onsite Wastewater Treatment Systems (POWTS)

In addition to public health and safety, the water supply and quality issues facing Wisconsin are a focus of the General Plumbing and POWTS programs in the Department of Commerce.

General Plumbing – Reuse and Stormwater Use. In May of 2003, Chapter Comm 82 of the plumbing code was revised to include standards for graywater reuse and stormwater use. In 2004, a revision to the plumbing code refined the reuse and storm water use standards to eliminate the irrigation of food crops. The revisions included the entire section of storm water plumbing systems, s. Comm 82.36 and allow greater flexibility for designers of plumbing systems when designing systems to comply with NR 151 performance requirements. These NR 151 post-construction stormwater requirements became effective on October 1, 2004.

Private Onsite Wastewater Treatment Systems (POWTS). The Department continues to communicate with the Department of Natural Resources regarding mutual issues such as large onsite sewage systems and Underground Injection Control (UIC) regulations. The Department is also communicating with the USEPA regarding POWTS related matters. Additionally, Department staff are participating in an effort to develop a national model code related to onsite sewage systems.

Petroleum Product and Hazardous Substance Storage Tanks

The ERS Division continues to maintain regulatory oversight of aboveground and underground petroleum and CERCLA hazardous substance storage tanks in the Comm 10 administrative code. Underground storage tank regulations include the Federal EPA Underground Storage Tank (UST) requirements, as well as heating fuels, tanks supplying stationary combustion engines such as emergency generators, and other tanks storing regulated liquid products. Comm 10 is progressing with the Phase II revision to address technical requirements associated with current day concerns, trends and technology.

Since 1991 the database inventory of petroleum product tanks regulated under Comm 10 has increased from 143,681 to 206,695 USTs as previously unregistered tanks have become registered. In 1991 the database included 68,056 tanks classified as federally regulated with 51,088 of those tanks in use. As of July 12, 2005 the database reflects 79,918 federally regulated tanks with only 12,424 tanks in use. In order to maintain a federally regulated tank in use, the tank must have a valid “permit-to-operate” and an annual inspection. Annual inspections involve verification of leak detection, spill and overfill protection, and record keeping. Permit renewal administrative review includes compliance assessment of the owner’s financial responsibility.

Program tank permit initiatives have resulted in approximately 88% of the tanks required to have financial responsibility being in compliance with the rule. The remaining tanks will not be permitted and will be shut-down if financial responsibility coverage is not verified. The closure of federally regulated tanks will continue, but at a slower pace than experienced over the past few years. Closure of out-of-service residential heating fuel tanks is continuing as realtors and lenders recognize the potential problems and liability.

The closure of underground storage tanks is being supplanted by private fueling moving to retail fueling and some operators moving storage tanks to above ground. Residential heating fuel has not been significantly impacted, as the closures are generally associated with the conversion to natural gas or liquid propane gas (LPG). Existing aboveground bulk storage facilities were subject to release prevention upgrade requirements in 2001 providing an enhanced measure of environmental protection over the former levels of acceptance.

Proactive educational outreach efforts and annual inspections by the Department and its agents have resulted in a high level of regulatory compliance, and a reduction of system failures and environmental contamination. The ongoing regulatory challenges are owner operational compliance with leak detection. Wisconsin's progress and regulatory oversight continues to reflect very favorably with the US EPA.

Petroleum Environmental Cleanup Fund Act (PECFA)

Since 1989, the PECFA program has reimbursed approximately $1.4 billion to petroleum storage tank system owners for costs associated with the investigation and remediation of petroleum contaminated sites. The program, in addition to auditing owner invoices and authorizing payments, performs technical reviews of site investigations, evaluates the feasibility of remedial options, conducts a competitive public bid process for scopes of work, and makes decisions regarding closures for the majority of the State’s leaking underground storage tank (LUST) sites.

The petroleum inspection fee supports PECFA's spending authority. The proposed annual spending authority is $40.4 million in FY06 and $37.6 million in FY07. In FY04, the PECFA program reimbursed $43.7 million to 1200 claimants. Currently, costs claimed per month are at or

below the monthly spending authority and the program provides reimbursement within approximately three months of receiving the claim.

The pending Budget Bill will eliminate the PECFA bonding authority and reduce the Petroleum Inspection Fee by one cent. The proceeds from the sale of revenue bonds were used to pay down the backlog of audited claims awaiting payment, and the total outstanding debt is $387 Million.

In addition to administering the PECFA fund, the Department of Commerce PECFA Bureau has the administrative authority for low and medium risk petroleum contaminated sites (which includes both soil and groundwater sites). The Bureau closes approximately 200 sites per year.

Data Management

Commerce is continuing its data integration information technology (IT) initiative. With regard to groundwater protection, Commerce maintains databases of underground petroleum storage tank systems and properties with petroleum contamination either in the past or currently. The database also stores information on activities associated with onsite sewage system design, installation and maintenance. The Department has successfully piloted a project involving a small group of governmental units (counties) that allows them to issue Sanitary Permits on demand using their own IT equipment. The goal is to reduce or eliminate duplicative records kept by the governmental units and the Department. Sanitary Permit information reporting and processing has been streamlined. Further efficiencies will be realized as the process is expanded to other governmental units. At least one governmental unit is accepting, processing and storing POWTS plans electronically. The Department continues to participate in discussions with county code administrators, service providers and other interested parties relative to reporting and recording of inspection, maintenance and servicing events for onsite sewage systems. Several governmental units have enhanced their maintenance reporting abilities in the last year and more are expected to follow in the future as additional contractors enter the state to market their data management services.

For more information, visit the following web site (http://www.commerce.state.wi.us) or contact Berni Mattsson, ERS Division Administrator, P. O. Box 7839, Madison, Wisconsin 53707-7839, phone: 608-266-9403, fax: 608-267-1381; e-mail bmattson@commerce.state.wi.us.

DEPARTMENT OF TRANSPORTATION

The Department of Transportation (DOT) regulates the storage of highway salt (ss. 85.17 and 85.18, Wis. Stats.) to protect the waters of the state from harm due to contamination by dissolved chloride. DOT is also responsible for potable well sampling at 29 rest areas and 73 waysides. Other DOT groundwater related activities include: road salt research; hazardous material and waste investigation or remediation; wetland compensation and research; and storm water management and research. Various divisions and sections in DOT are responsible for these activities:

- Salt Use and Storage - Bureau of Highway Operations
- Salt Research - Bureau of Highway Construction (Geotechnical Section)
- Hazardous Materials (petroleum) - Environmental Services Section
- Hazardous Waste - Risk & Safety Management Section
- Wetlands - Environmental Services Section
- Erosion Control and Storm Water Management - Environmental Services Section

- Rest Area Potable Well Sampling - Bureau of Highway Operations

Salt Storage

Highway salt is stored statewide by suppliers, counties, cities, villages, and private companies. Annual inspections occur and reports are provided for salt storage sites to insure that storage practices are in accordance with ch. Trans 277, Wis. Adm. Code (Highway Salt Storage Requirements). The intent of the Code is to help prevent entry of highway salts into waters of the state from storage facilities. All salt must be covered and stored on an impermeable base. The base for stockpiles is required to function as a holding basin and to prevent runoff. The covers must consist of impermeable materials or structures to prevent contact with precipitation. State funded facilities are being added to the DOT salt storage program to provide greater capacity of indoor storage. This will improve groundwater protection and create greater flexibility for scheduling salt purchase at optimal prices.

The DOT annually updates salt storage facility records into a database and assists the DNR source water protection program in locating salt storage facilities for GIS mapping applications. There are currently 1,219 salt storage sites listed in the database and 2,320 sub-sites. Each county keeps detailed inventories of salt which are updated monthly. Facility inventories, inspections, repairs and improvements are included in the database.

Salt Use

The DOT Bureau of Highway Operations produces the Annual Winter Maintenance Report describing statewide salt use based on weekly reports from each county. Current policy in the State Highway Maintenance Manual restricts the spreading of deicer salts to a maximum of 400 pounds per lane mile per initial application, and 300 pounds per lane mile for subsequent applications. Electronic controls for salt spreader trucks are continually tested to record and verify application rates and coverage effectiveness. Other technology is used on county highway patrol trucks to keep salt on pavement surfaces (e.g., zero-velocity spreaders, ground speed controllers, and onboard liquid pre-wetting units). Additional efforts to minimize and conserve salt applications include the use of in-situ weather monitoring system. Pavement temperature sensors recorded at 62 locations along major highway routes are used to determine application methods. Annual training for snowplowing and salt spreading techniques is provided for county snowplow operators.

Salt Monitoring and Research

Since 1970, DOT has investigated potential road salt impacts on the environment adjacent to highways. Early investigations (1970s to early 80s) were focused on evaluating road salt impacts to surface water runoff, vegetation, and soils. In the last several years DOT has conducted limited investigations evaluating road salt impacts to groundwater. Approximately 20 sites throughout the state have been studied. In general, 1 or 2 shallow monitoring wells at each site were monitored quarterly for a period of 5 years. The monitoring consists of analyzing soil, water, or vegetation samples for calcium, sodium, chloride, and electrical conductivity. Approximately 5 sites are currently monitored, and new sites are added periodically. Results from the studies are discussed in 5 separate DOT progress reports entitled: Investigation of Road Salt Content of Soil, Water and Vegetation Adjacent to Highways in Wisconsin (1972, 1975, 1979, 1989 and 1996).

For more information, visit the following web site (http://www.dot.state.wi.us) or contact Mr. Dan Scudder, Chief, Environmental Services Section, Room 451, P. O. Box 7965, Madison, Wisconsin 53707-7965; phone: 608-267-3615, or e-mail dan.scudder@dot.state.wi.us.

DEPARTMENT OF HEALTH AND FAMILY SERVICES

Chapter 160, Wis. Stats., directs the Department of Health and Family Services (DHFS) to recommend health-based enforcement standards for substances found in groundwater and specifies the protocol for developing the recommended standards. Recommended standards are sent to the DNR and are submitted through the rule-making process as amendments to ch. NR 140, Wis. Adm. Code. DHFS staff serve as a primary resource for information about the health risks posed by drinking water contaminants, and are charged with investigating suspected cases of water-borne illness. Toxicologists, public health educators, and epidemiologists employed in the Department's Division of Public Health present this information to the public at meetings and conferences, and provide direct assistance to Wisconsin families via home visits, letters to well owners, and telephone consultations. DHFS staff review correspondence sent to well owners by DNR representatives. The agency frequently provides supplemental advice to owners of wells that are highly contaminated with volatile substances such as benzene and vinyl chloride, especially in cases where the contaminants may pose concerns from inhalation of indoor air. Follow-up letters sent by DHFS explain the health effects of specific contaminants and suggest strategies for reducing exposure until a safe water supply can be established. DHFS staff are called upon to review the toxicity of constituents of well construction and rehabilitation products to ensure that products approved for use in Wisconsin can be used safely without risk of chemical overexposure. DHFS prepares and distributes a wide variety of informational materials on groundwater and drinking water issues related to human health.

Summary of Agency Activities in FY 05

In October of 2004, DHFS sponsored a conference in Madison for local health department staff and others interested in environmental health hazards. The program included sessions on both groundwater and surface water contaminants such as pesticides, well sampling, testing water for viruses, and applying GIS technology to the management of groundwater quality.

Based on funding from the federal Centers for Disease Control and Prevention (CDC), DHFS has begun work on developing environmental public health tracking modules for childhood cancer, multiple sclerosis (MS) and amyotrophic lateral sclerosis (ALS) to create data systems that link information on relevant hazards, exposures and health outcomes. In support of this initiative, DHFS is working with DNR to access groundwater and drinking water data to create exposure profiles and generate environmental hypotheses about the etiology of these conditions. Other partners in this program include DATCP, the Division of Information Technology (DoIT) and the medical school at the University of Wisconsin - Madison, and the Wisconsin State Laboratory of Hygiene.

DHFS oversaw the implementation of three environmental health projects relating to groundwater-related issues. The three projects used GIS technology to map well testing results. The ***Eau Claire City-County Health Department*** mapped results from a recent well testing campaign for semi-volatile organic compounds, nitrate, bacteria and other contaminants. The ***Dunn County Local Health Department*** mapped nitrate well test results in specific areas. The ***Wood County Health Department*** used GIS to assess the impact of pesticide use on groundwater. GIS mapping provided an organized method to assess if groundwater quality was being impacted and if specific areas were at higher risk for drinking water problems.

For more information, visit http://dhfs.wisconsin.gov/eh/Water/, or contact Henry Anderson (608-266-1253; anderha@dhfs.state.wi.us), Lynda Knobeloch (608-266-0923; knobelm@dhfs.state.wi.us) or Mark Werner (608-266-7480; wernema@dhfs.state.wi.us), 1 W. Wilson St., Rm. 150, Madison, Wisconsin, 53702.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

The Wisconsin Geological and Natural History Survey (WGNHS), University of Wisconsin-Extension, performs basic and applied groundwater research and provides technical assistance, maps, and other information and education to aid in the management of Wisconsin's groundwater resources. The WGNHS groundwater program is complemented by the geology and soils programs, which provide maps and research-based information essential to the understanding of groundwater recharge, occurrence, quality, and movement.

Highlights of the WGNHS groundwater activities for FY 05 include the following:

Groundwater-level monitoring network

Wisconsin's statewide groundwater-level monitoring network has been operated jointly with the U.S. Geological Survey (USGS) since 1946. Currently, the network consists of approximately 120 wells in 66 counties. The groundwater-level monitoring network provides a consistent, long-term record of fluctuations in water levels in deep and shallow aquifers. Such information is critical for accurate analyses of the effects of high-capacity wells pumping, the response of groundwater levels to droughts, and the effects of land-use changes on groundwater systems. The WGNHS will continue to supply the information to public and private clients and aid in data interpretation. For available data see http://wi.water.usgs.gov/public/gw/.

County groundwater studies.

Geologic and groundwater studies at the county scale continue to be an important part of WGNHS programs. During 2004 the Survey initiated or carried out geologic and/or groundwater studies in the following counties: Dane, Calumet, Fond du Lac, Iowa, Pierce, St Croix, Sauk, Washington, Waukesha, and Winnebago. Many of these studies will generate or have generated water-table maps. For a current list of available county-scale water-table maps see http://www.uwex.edu/wgnhs/watertable1.htm.

Regional groundwater studies

Regional geologic and groundwater studies usually span multiple counties. During 2005 the WGNHS was involved in several regional projects, including the following:

a. Geologic and hydrogeologic analyses in southeastern Wisconsin. The WGNHS conducted regional groundwater modeling in the SEWRPC (Southeastern Wisconsin Regional Planning Commission) region, spanning seven counties in SE Wisconsin. (see http://www.uwex.edu/wgnhs/gw_se_wisc.htm and http://water.usgs.gov/pubs/fs/fs-116-03/)

b. Development of well-drilling guidelines for the Lower Fox River Valley. This effort assisted the DNR in developing casing guidelines to reduce potential arsenic contamination in private wells. See http://www.dnr.state.wi.us/org/water/dwg/arsenic/casingrequire.htm

c. Geologic mapping and groundwater investigations in northeastern Wisconsin. With funding from the federal STATEMAP program and additional funding from the UW

Groundwater Research Advisory Council (GRAC), WGNHS scientists are preparing new geologic maps and acquiring new groundwater data for Pierce, Polk, and St Croix Counties.

Groundwater Research Activities

The WGNHS carries out specific groundwater research projects focused on understanding topics important to groundwater use and management in Wisconsin and elsewhere. Active projects during FY05 include the following:

a. *Methods of investigating aquitards.* Aquitards, low-permeability geologic materials such as clay or shale, are critical resources for protecting water-supply wells from contamination, yet are often difficult to characterize. In late 2001 the WGNHS received a grant from the American Water Works Association Research Foundation (AWWARF) for evaluation of the properties of aquitards. See http://www.awwarf.org/research/TopicsAndProjects/projectSnapshot.aspx?pn=2780

b. *Arsenic in groundwater*. The WGNHS is continuing research on the source(s) and geochemical characteristics of arsenic contamination in water-supply wells in northeastern and southeastern Wisconsin.

c. *Groundwater recharge.* Groundwater recharge is critical to maintaining the supply of Wisconsin's groundwater, but mapping and quantifying recharge areas and rates can be a difficult process. In cooperation with UW-Madison, the WGNHS has developed a computerized technique for rapidly delineating recharge areas for use in regional groundwater models. Currently, the WGNHS is incorporating the recharge delineation methodology into new projects and is cooperating with the USGS in using it in other areas of Wisconsin.

d. *Fluid flow in carbonate rocks.* Carbonate rocks (limestone and dolomite) underlie much of Wisconsin and form important aquifers over large parts of the state. Groundwater in carbonate rocks can move through fractures and solution features. Groundwater velocities in such rocks can be unusually high, and the rocks usually have very low ability to attenuate contaminants. Work by the WGNHS on carbonate aquifers in eastern Wisconsin suggests that detailed stratigraphic analysis, coupled with geophysical and hydrogeologic data, may help predict the hydraulic properties of these complex and vulnerable aquifers.

   Karst features, including a variety of sinkholes, cavities, and solution openings, commonly are found in carbonate rock (limestone and dolomite). In recent years there has been increased concern about the hazards and effects of karst features in many parts of Wisconsin, but little published information has been available. The WGNHS is serving as a clearinghouse for karst information, and has begun assembling a karst database for the state: http://www.uwex.edu/wgnhs/karst.htm.

e. *Crandon Mine*. Until withdrawal of the permit application in late October 2003, the WGNHS was actively assisting the DNR in its review of the proposed massive sulfide mine near Crandon, Wisconsin. This review included development and testing of groundwater flow and contaminant transport models being used to evaluate the potential effects of the mine on local groundwater and surface-water features. During 2004 the WGNHS finalized reports on technical aspects of these groundwater flow models so that

the knowledge gained during the mine-permit review is available to future environmental projects.

f. *Investigation of unsewered rural subdivisions*. Population growth and urban expansion in many areas has resulted in residential development on formerly agricultural land, but there have been few studies of the impacts of such developments on groundwater quality. To document the effects of this land-use conversion on groundwater quality, the WGNHS initiated a monitoring program to collect water-quality data before, during, and after construction of a new, unsewered subdivision located on agricultural land several miles outside of Madison, Wisconsin. See http://www.wri.wisc.edu/NewProject-BradburyDNR.html

g. *Groundwater use*. This project began in FY 05 and focuses on determining the cause of exponential growth in groundwater pumping that has occurred in Waukesha County over the last several decades, and compare this to changes in groundwater pumping that have occurred in a predominantly rural area (Sauk County). This study, funded by the USGS and the Water Resources Institute, will also evaluate methods for tracking groundwater pumping in Wisconsin.

h. *Hydrogeology/geochemistry in southeast Wisconsin.* A major issue facing water managers and users in eastern Wisconsin is a high, and in certain wells, increasing concentration of TDS and radioactivity in the deep sandstone aquifer. WGNHS scientists are working with USGS and UW-Milwaukee personnel to investigate these issues in Waukesha County. See http://www.wri.wisc.edu/Project-Grundl.html.

Groundwater data management

During 2004 the WGNHS continued to collect geologic and groundwater data and provide this data to a variety of users. Significant efforts include the following:

a. *WiscLith database*. The Survey has developed and distributed a digital database, called *wisc*LITH, that contains lithologic and stratigraphic descriptions of geologic samples collected from across the state. This database was updated during 2004. Current work efforts aim to improve the quantity of data for areas of the state where there are active geologic and hydrogeologic projects, and to improve quality control and consistency of information in the state-wide database. See http://www.uwex.edu/wgnhs/wisclith.htm

b. *Well construction reports.* The WGNHS serves as the repository for 1936–1995 Well Constructor's Reports, one- to two-page reports that are usually submitted to the DNR by a well driller within a few months of a well's completion. The database and scanned images are now available to state agencies, consulting firms, and private well owners on CD-ROM. See http://www.uwex.edu/wgnhs/wcrs.htm

c. *Tillpro Database*. TILLPRO is primarily a database of grain-size analyses performed on unlithified sediment samples collected from Wisconsin and analyzed in the Quaternary Laboratory at the Department of Geology and Geophysics, University of Wisconsin-Madison. During 2004 the WGNHS released this database for public distribution on CD-ROM. See http://www.uwex.edu/wgnhs/wisclith.htm

d. *New core and sample repository.* During 2004 the WGNHS acquired space for storage of geologic records, core samples, and other materials in Mt Horeb, Wisconsin. See http://www.uwex.edu/wgnhs/core.pdf

Groundwater education

WGNHS groundwater education programs for the general public are usually coordinated with the UW-Extension network of county-based faculty, the DNR, the Central Wisconsin Groundwater Center, or the UW-Extension Environmental Resources Center. The WGNHS also produces and serves as a distributor of many groundwater educational publications and visual aids. In FY 06 WGNHS staff members plan to participate in groundwater educational meetings in counties where county mapping and/or other hydrogeologic studies are in progress. Arsenic in groundwater and the potential groundwater implications of proposed quarries, gravel pits, and high-capacity wells have been popular topics recently and probably will continue to provide educational opportunities in FY 06. Geologic and hydrogeologic field trips for DNR water staff and new DNR employees have been held in the past and will continue in FY 06.

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UNIVERSITY OF WISCONSIN SYSTEM

The University of Wisconsin System (UWS) has research, teaching and outreach responsibilities. These three missions are integrated through cooperation and joint appointments of teaching, research and Extension personnel who work on groundwater issues. UWS staff members work

with state and federal agencies and other partners to solve groundwater resource issues. Citizen outreach is accomplished through use of publications, news media, public meetings, teleconferences, and water testing and satellite programs. Activities of several specific programs follow.

The UW Water Resources Institute (WRI)

The UW Water Resources Institute (WRI) is one of 54 water resources institutes located at Land Grant universities across the nation. It promotes research, training, and information dissemination focused on the nation's water resources problems.

Research. The WRI research portfolio includes interdisciplinary projects in four broad areas: groundwater, surface water, groundwater-surface water interactions, and drinking water. Groundwater is a top priority and an area of particular strength at the WRI. Key areas of emphasis in FY 05 included identifying contamination of groundwater by pharmaceuticals and other endocrine disrupting compounds in groundwater, addressing groundwater resources in Wisconsin's Smart Growth planning, and developing treatment processes for pesticides and arsenic.

During FY 05, the WRI directed a wide-ranging program of priority groundwater research consisting of 14 projects. These included short- and long-term studies both applied and fundamental in nature. They provide a balanced program of laboratory, field, and computer-modeling studies and applications aimed at preserving or improving groundwater quality. Groundwater problems investigated during the past year include:

- A study on the potential for antibiotics from municipal treatment plants and agricultural areas to leach into groundwater;
- Applying a screening technique to test for the presence of endocrine disrupting compounds in groundwater;
- Assessing the use of slag from steel processing for treatment of arsenic in groundwater;
- Determination of the role of hyporheic zones (layers of sediment beneath or adjacent to a stream) in the production and transport of methylmercury;
- Delineating zones in remote areas of northern Wisconsin that are important for recharging groundwater;
- A study evaluating long-term viability of landfill liners in protecting groundwater quality;
- Determination of the effects of dewatering of important groundwater aquifers in southeastern Wisconsin;
- Studying methods to best incorporate effects on groundwater resources as communities develop Smart Growth plans (two projects);
- Development of an enzyme-based protocol for coliform testing of groundwater;
- Determination of the influence of trees on groundwater pesticide remediation;
- Testing the use of "rain gardens" for receiving runoff and recharging local aquifers;
- Evaluating the use of a two-phase approach to remediate groundwater contamination during "pump and treat" processes; and
- Understanding the groundwater regime of an area in west-central Wisconsin that is highly susceptible to shallow groundwater contamination.

These 14 funded projects provided training in several disciplines for post-doctoral research associates, graduate student research assistants and undergraduate students at UW-Madison, UW-Milwaukee, UW-Stevens Point, UW-Extension and UW-Parkside.

The UWS selected eight new groundwater research projects from this year's Solicitation for Proposals for support during FY 06 (July 1, 2005–June 30, 2006) (see Table 2). Four projects, selected from the previous year's solicitation, will receive continuation support during FY 06. The new projects are based at UW-Madison, UW-Milwaukee, UW-Extension, and UW-Stevens Point.

Teaching. Institutions within the UWS continue to offer undergraduate- and graduate-level courses and programs focusing on diverse issues regarding groundwater resources. Additionally, several campuses offer for-credit, field-oriented water curriculum courses for middle and high school teachers during summer sessions. The WRI views education as an important component of its total program and recognizes the importance of K-12 education as a fundamental component of its outreach and training effort. The WRI distributes two publications—*Local Watershed Problem Studies-Elementary Activities* and *Local Watershed Problem Studies-Middle and High School Curricula Guide*—upon request. These two guides assist educators in the development and dissemination of curricula concerning soil and water resources. In addition, the UW-Madison Water Resources Library has purchased a number of other guides with innovative approaches to teaching water-related science in K-12 classes.

Grants administration**.** WRI staff members developed a Web site that enables online proposal submission and review of the FY 06 Joint Solicitation of Groundwater and Related Research and Monitoring Proposals. The site allows investigators to submit proposals one section at a time, as they are completed, rather than waiting until the entire proposal document is finished. Having proposals in electronic format also makes the proposal peer-review process more convenient. Reviewers can log on to the site and review proposals at their convenience. Review packets for the GRAC funding meeting are generated directly from this Web-based database.

Information transfer**.** An effective system of water information dissemination is vital for researchers, state agency personnel, state legislators and legislative agencies, and the general public to make informed decisions on water policy and promulgate intelligent water-related regulations.

WRI maintains a Web site to disseminate groundwater information and increase awareness of WRI activities; distributes news releases; provides a library of water-related printed and electronic materials; offers library reference services to interested individuals; sponsors conferences; and publishes and distributes technical reports and conference proceedings. Other projects to disseminate groundwater information include Wisconsin's Water Library and Wisconsin's Water Policy Inventory.

The results of WRI-supported research are published in a variety of formats. Most WRI research ultimately appears in refereed professional journals, although results are also published in technical reports, conference proceedings and abstracts, book chapters, dissertations and theses, and conference presentations. In addition, WRI disseminates the results of more than 120 groundwater research projects funded since 1989 by itself, DNR, DATCP and the state Department of Commerce through its Web site devoted to the Wisconsin Groundwater Research and Monitoring Program at http://www.wri.wisc.edu/wgrmp/wgrmp.htm. Many of the final reports are available online in full text.

UW Water Resources Library and Wisconsin's Water Library. The Water Resources Library is a special collection of approximately 30,000 volumes of water-related information, more than 60 journals and 100 newsletters. The collection covers all major topics in water resources, but is particularly strong in groundwater-related publications.

During 2003, initially as a special Year of Water project, the library made its collection and services available to all Wisconsin residents by developing Wisconsin's Water Library at http://aqua.wisc.edu/waterlibrary. Any Wisconsinite may check out books or ask for assistance free of charge. Books are sent to the requestor's local public library for pick up and return. This outreach project makes it possible for users to search the collection online; peruse lists of recommended books, videos and Web sites by topic; and read water-related book reviews and special features. Groundwater-related materials have been and will continue to be featured.

Wisconsin's Water Policy Inventory (www.aqua.wisc.edu/waterpolicy). WRI staff in cooperation with a UW-Madison graduate seminar developed the Wisconsin Water Policies Inventory (WWPI), a Web-based tool for researching the state's major policies pertaining to water. The WWPI enables Wisconsinites to browse state policies by category or to search using keywords. Steve Born, UW-Madison professor of planning and environmental studies, co-directed the project with Elisa Graffy, U.S. Geological Survey policy specialist. Wisconsin citizens should now be able to easily find state laws, rules, and programs that govern Wisconsin's groundwater resources.

Conferences, meetings, and presentations**.** The Wisconsin WRI co-sponsored the American Water Resources Association-Wisconsin Section 29th annual meeting, "Wisconsin's Waters: A Confluence of Perspectives", held in March 2005 in Delevan. This annual meeting is unique in that it encourages students to present papers or posters describing their original research. Students funded through the Wisconsin Groundwater Research and Monitoring Program are particularly encouraged to present results of their research.

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UW-Extension's Central Wisconsin Groundwater Center

The Central Wisconsin Groundwater Center provides groundwater education and technical assistance to the citizens and governments of Wisconsin. Assistance includes answering citizen questions, helping communities with wellhead protection planning, describing the extent and causes of groundwater nonpoint pollution in Wisconsin, assessing drinking water quality, and working on groundwater policy. The center is part of the Center for Watershed Science and Education, an office of UW-Extension Cooperative Extension Service and the UW-Stevens Point College of Natural Resources, and frequently works through county Extension faculty in program delivery. More information can be found online at http://www.uwsp.edu/cnr/gndwater/.

Drinking Water Programs. In 2004, the Center assisted over 3,100 households in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and

Environmental Analysis Laboratory. Of these, 11% exceeded drinking water standards for nitrate-nitrogen. Seventeen percent of samples were unsafe because of coliform bacteria. Sixteen Drinking Water Education Programs helped over 1,000 well users in seven counties to understand potential remedies for these problems and the relationship of land use practices to groundwater quality.

Water quality database. The Groundwater Center maintains a database of private well testing data from the Water and Environmental Analysis Regional Laboratory at UW-Stevens Point, and Drinking Water Education Programs conducted through the Center. There are currently over 400,000 individual test results for approximately 57,000 samples covering the state. Chemistry data includes pH, conductivity, alkalinity, total hardness, nitrate-nitrogen, chloride, saturation index, and coliform bacteria. In 1998, a new sampling program for iron, sodium, potassium, copper, lead, calcium, magnesium, manganese, zinc, and triazine was also initiated. Arsenic and sulfate were added late in 1999. The database primarily covers the period 1985 to the present. The database is PC-based and can be easily queried to be a significant source of information for local communities and groundwater managers. Forty-four counties are represented by 100 or more samples in the databases and 27 counties are represented by 500 or more samples.

Policy. Center staff continues to play pivotal roles in a number of state groundwater issues. Working with partners in the private and public sectors on groundwater quantity policy and law has been a continuing priority for the Center.

Partnerships. Center staff works with agencies and private organizations, including the Wisconsin Agricultural Stewardship Initiative, Wisconsin Potato and Vegetable Growers Association Nonpoint Pollution subgroup, DATCP Atrazine Technical Advisory Committee, Golden Sands Resource Conservation and Development Area Water Resources Committee, and Extension Nutrient Management Self-Directed Team. The Center is involved with the Groundwater Guardian program and many local watershed based groups.

Groundwater Guardian. The Center has continued to promote the Groundwater Guardian program, helping to build the groundwater knowledge and leadership skills of Wisconsin citizens at the grass-roots level. In partnership with the DNR, the Center has the statewide Groundwater Guardian program coordinator who has developed outreach materials; made numerous presentations to interested groups; assisted the fourteen existing Wisconsin Groundwater Guardian communities in carrying out their activities; and was heavily involved in coordinating the 3rd Annual WI Groundwater Festival in Eau Claire attended by nearly 600 students and nearly 100 volunteers. More about the WI Groundwater Guardian program can be found at http://www.uwsp.edu/cnr/gwguardian/.

Other UW-Extension Water Programs

UWS Farm and Home Environmental Management Program. The UWS Farm and Home Environmental Management Program encompasses voluntary pollution risk assessment and prevention activities. The program was known originally for its Farm Assessment System (Farm*A*Syst) and Home Assessment System (Home*A*Syst) projects and materials. The "Farm and Home" program emphasizes integrating water quality protection with other types of environmental citizenship. Projects are designed to enable and motivate urban and rural landowners, managers and residents to assess environmental and health risks and to take voluntary actions to prevent pollution from long-term investments such as the siting of structures, and from daily management practices. While the program continues to publish pollution

prevention worksheets and fact sheets, increasingly it is making customized interactive worksheets available via the World Wide Web. The programs are available statewide.

The Wisconsin Dairy Environmental Management Systems (EMS) project coordinates interests among WDNR, DATCP commodity and farm organizations, environmental organizations, and private sector advocates of EMS. One tangible benefit to farmers that has emerged is reduced insurance rates for pollution and general liability. Using the project's 12 page Livestock EMS synopsis to create a template, a Green Bay insurance agent negotiated reduced liability insurance premiums for manure haulers and dairy farms. The project is working with the Dairy Business Association to integrate the EMS framework with the Dairy Quality Assurance audit program. The Wisconsin Milk Marketing Board is collaborating on a web site to explain to farmers the relationships among various state environmental programs. Farmers engaged with EMS implementation indicate that the framework has improved farm profitability, their sense of security about their farm's environmental and health impacts, and their greater sense of control over the whole farm's management and profitability, even in the face of rising regulatory scrutiny, and greater international competition. The Farm & Home program is producing an EMS Guidebook for Wisconsin Farms.

A grant from the North Central Sustainable Agriculture, Research and Education Program (SARE) is supporting research on six different approaches to managing the environmental impacts of Midwestern dairy farming. Our goal is to identify whether and how each approach falls short of achieving (or promising to achieve) environmental sustainability, and how it might be complemented with an "Environmental Management System" to strengthen farm sustainability. The six management approaches are: certified organic, certified Midwest Food Alliance operation, grass-based Holistic Management, biodynamic, permitted Confined Animal Feeding Operation (CAFO) and a conventional farm which meets NRCS requirements for incentive payments. Methods include document analysis as well as six case studies to pinpoint environmental vulnerabilities and develop and publicize recommendations toward filling the gaps with each approach. Results of this project will be put on a web site as they become available.

The Healthy Homes Partnership, a subset of Home*A*Syst held a Healthy Homes offers materials via CD and on the Web as well as the current print edition of Help Yourself to a Healthy Home. The Home*A*Syst, Farm & Home Program conducted research with landscape managers about pesticide use and practices in the Lake Monona Watershed. Data from this research is being compiled and analyzed. Preliminary work and subsequent reports and products can be found at http://www.uwex.edu/farmandhome/monona. Lessons will be relevant to encouraging landscape managers statewide to adopt more water pollution preventing techniques.

Additional information is available at http://www.uwex.edu/agems/ and http://www.uwex.edu/healthyhome.

UW Environmental Resources Center (ERC). The UW Environmental Resources Center (ERC) develops and coordinates a number of national youth water education initiatives related to groundwater. The ERC provides national coordination for two youth water education programs, *Educating Young People About Water* (EYPAW) and *Give Water a Hand* (GWAH). The EYPAW guides and water curricula database provide assistance for developing a community-based, youth water education program. The EYPAW web site, http://www.uwex.edu/erc/eypaw, provides access to a database of more than 140 water-related curricula that may be searched by grade level or water topic. The goals of the GWAH curriculum are to protect and improve local water quality by encouraging youth to investigate local issues, and plan and complete a service project. Youth then address a problem they identify with the assistance of a local natural resource

expert. Program materials consist of an Action Guide for youth, with step-by-step instructions for addressing local watershed concerns, and a Leader Guidebook to assist teachers and youth leaders in facilitating projects. Both guides may be downloaded from the *Give Water a Hand* web site, http://www.uwex.edu/erc/gwah. Other ERC youth water education initiatives include: *Agua Pura*, a leader institute planning manual and guide for Latino water education; an evaluation of USGS water education materials to assist with USGS education program development decisions; and gap analyses of youth water curriculum for source water education and riparian education resources. New water education projects include the development of a national riparian curriculum and a collaboration with USDA/CSREES and other federal agency clean and safe water partners to develop and promote best education practices for water education and to improve access to education resources and strategies. Find links to these programs on the ERC web site at http://www.uwex.edu/erc.

UW Nutrient and Pest Management (NPM) program. In 1990 a broad coalition of agricultural organizations, environmentalists, and the University sought funding for a water quality program for farmers and the agricultural community. Over the past fourteen years, the NPM outreach program has conducted on-farm demonstrations and education throughout Wisconsin to address groundwater and surface water contamination from agriculture and the profitability of recommended practices.

A major portion of the program's focus has been nutrient management – the careful, profitable use of fertilizers and animal manures in crop production. NPM recently revised and distributed the *Nutrient Management Farmer Education Curriculum* that includes a discussion of nitrates in groundwater. The curriculum has been taught throughout the state to several hundred producers. NPM also coordinates training workshops for Nutrient Management Planners that teach agricultural and conservation professionals how to write nutrient management plans following the new USDA-NRCS-Wisconsin 590 standard. To prevent pesticide contamination of groundwater resulting from field applications, the program delivered integrated pest management education and coordinated Wisconsin extension's WeedSoft development and delivery. WeedSoft is a computer program that helps growers makes cost effective, environmentally sound weed management decisions. One module includes leaching ratings to assist growers in herbicide selection.

NPM continues to work with Wisconsin farmers to ensure they are not over-applying nitrogen and other inputs so as to minimize potential losses to groundwater. The NPM field staff completed on-farm demonstrations, manure spreader calibration, and taught many farmers how to write and update their nutrient management plans. More information on these efforts and many publications are available at the NPM web site (http://ipcm.wisc.edu).

Basin Education Initiative. The UWS cooperates on community-focused educational programs with other state agencies involved with water resources and natural resource issues. Since 1998, UW-Extension had worked in partnership with the DNR, USDA-NRCS, and local organizations and agencies to provide water and related natural resources education within the state's 22 major river basins. Fifteen Basin Educators work collaboratively at the local level and access state-level support for educational material development and program evaluation. The Basin Education Initiative works to support local conservation professionals such as county Extension agents, Land Conservation Department staff, and NRCS staff. The educational programs address a broad range of groundwater-related topics, including drinking water, threats to groundwater quality, impacts of land-use changes and land management decisions on groundwater quantity, information about localized groundwater problems such as karst, and a variety of other water quality issues. More information can be found at http://basineducation.uwex.edu.

Multi-Agency Land and Water Education Grant Program (MALWEG). UW-Extension coordinates the Multi-Agency Land and Water Education Grant Program (MALWEG) which has funded ten groundwater-focused projects since its inception in 1997. These projects, which totaled over $170,000 in educational assistance funds, examined the effects of intensive rotational grazing on groundwater quality, provided well testing for rural landowners, and conducted Farm*A*Syst assessments to help farmers identify and address groundwater contamination on their property. Altogether, between January 1, 1997, and December 31, 2002, 134 projects totaling over $1.8 million have been funded to improve Wisconsin's land and water resources. The source of this money has primarily been the USDA's Environmental Quality Incentives Program and Grazing Lands Conservation Initiative. The program has also reached more than 600 farmers through educational workshops addressing comprehensive nutrient management planning. More information can be found at http://clean-water.uwex.edu/malweg/.

For more information on UW Extension groundwater programs, contact Ken Genskow, UW Environmental Resources Center, 1545 Observatory Drive, WI 53706-1289, phone (608) 262-0020, fax (608) 262-2031, or email* kgenskow@wisc.edu*; or George Kraft, Center for Watershed Science and Education, College of Natural Resources, UW-Stevens Point, Stevens Point, WI 54481; phone (715) 346-4270; email: gndwater@uwsp.edu.

Wisconsin State Laboratory of Hygiene

General program description. At the Wisconsin State Laboratory of Hygiene (WSLH), a great deal of effort is focused on identifying and monitoring chemical and microbial contaminants in groundwater through routine testing, emergency response, education and outreach, and specialized research. The activities related to groundwater span several departments at WSLH and, collectively, their efforts make up the WSLH Drinking Water Quality Program. The mission of the WSLH Drinking Water Quality Program is to protect the health of drinking water consumers by providing analytical expertise, research and educational services to the scientific and regulatory communities.

The chemical and microbial groundwater contaminants routinely tested for include all contaminants regulated by the federal Safe Drinking Water Act as well as many emerging contaminants that appear on the USEPA Contaminant Candidate List. Examples include: fecal indicators (total coliform, *E. coli*, coliphage), *Helicobacter pylori*, *E. coli* O157:H7, *Salmonella*, waterborne viruses, parasites (*Cryptosporidium*, *Giardia*, and microsporidia), radioactivity, inorganic compounds (mercury, nitrate, arsenic) and organic compounds (atrazine, PCBs, PBDEs).

Another important focus of the WSLH Drinking Water Quality Program is emergency response to incidences involving groundwater. For example, WSLH works with DHFS and DNR to investigate outbreaks of illnesses of unknown (possibly food or water) origin. Staff provides background information on the outbreaks for local public health officials, local media, and the general public. WSLH also responds to spills and incidents and supports state agencies in remediation and emergency clean-up activities. Most recently, WSLH has focused its efforts on enhancing and expanding terrorism response programs.

WSLH also provides educational and outreach activities related to groundwater and drinking water including: instructional consultations for well owners and well drillers; on-site training of municipal water supply operators; and tours for a variety of international, educational, regulatory, and other governmental groups. Staff has developed an interactive study guide dealing with safety, sampling, and chemistry for drinking water operators and publications related to drinking

water. Staff attends and presents papers at a variety of conferences and symposia and publishes research finding in professional journals.

Summary of groundwater-related activities in FY 2005.
Two research projects funded by the UW System through the GCC's Groundwater Research and Monitoring Program were begun in FY 05:

Occurrence of Estrogenic Endocrine Disruptors in Groundwater. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene.

A comparison of USEPA approved enzyme-based total coliform/E. coli tests for microbiological groundwater monitoring and laboratory consultation. Jeremy Olstadt, Wisconsin State Laboratory of Hygiene.

Research projects that were on-going or completed in FY 05 include:
Evaluation of Gross Alpha and Uranium Measurements for MCL Compliance. Michael F. Arndt, PhD, Wisconsin State Laboratory of Hygiene (funded by the American Water Works Association).

Assessment of endocrine disrupting chemical in water reclamation systems Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene (funded by the Water Environment Research Foundation).

Comparison of pesticide home water testing kits with certified analytical laboratory results. John Strauss, Wisconsin State Laboratory of Hygiene (funded by WDNR).

For more information, visit the following website (http://www.slh.wisc.edu/) or contact William Sonzogni, Wisconsin State Laboratory of Hygiene, 2601 Agriculture Drive, Madison, WI 53703, phone (608) 224-6200, or email sonzogni@facstaff.wisc.edu.

FEDERAL AGENCY PARTNERS

U.S. Geological Survey: Water Resources Division - Wisconsin Water Science Center

The mission of the U.S. Geological Survey-Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This mission is accomplished, in large part, through cooperation with other Federal, State and local agencies, by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.

- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface water and ground water.

- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict

their response to stress.

- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.

- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and groundwater.

- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

The Wisconsin Water Science Center is currently conducting cooperative projects that have a significant groundwater component with the DNR, WGNHS, Southeast Wisconsin Regional Planning Commission (SEWRPC), the Menominee, Stockbridge-Munsee, Ho-Chunk and Lac Court Oreilles Tribes of Wisconsin, and the numerous county governments. In addition, several projects are funded by Federal agencies: EPA-Region 5, National Park Service, and USGS. Recent and current projects that have a significant groundwater component are listed below.

Cooperatively funded projects with state and local agencies:

1. Collection of data from the Wisconsin groundwater observation-well network.
2. Compilation of data for the Wisconsin water-use data file.
3. Southeast Wisconsin Hydrologic Study and Regional Water Supply Plan.
4. Completion of an educational website highlighting groundwater and the Great Lakes.
5. Quantification of the impacts of urbanization on infiltration in the Black Earth Creek watershed.
6. Evaluation of the effectiveness of Wisconsin closure protocols for petroleum contaminated sites.
7. Simulation of groundwater/surface-water systems in Pierce, St. Croix, and Polk Counties.
8. Evaluation of drinking water vulnerability.

Projects funded primarily by Federal agencies:

1. Availability and use of fresh water in the United States: Lake Michigan Pilot Study (USGS funded) http://water.usgs.gov/ogw/gwrp/activities/wateravail_pilot.html.
2. Hydrologic and biogeochemical budgets in temperate lakes and their watersheds, northern Wisconsin (USGS funded) http://infotrek.er.usgs.gov/doc/webb/index.html.
3. Western Lake Michigan Drainages National Water-Quality Assessment (USGS funded) http://wi.water.usgs.gov/nawqa/index.html.
4. Simulation of groundwater/surface water interaction in the St. Croix River Basin, Wisconsin and Minnesota; National Park Service and USGS funded.
5. Spatial and temporal shallow groundwater recharge rates in Wisconsin; USGS funded.

The USGS contributed two significant accomplishments to help protect Wisconsin's groundwater in FY 05:

- In cooperation with the University of Wisconsin and Departments of Natural Resources and Commerce a study was undertaken to determine the effectiveness of decision-making when applying natural attenuation closure protocols to petroleum contaminated sites. Eight closed

LUST sites across the state have been evaluated to identify site characteristics that may indicate the need for a modified closure protocol and/or post-closure monitoring.

- In cooperation with the Village of Cross Plains and the Department of Natural Resources existing data from the Black Earth Creek watershed were compiled and a linked groundwater and surface water model of the watershed was constructed. The model is suitable for quantitatively characterizing the hydrologic system and assessing gaps in the existing data. Additional field data (stream flows, water temperature, groundwater levels) were collected to improve the representativeness of the model, especially in the downstream reaches of the basin. When finalized this model will be a tool suitable for simulations of urbanization and associated mitigation scenarios.

A summary of the Wisconsin Water Science Center projects and listing of publications is published annually in "Water-Resources Investigations in Wisconsin." Copies of the summary are available at the Wisconsin Water Science Center or by calling 608-821-3801.

For more information please contact Chuck Dunning USGS, 8505 Research Way, Middleton, Wisconsin, 53562-3581 (608-821-3827*), cdunning@usgs.gov*, Randy Hunt (608-821-3847),* rjhunt@usgs.gov *or visit the Wisconsin Water Science Center web page (http://wi.water.usgs.gov).

USDA Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is a federal agency within the US Department of Agriculture. The NRCS, formerly the Soil Conservation Service, works with private landowners to promote conservation of natural resources. In Federal fiscal year 2004 (Oct. 1, 2003 to Sept. 30, 2004), nearly 414,000 acres of conservation plans were developed on Wisconsin cropland through NRCS and in cooperation with county Land Conservation Departments.

The agency protects groundwater by providing technical assistance to landowners through the following ongoing conservation practices and programs:

- *Nutrient management*: management of the amount, form, placement and timing of nutrients applied to the soil so that the amount applied is only what is needed to produce optimum crop yield. This reduces the potential for applied nutrients to pollute surface and groundwater. Last year 800 farmers implemented nutrient management plans through the Environmental Quality Incentives Program in Wisconsin.
- *Pest management*: utilization of environmentally sensitive prevention, avoidance, monitoring and suppression strategies to manage weeds, insects, diseases, animals and other organisms that directly or indirectly cause damage or annoyance. This enhances quantity and quality of commodities. It also minimizes negative impacts of pest control on soil resources, water resources, air resources, plant resources, animal resources and/or humans.
- *Animal waste storage*: proper waste storage siting and design is imperative to protect groundwater from contamination by nutrients in animal waste. Last year 31 animal manure storage structures were installed.
- *Comprehensive Nutrient Management Plan (CNMP):* a conservation system unique to livestock farms. It is a grouping of conservation practices and management activities to insure both production and resource protection goals. It addresses soil erosion, manure, and organic by-product impact on surface and groundwater quality. CNMP components include nutrient management based on phosphorus or nitrogen, manure and wastewater

handling and storage, adequate erosion control of cropland, and proper record keeping. CNMPs entail a thorough review of the farmstead, ensuring that manure and wastewater are properly stored and handled, stormwater remains clean or is captured, and drinking water wells are properly protected. It may also include feed management to reduce phosphorus in manure and other manure use alternatives such as biofuel production and composting. Last year, CNMPs were implemented on 40 farms involving 10,628 acres.

- *Wetland Reserve Program*: restores wetlands through permanent or 30-year easements or 10-year contracts. Last year about 3,400 acres of wetlands were restored, bringing the total acres in WRP to over 43,000.
- *Environmental Quality Incentives Program*: provides cost sharing for conservation practices on agricultural land. Statewide priorities include groundwater protection practices such as well decommissioning and nutrient and pesticide management and prescribed grazing. Last year about 550,000 acres of conservation systems were planned, plus 12,000 acres of forest stand improvement, 17,600 acres of upland wildlife habitat, and 26,600 acres of managed grazing land.
- *Well decommissioning*: proper decommissioning is essential to prevent contaminants from entering groundwater through abandoned wells, which are direct conduits to the groundwater. NRCS planned 117 well decommissionings, and completed 52.
- *Conservation Reserve Program/Conservation Reserve Enhancement Program*: participants establish permanent vegetative cover on agricultural lands in return for guaranteed rental payments.
- *Dam rehabilitation pilot project*: From the 1950s to 1980s, through the Watershed Flood Prevention Act (PL566), NRCS built 87 small flood control dams in Wisconsin that reduced flooding and improved groundwater infiltration. Since 2000, NRCS has planned or completed the rehabilitation of 13 deteriorating dams in seven western counties as part of a four state pilot project. These accomplishments resulted in the obligation of $4 million in federal rehabilitation funds. In an average year, these projects reduce flood damages on crops, roads, and communities by an estimated $2 million. With the heavy rains in 2004, the estimated reduction in flood damages was $15 million.
- *Conservation Security Program*: In 2004, Wisconsin was one of the pilot states to launch the new CSP, a program to reward good land stewardship and provide incentives to farmers to increase and enhance their conservation practices. In 2004, 212 CSP contracts were signed with farmers in the Lower Chippewa and Kishwaukee watersheds, with average payments of $9,000. Good erosion control, water quality protection and improving soil quality are prerequisites for the program.

The agency also provides leadership in the following:

- *Standards Oversight Council – an Interagency Committee to revise and maintain Conservation Practice Standards*. Practice Standards benefit the public by helping to protect groundwater. For example NRCS Practice Standard Code 590 – Nutrient Management is being revised in 2005. This revision enhances groundwater protection by promoting better nutrient management and minimizing agricultural nonpoint source pollution of surface and groundwater resources. Several new standards were developed in 2004-5 for manure storage, handling and management.

To find out more information about NRCS, go to the home page at http://www.wi.nrcs.usda.gov, contact Renae Anderson at 608-662-4422 ext. 227, or Jim Kaap at 608-662-4422 ext. 266.

Chapter 4 -- CONDITION OF THE GROUNDWATER RESOURCE

The Groundwater Coordinating Council (GCC) is directed by s. 15.347(13)(g), Wis. Stats., to submit an annual report which "…describes the state of the groundwater resource…" and to "…include a description of the current groundwater quality of the state…and a list and description of current and anticipated groundwater problems."

The purpose of this chapter is to describe the state [condition] of the groundwater resource, provide an assessment of groundwater quality and quantity issues, as well as describe current and anticipated groundwater problems. In general, groundwater is plentiful and of high quality in Wisconsin, but concern is growing about its limits and the existence of persistent and emerging threats. In addition, there is growing recognition of the interdependence of groundwater and surface water resources, as well as the influence of groundwater quantity on water quality. Further recommendations of the Council are listed in Chapter 6, *Future Directions for Groundwater Protection*.

GROUNDWATER QUALITY

As part of 1983 Wisconsin Act 410, the Groundwater Account of the Environmental Fund was created to support groundwater monitoring by state agencies to determine the extent of groundwater contamination in Wisconsin and identify the sources of contamination. Groundwater monitoring has found that the primary contaminants of concern are volatile organic compounds (VOCs), pesticides and nitrate. Increased attention is also being given to several "emerging threats," including naturally occurring radioactivity, arsenic, and microbial agents (bacteria, viruses, and parasites). Each is discussed below.

Volatile Organic Compounds

VOCs are a group of common industrial and household chemicals that evaporate, or volatilize, when exposed to air. Examples of VOCs include gasoline and industrial solvents, paints, paint thinners, drain cleaners, air fresheners, and household products (such as spot and stain removers). Short-term exposure to high concentrations of many VOCs can cause nausea, dizziness, tremors or other health problems. Some VOCs are suspected of causing cancer upon long-term exposure. Sources of VOCs in Wisconsin’s groundwater include landfills, underground storage tanks (USTs), and hazardous substance spills.

Thousands of wells have been sampled for VOCs. Fifty-nine different VOCs have been found in Wisconsin groundwater, though only 34 of those have associated health standards. Trichloroethylene is the VOC found most often in Wisconsin's groundwater. **Figure 4.1** shows the location of drinking water wells with past ES and PAL exceedances based on data from 6,399 unique wells recorded in the GRN database.

Wisconsin has 72 active, licensed solid waste landfills, all of which are required to monitor groundwater. In addition, the DNR currently tracks 19,284 leaking underground storage tanks (LUSTs) and about 4,000 waste disposal facilities. Many of these sites have been identified as sources of VOCs. Facilities include gas stations, bulk petroleum and pipeline facilities, plating, dry cleaning, industrial facilities, and abandoned non-approved unlicensed landfills.

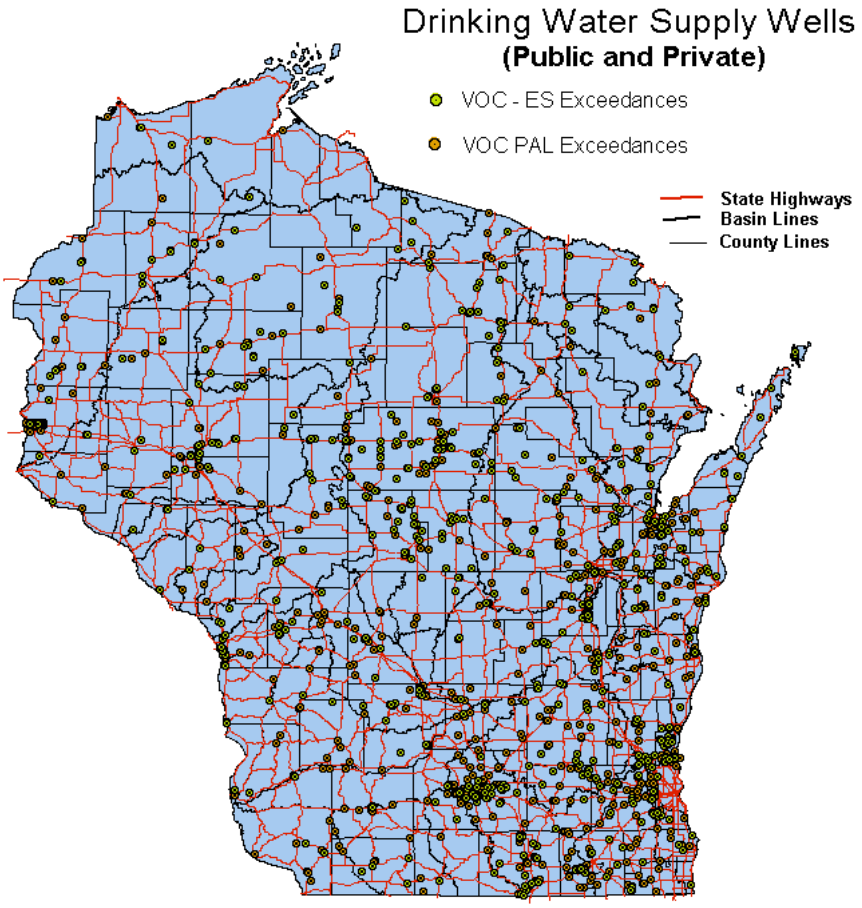

Figure 4.1 Volatile Organic Compounds (VOCs) past enforcement standard (ES) and preventive action limit (PAL) exceedances for public and private drinking water supply wells. Source WDNR

Landfills. Two studies conducted over four years revealed that VOCs were significant contributors to groundwater contamination at Wisconsin landfills (WDNR 1988, 1989). Out of a total of 45 unlined municipal and industrial landfills tested, 27 (60%) had VOC contamination in groundwater. All of these landfills are currently closed. Of 26 unlined municipal solid waste landfills tested, VOCs contaminated groundwater at 21 (81%). No VOCs were confirmed present at any of the six engineered (liner and leachate collection) landfills included in the studies. While 20 different VOCs were detected overall, 1,1 – Dichloroethane was the most commonly occurring VOC at all of the solid waste landfills.

In a follow-up VOC study conducted from July 1992 through July 1994, the DNR reviewed historical data and sampled groundwater at 11 closed, unlined landfills and at six lined landfills. VOC levels had decreased after closure at all but two of the unlined landfills, though at many sites VOC levels did not show continued improvement. Also, the level of contamination, while below initial concentrations, remained high at many closed sites. No VOC contamination attributable to leachate migration was found at any of the six lined landfills investigated.

Over the past few years increasing numbers of residential developments have been located close to old, closed landfills. In 1998 and 1999 the DHFS sampled private wells down-gradient of 17 small, closed landfills in Ozaukee County. Eight of the private wells had VOC results above

maximum contaminant levels. The results of this sampling showed that there may be more landfills with serious problems that have not yet been identified.

The DNR Bureaus of Waste Management, Remediation and Redevelopment, and Drinking Water and Groundwater in cooperation with the DHFS, responded to this issue in early 1999 by evaluating 16 old, closed landfills – at least three from each of the five DNR regions across the state. Private wells around each of the landfills were sampled in 1999 and significant levels of contamination found. Of the 113 wells that were tested, 31 had detects of VOCs. Fourteen of the homes had levels exceeding drinking water standards and have been given health advisories not to drink their water.

Underground storage tanks. Wisconsin requires underground storage tanks with a capacity of 60 gallons or greater to be registered with the Department of Commerce. Since 1991, this registration program has identified a total of 178,166 underground storage tanks. As of July 1, 2005 the database reflects 79,918 federally regulated tanks with only 12,424 tanks in use. A federally regulated tank is any tank, excluding exempt tanks, that is over 110 gallons in size, has at least 10 percent of its volume underground, and is used to store a regulated substance. Wisconsin regulates USTs down to 60 gallon capacity. Exempt tanks include: farm or residential tanks of 1,100 gallons or less; tanks storing heating oil for consumptive use on the premises where stored; septic tanks; and storage tanks situated on or above the floor of underground areas, such as basements and cellars.

Hazardous waste. Hazardous waste treatment storage and disposal facilities are another VOC source. The DNR Bureau for Remediation and Redevelopment is investigating or remediating contamination at 27 sites. Approximately 140 sites statewide are subject to corrective action authorities. However, only a small percentage will follow the corrective action process because of minimal contamination at the site or jurisdiction under other regulatory authorities. Generators improperly managing hazardous waste are another source of VOC contamination. All new generator remediation cases statewide and many existing actions are to be addressed in accordance with the NR 700 Wis. Adm. Code series.

Hazardous Substance Spills. The Hazardous Substance Spill Law, ch. NR 292.11 Wis. Stats., requires immediate notification when hazardous substances are discharged, as well as taking actions necessary to restore the environment to the extent practicable. Approximately 800 discharges are reported annually to the DNR, and of those, approximately 65% are petroleum related, with another 15% being agrichemicals.

The NR 700 Wis. Adm. Code series, specifically ch. NR 706, contains the requirements for notification when a discharge or spill occurs. Chapter NR 708 contains requirements for taking immediate and/or interim actions when releases occur. Groundwater monitoring is performed when necessary to delineate the extent of contamination. The spills program develops outreach materials to help reduce the number and magnitude of spills and provide guidance for responding to spills. Topics addressed include spills from home fuel oil tanks, responses to illegal methamphetamine labs, and mercury spills, all of which can lead to significant environmental impacts, if not properly addressed.

References cited:

WDNR, 1988. Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills. Wisconsin Department of Natural Resources, Bureau of Solid and Hazardous Waste, February 1988.

WDNR, 1989. VOC Contamination at Selected Landfills – Sampling Results and Policy Implications. Wisconsin Department of Natural Resources, Bureau of Solid and Hazardous Waste, June 1989.

Pesticides

Pesticide contamination in groundwater results from field applications, pesticide spills, misuse, or improper storage and disposal. Serious concerns about pesticide contamination in Wisconsin were first raised in 1980 when aldicarb, a pesticide used on potatoes, was detected in groundwater near Stevens Point. The DNR, DATCP, and other agencies responded to these concerns by implementing monitoring programs and conducting groundwater surveys.

The DNR and DATCP expanded their sampling programs in 1983 to include analysis of pesticides commonly used in Wisconsin. The most commonly detected pesticides in Wisconsin groundwater are:

- Metabolites of alachlor (Lasso) and metolachlor (Dual)
- Atrazine and its metabolites
- Metribuzin (Sencor)
- A metabolite of Cyanazine (Bladex). Cyanazine is no longer manufactured.

Federal and state groundwater quality standards for many of these compounds have also been adopted. To date, standards for over 30 pesticides are included in ch. NR 140, Wis. Adm. Code.

Atrazine, a herbicide used on corn, is one of the pesticides most often found in private drinking water wells in Wisconsin. The first systematic well sampling program to characterize atrazine contamination on a statewide basis was the 1988 DATCP Grade A Dairy Farm Well Water Quality Survey. This state-funded well survey estimated that atrazine was present in 12% of the Grade A Dairy Farm Wells in the State. Since that initial study, DATCP has collected data from many private and monitoring wells in the state as part of statewide surveys and focused monitoring projects (summarized below).

In July 2005, DATCP produced a map showing locations of private drinking water wells tested for atrazine in the state (**Figure 4.2**). The DATCP pesticide database contains test results from nearly 16,000 wells tested with the immunoassay screen for atrazine and over 7000 wells tested by the full gas chromatograph method. The immunoassay screen results show that about 40% of private wells tested have atrazine detections, while about 1% of wells contain atrazine over the groundwater enforcement standard of 3 µg/L. The 7000 wells tested by full gas chromatograph show detectable levels of atrazine 25% of the time and are over the enforcement standard in about 5% of the wells. The enforcement standard for atrazine includes parent atrazine and three of its breakdown products (metabolites).

Some pesticides, like atrazine, get into groundwater mostly through general use, while others are only found in groundwater if they have been spilled or mishandled. A combination of factors is most likely responsible for the widespread atrazine contamination shown on this map:

- atrazine has been the most widely used herbicide in Wisconsin for more than 30 years because it is effective and inexpensive
- atrazine was commonly used at much higher rates and applied more often before DATCP's Atrazine rule (ch. ATCP30, Wis. Adm. Code) began in 1991

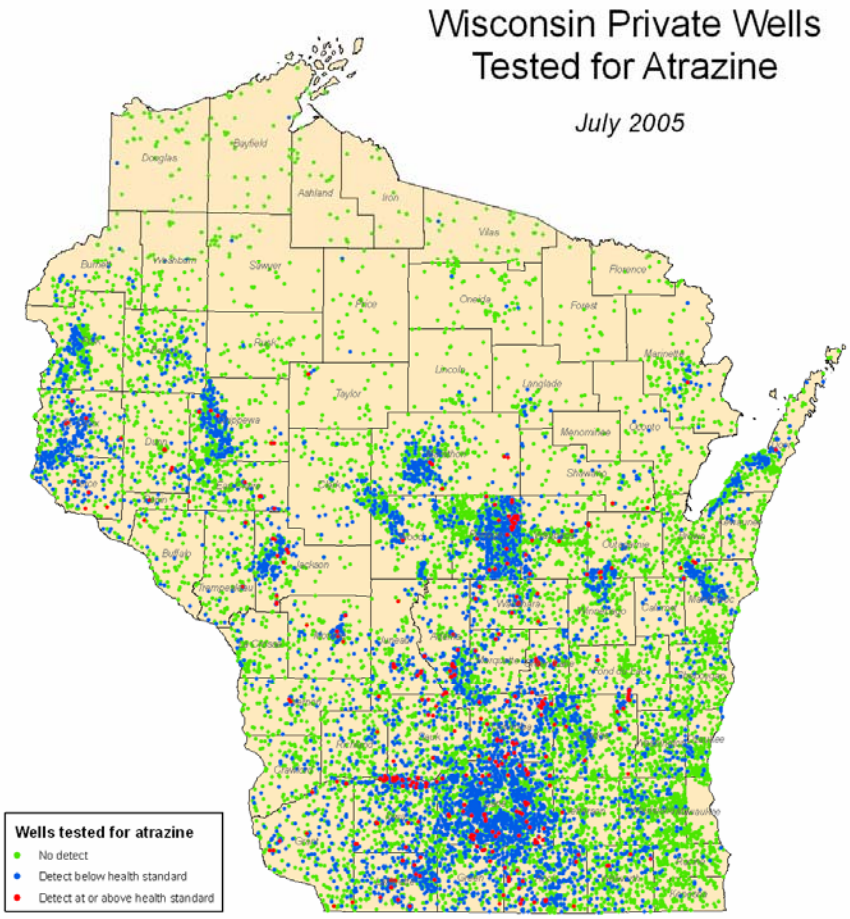

Figure 4.2 Private wells tested for atrazine in Wisconsin as of July 2005. Source: DATCP

- atrazine sinks (leaches) through the soil into groundwater faster than many other herbicides

Triazine screen. In 1991, the Wisconsin State Laboratory of Hygiene (WSLH) began a public testing program using an immunoassay screening test for triazine-based compounds, such as atrazine. The triazine immunoassay screen uses specific antibodies designed to selectively bind to target compounds that are present at low concentrations. While there is no enforcement standard (ES) for the triazine screen, comparing the triazine results to the ES and preventive action limit (PAL) for atrazine provides a reference point for the severity of contamination. In a recent survey of DNR groundwater databases, more than 14,000 triazine screen results have been recorded. Forty-two percent of the samples had a detection for a triazine compound; 13%

exceeded the PAL for atrazine of 0.3 µg/L; and 1.6% exceeded the ES for atrazine of 3.0 µg/L.

One problem with the triazine screen is that it does not detect all the atrazine metabolites and therefore underestimates the total atrazine concentration. The WSLH advises homeowners that the triazine screen results should be used for initial screening purposes only. Higher triazine detects often receive a follow-up gas chromatography test. In 2002, the DNR funded a study with the WSLH to evaluate a new immunoassay test for the metabolite diamino atrazine. Results were delivered in late 2003 and it appears that a combination of new and existing tests can improve analytical accuracy greatly.

Chloroacetanilide herbicide metabolites are increasingly being detected in Wisconsin groundwater. In a study completed in 2000, 27 monitoring wells, 22 private drinking water wells, and 23 municipal wells in Wisconsin were sampled for alachlor, metolachlor, acetochlor, and their ethane sulfonic acid (ESA) and oxanillic acid (OA) metabolites. Wells were selected based on previous detections of pesticides or proximity to agricultural fields. Alachlor, metolachlor, and acetochlor are chloroacetanilide herbicides that are commonly used on corn and other crops in Wisconsin. With the exception of alachlor ESA, no historical data exists for these metabolites in Wisconsin groundwater because laboratory methods were not previously available. Over 80 percent of the monitoring wells and drinking water wells included in the survey contained the ESA and OA metabolites of alachlor and metolachlor. The metabolites of acetochlor showed a lower frequency of detection. Metabolite concentrations ranged from near the level of detection to 42 µg/L. Monitoring wells and private drinking water wells showed higher detection frequencies and concentrations than the deeper municipal wells, but the municipal wells did show significant impacts. Fifty-two percent of the municipal wells had at least one detection. No municipal well had pesticide levels that exceeded an enforcement standard.

Beginning in October 2000 and ending in May 2001, DATCP collected 336 samples from private drinking water supplies to determine the statewide impact of pesticides on groundwater resources (DATCP 2002). DATCP analyzed the samples for commonly used herbicides including the chloroacetanilide herbicides and their metabolites. This study also was compared to previous surveys to attempt to understand trends in groundwater quality over time. A total of seven common herbicides, ten metabolites and nitrate were included in the latest survey. Highlights from this overall study show:

- The proportion of wells that contain a detectable level of a herbicide or herbicide metabolite is 37.7%.
- Alachlor ESA and metolachlor ESA are the most commonly detected herbicide compounds with proportion estimates of 27.8 and 25.2%, respectively.
- A significant decline in parent atrazine concentrations between 1994 and 2001.
- However, a decline in total chlorinated residues of atrazine was not apparent.

The following are other DATCP pesticide related studies conducted recently or as part of ongoing research.

Exceedance Survey. In 1995, DATCP completed a re-sampling of 122 Wisconsin wells that previously exceeded a pesticide enforcement standard. Most of the wells in the survey had exceeded standards for atrazine. Most were also within an atrazine prohibition area. Of wells exceeding standards for atrazine, 84% had declined in concentration and 16% had increased. About 50% of well owners continued to use their contaminated well and about 25% had installed new wells at an average cost of $6,300. This well survey has been repeated annually through 2004, with samples collected from 150 different wells at least once during this time period. As of

2004, atrazine levels have gone down in 82% of the wells, up in 15%, and stayed about the same in 3%. Eighteen wells remain above the enforcement standard.

Pesticide and Groundwater Impacts Study. In 1985, DATCP began a 2-year study funded by the Wisconsin DNR to evaluate the potential impact of agriculture on groundwater quality. The study focused on areas of the state with high groundwater contamination potential. In 2003, this study entered its 18th program year. In 2004 samples from monitoring wells near 15 agricultural fields were sampled. A total of ten compounds were detected in groundwater. Three of these (nitrate, alachlor ESA and atrazine + metabolites) were found at levels above an existing water quality standard. Other compounds detected include alachlor, acetochlor ESA, metribuzin, metolachlor and its ESA and OA metabolites, and cyanazine amide.

Monitoring Reuse of Atrazine in Prohibition Areas - In FY 98, DATCP began monitoring the limited reuse of the herbicide atrazine in selected areas where atrazine use has been prohibited. DATCP is gathering data to see if renewed atrazine use at current restricted use rates will cause groundwater contamination. DATCP is monitoring groundwater quarterly at 17 fields, 10-40 acres in size, for 5 years. Although it is too early in the project to make recommendations, 1998 through 2002 summary data showed that atrazine concentrations increased at all but one site. One or more wells at 14 of 17 of sites exceeded the enforcement standard for atrazine (3.0 parts per billion) at some time during the first 3 years of the project. The nitrate enforcement standard was exceeded at 100% of these sites over the same sampling period.

Atrazine Rule Evaluation Survey. In FY 97, DATCP completed a groundwater sampling survey designed to evaluate the effectiveness of the Atrazine Rule (ch. ATCP 30, Wis. Adm. Code). The survey, required under ATCP 30, was to determine if a "statistically significant change" occurred in groundwater concentrations of atrazine and its three chlorinated metabolites between Phases 1 (1994) and 2 (1996) of the survey. The survey showed a statistically significant decline in the level of atrazine contamination in Wisconsin groundwater between 1994 and 1996. However, atrazine still reaches groundwater and in some cases exceeds the enforcement standard. The Atrazine Rule appears to be effective in reducing atrazine contamination of groundwater. DATCP recommends that current limits on atrazine use be continued.

References cited:

DATCP, 2002. Groundwater Quality: Agricultural Chemicals in Wisconsin Groundwater. Wisconsin Department of Agriculture, Trade and Consumer Protection, Water Quality Section, ARMPUB98.qxd. 18 p.

Copies of this survey, as well as summaries of other DATCP monitoring projects are available at http://datcp.state.wi.us/arm/agriculture/land-water/water-quality/monit_proj.html.

Nitrate

Two Wisconsin state agencies, the DNR and DATCP, both agree that nitrate is the most widespread groundwater contaminant in Wisconsin and is increasing in extent and severity. Nitrate (NO3-N) is a water-soluble molecule made up of nitrogen and oxygen that forms when ammonia or other nitrogen rich sources combine with oxygenated water. Nitrate occurs naturally in water but only at very low levels of less than 1 milligram per liter (mg/L), higher levels indicate a source of contamination. Common sources of nitrate contamination include fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris.

Since 80% of nitrate inputs into groundwater originate from manure spreading, agricultural fertilizers, and legume cropping systems (Shaw, 1994), it makes sense that nitrate contaminated wells are found to be more prevalent in agricultural districts. Studies have repeatedly shown that predominantly agricultural counties in southern and west-central parts of Wisconsin have a higher percentage of wells exceeding the 10 mg/L federal and state nitrate enforcement standard (ES).

In a 1994 study, WGNHS and DHFS estimated that 9 to 14% of private water wells in Wisconsin exceed the nitrate standard. A 1997 DATCP study showed exceedance rates of 17 to 26% for wells in agricultural districts. In 2005, DNR aggregated and analyzed data from three extensive statewide groundwater databases as part of a "Condition of the Resource" paper focused on the contamination of nitrate in Wisconsin groundwater. This combined dataset from DNR's Groundwater Retrieval Network (GRN) database (25,894 samples), the Center for Watershed Science and Education database (21,525 samples) and DATCP's groundwater database (1,399 samples), includes only the most recent nitrate result for each sampled private well. Out of the 48,818 samples, 5686 (11.6 %) equaled or exceeded the ES of 10 mg/L. As seen in **Figure 4.3**, the percent of wells exceeding the ES varies across the state. Calumet, Columbia, Dane, La

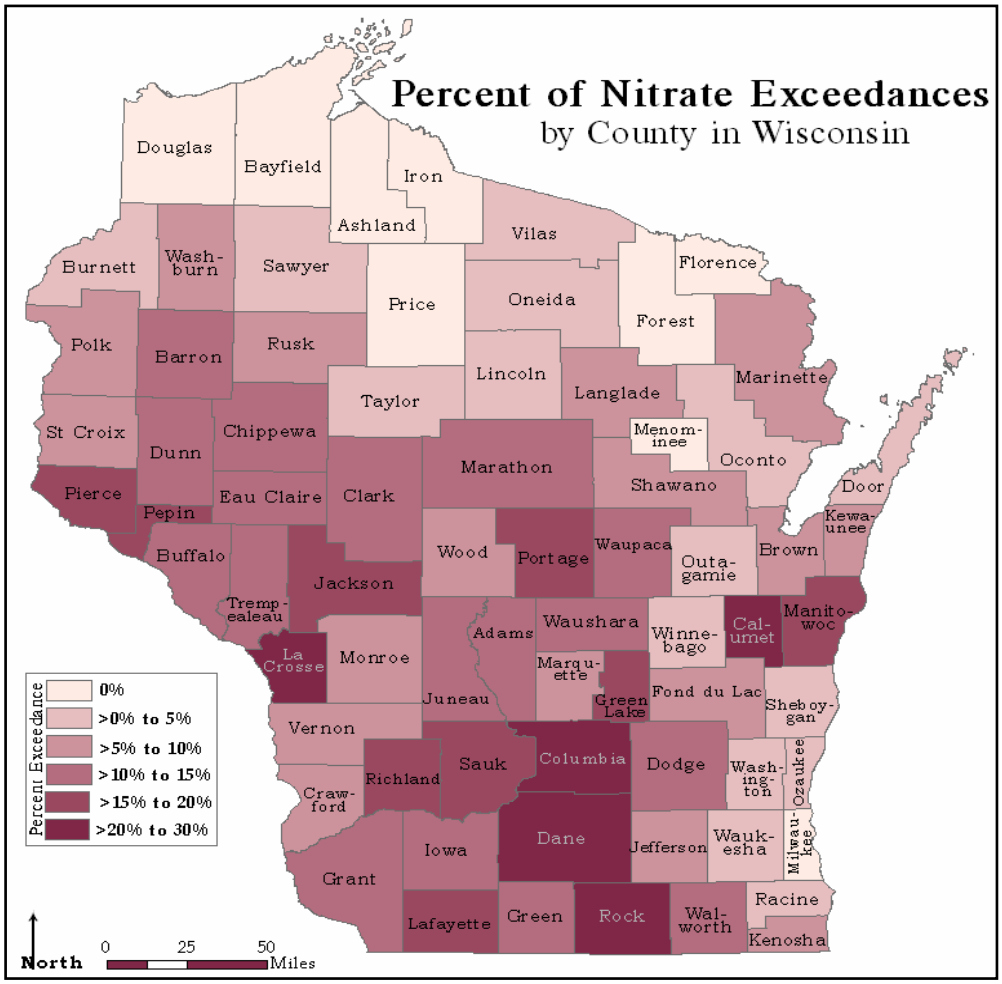

Figure 4.3 - Percentage of nitrate samples from private wells exceeding 10mg/L by county. Date sources: WDNR, Center for Watershed Science and Education, and DATCP groundwater databases.

Crosse and Rock counties all show the highest percent exceedances with 20% to 30% of the samples from private wells exceeding the 10 mg/L ES.

Human health concerns are the primary reason high levels of nitrate in drinking water are of concern. Nitrate can cause a condition called methemoglobenemia or "blue-baby syndrome" in infants under six months of age. Nitrate in drinking water used to make baby formula is converted to nitrite in the child's stomach, the nitrite then changes hemoglobin in blood (that part of the blood that carries oxygen to the body) to methemoglobin which deprives the infant of oxygen and in extreme cases can cause death. The Wisconsin DHFS has investigated several cases of suspected blue-baby syndrome and associated at least two with nitrate contaminated drinking water. These two non-fatal cases were reported in Columbia County (July 1998) and Grant County (April 1999). The Grant County case required an emergency MedFlight to a regional medical center and 17 day hospitalization to stabilize the 3 week old infant (Knobeloch, 2000).

When nitrate converts to nitrite in the human body it can then convert into a carcinogen called N-nitroso compounds (NOC's). NOC's are some of the strongest know carcinogens and have been found to induce cancer in a variety of organs. As a result, additional human health concerns linked to nitrate contaminated drinking water include; increased risk of: non-Hodgkin's lymphoma (Ward et al., 1996); gastric cancer (Xu et al., 1992; Yang et al., 1998); and bladder and ovarian cancer in older women (Weyer et al., 2001). There is also growing evidence of a correlation between nitrate and diabetes in children (Parslow et al., 1997; Moltchanova et al., 2004).

Because of these health concerns, city and village water supplies that exceed the 10 mg/L ES are required to mitigate the problem. Common solutions include drilling of a new non-contaminated well or the removal of excess nitrate through water treatment processes. Currently 25 (up from just 14 in 1999) of Wisconsin's public drinking water systems have exceeded the nitrate ES and have collectively spent over $24 million on remedies.

The 10 mg/L ES is also advised for privately owned wells that supply drinking water; however, the individual owners carry the responsibility of making sure their wells are tested. Private wells should be tested for nitrate at the time of installation and at least every five years during their use. Testing is also recommended for wells used by pregnant women and is essential for wells that serve infants less than 6 months of age. Owners of nitrate-contaminated water supplies have few mitigation options. They do not qualify for well-compensation funding unless the nitrate level in their well exceeds 40 mg/L and is used for farm stock. In order to establish a safe water supply, they may opt to replace an existing well with a deeper, better cased well or to connect to a nearby public water supply. Alternatively, they may choose to install a water treatment system or to use bottled water. A study published by DHFS examined this issue (Schubert et al., 1999). Their survey of 1500 families found that few took any action to reduce nitrate exposure. Of those who did, most purchased bottled water for use by an infant or pregnant woman.

With nitrate contamination increasing in extent and severity, it makes sense to reduce the amount of nitrate inputs into Wisconsin groundwater. Current proposed changes to state rules that could decrease groundwater nitrate contamination (at least near existing wells) include:
NR243 – Would lower the levels of nitrogen associated with manure and process wastewater from reaching groundwater by reducing improperly designed manure storage facilities and excessive or improper application of manure and process wastewater on cropped fields.
ATCP51 – With its emphasis on water quality protection, this proposed new livestock siting standard would afford protection to areas susceptible to groundwater pollution. Required

standards would prevent runoff from entering sinkholes, ensure that existing storage structures do not leak, and require application of manure according to plan that minimizes risks to groundwater. It would impose standards that will reduce water pollution risks including the potential for well contamination.

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Microbial agents

The United States produces some of the cleanest drinking water in the world and yet there are still reports of waterborne disease outbreaks. These outbreaks are produced by microbial agents including bacteria, viruses and parasites. These agents can cause acute and chronic illnesses and result in life-threatening conditions for individuals with weakened immune systems. Of the approximately 20 outbreaks reported nationally per year, more than half are related to groundwater consumption (Lee, et al. 2002). Many waterborne outbreaks are not reported or detected.

In one statewide assessment a decade ago, approximately 23% of private well water samples statewide tested positive for total coliform bacteria, an indicator species of other biological agents

(Warzecha et al 1995). Approximately 3% of private well water samples tested positive for *E. coli*, an indicator of water borne disease that originates in the mammalian intestinal tract.

Some parts of the state are particularly vulnerable to microbial contamination. Microbiological contamination often occurs in areas where the depth to groundwater or depth of soil cover is shallow or in areas of fractured bedrock. In these areas, there is little natural attenuation potential. Door County is one such location where bedrock is fractured and wells are often shallow.

In a recent survey of 25 private wells in Door County, 18 had detections of total coliform in at least one monthly sample over a 1-year period (Braatz, 2004). 40% had detections of a fecal indicator (*E. coli* or enterococci). Significant seasonal trends were also apparent, with higher percentages of wells with fecal indicators in the summer months. There was also a waterborne illness outbreak at a Door County restaurant in December 2004 (Wisconsin DNR).

Researchers at the Marshfield Clinic Research Foundation have investigated the association of pathogenic viruses and bacteria in private wells with incidences of infectious diarrhea and indicators of well water contamination (Borchardt et al. 2003b). In general, infectious diarrhea was not associated with drinking from private wells, nor was it associated with drinking from wells positive for total coliform. However, wells positive for enterococci were associated with children having diarrhea of unknown etiology, which was likely caused by Norwalk-like viruses. Results from a subsequent study of 50 private wells throughout the state indicate that 8% of private wells may be subject to virus contamination (Borchardt et al. 2003a). Wells positive for viruses were not consistent seasonally, nor were they associated with commonly used indicators of microbial contamination such as total coliform or fecal enterococci. These studies suggest that increased monitoring and detection methods for viruses are needed to assess the risk of drinking water with potential microbial contamination.

In another recently completed study in collaboration with the US Geological Survey, Marshfield researchers found that 50% of water samples collected from four La Crosse municipal wells were positive for enteric viruses, including enteroviruses, rotavirus, hepatitis A virus, and Norwalk-like virus (Borchardt et al. 2004). As with the private well study, there was no correspondence to common indicators of sanitary quality, nor was there a consistent seasonal trend. More surprising, viruses were common even in those wells without any Mississippi River water infiltration, suggesting other fecal sources were contaminating the wells. The most likely source is leaking sanitary sewers. The study did not address whether the viruses are inactivated through disinfection processes, or result in illness in the community.

The DNR recommends that private well owners test for microbial water quality annually or when there is a change in taste, color, or odor of the water. Public drinking water systems that disinfect their water supplies are required to sample, on a quarterly basis, for bacteria from the raw water (before treatment) in each well. These raw water samples are representative of the source from which the wells draw groundwater. The DNR has recently begun tracking total coliform detects in the raw water samples through its Drinking Water System database. The number of public water systems and locations where groundwater samples are collected quarterly for microbial analysis, along with the number of total coliform positive (TCP) samples for the period July 1, 2004 through June 30, 2005 are listed in the following table.

System type	# systems w/ Raw Req.	# locations w/ Raw Req.	# Raw TCP samples	# sys w/ Raw TCP
Municipal (MC)	475	1350	204	60 (12.6%)
Other-than-municipal (OTM)	64	100	9	6 (9.4%)
Non-transient, non-community (NN)	38	59	6	3 (7.9%)
Transient non-community (TN)	39	40	9	5 (12.8%)

Most wells belonging to the group of transient non-community systems (TN), such as restaurants and convenience stores, sample for bacteria on an annual basis. These systems have very small distribution systems and are similar to private water systems in that their water samples represent the groundwater source. There are 9448 TN active systems in Wisconsin.

Data from the Environmental Protection Agency (EPA) shows that the highest percentage of microbial unsafe water is found in small water systems, like TNs, serving less than 500 people (Peterson 2001). The mobility of transient people consuming water at small water systems and general lack of knowledge of illness symptoms hinder waterborne illness outbreak identification.

Nationally, the Center for Disease Control continues to track and identify failures in water systems that lead to illness outbreaks. Because of the increasing evidence for widespread occurrence of microbial contaminants, additional monitoring requirements for vulnerable public water systems are on the horizon. The Environmental Protection Agency (EPA) is developing a strategy, known as the "Groundwater Rule," which would modify Safe Drinking Water Act requirements to increase detection of fecal contamination in groundwater and reduce the occurrence of illness from microbial pathogens. The Groundwater Rule will include 5 preventative strategies that prior EPA drinking water legislation did not adequately address.

The first strategy includes sanitary surveys of public systems to identify deficiencies. The second strategy is a hydrogeologic sensitivity assessment of each public system to identify wells sensitive to fecal contamination. The third strategy is source water monitoring. Currently, the Safe Drinking Water Act focuses on sampling for microbial indicators in the distribution system. Fourth, the law will require corrective action for non-complying features found in the water system and eliminating fecal contamination with treatment or providing an alternative permanent source of water. The fifth strategy of the law is monitoring requirements to ensure that treatment equipment is maintained.

Wisconsin already conducts inspections and requires correction of non-complying features. Therefore, the major changes resulting from the proposed EPA law will be additional monitoring of source water for sensitive systems and installation of approved treatment devices or a new water source the wells found to contain fecal contamination.

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Arsenic

Naturally occurring arsenic has been detected in wells throughout the State of Wisconsin. DNR historic data show that 3,830 public wells and 3,013 private wells had detectable levels of arsenic. About 10% of these wells exceed the Federal drinking water standard of 10 µg/L. The highest concentration of arsenic detected in a private well in Wisconsin is 15,000 µg/L.

Arsenic has been detected in well water samples in every county in Wisconsin. However, the problem is especially prevalent in northeastern Wisconsin where increased water use has likely mobilized arsenic into the groundwater (**Figure 4.4**). In Outagamie, Winnebago, and Brown Counties approximately 45% of private drinking water wells sampled have detectable levels of arsenic. These findings led to the establishment of an “Arsenic Advisory Area” in the early 1990s. This area includes the strip of land five miles either side of the bedrock subcrop of the St. Peter Sandstone, extending in a northeasterly trend, from a location just southwest of Oshkosh, to a location just west of Green Bay. For this area, DNR developed special well construction specifications to increase the likelihood of installing a well free of arsenic.

Arsenic bearing geologic units exist across the state. It is found in the igneous rocks of the Precambrian shield, the Paleozoic sedimentary rock, and within glacial deposits. The highest concentrations are present in the sedimentary bedrock. Results from several DNR studies indicate the geochemical reactions causing the elevated levels of arsenic in groundwater of the northeastern part of the state are associated with oxidation of sulfide-mineralized zones within the bedrock aquifers. In the Northeast the main zone of mineralization extends some ten feet below the base of the Platteville Dolomite, which is part of the main upper bedrock formation of this region. If the St. Peter Sandstone is present within the geologic sequence, it lies directly below the Platteville Dolomite and the arsenic-rich mineralized zone then extends about ten feet into this sandstone. Although it is certain that this is the main mineralized zone, experts believe that there

are other lateral and vertical occurrences of arsenic-rich strata. In other areas of the state the arsenic bearing minerals are in glacial sediments or other Paleozoic bedrock formations.

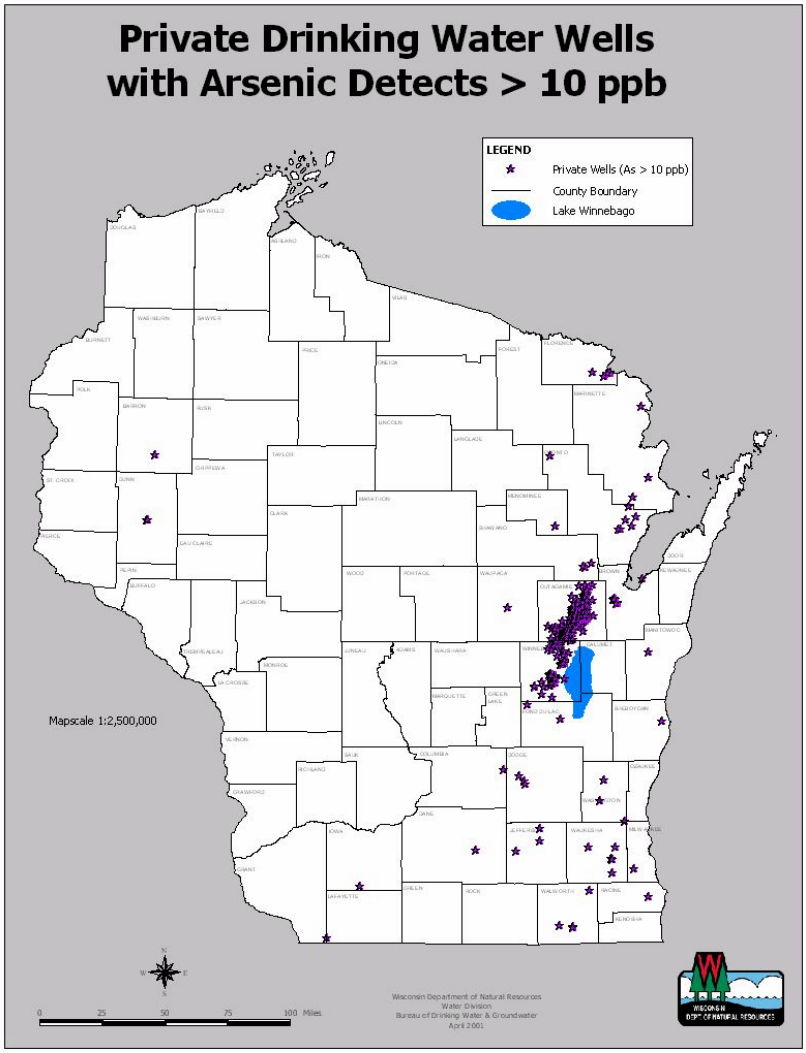

Figure 4.4 Private wells tested for arsenic in Wisconsin that have historically exceeded 10 ug/L (ppb). Source: WDNR

Recent information has raised questions about the St. Peter Sandstone – Sinnipee Dolomite contact being the only location where high arsenic concentrations are found. In cooperation with the Wisconsin Geologic and Natural History Survey the DNR located over 6000 wells, assessed the geology of the wells and remapped Outagamie and Winnebago Counties. The new maps were used to develop a Special Casing Depth Area for both counties. The drilling requirements can be found at: http://dnr.wi.gov/org/water/dwg/arsenic/casingrequire.htm. The goal is to finish the wells above the arsenic bearing zone or case all the way through it and get water from low arsenic aquifers.

In addition, there is evidence to suggest that increased levels of arsenic in this region may be related to increased groundwater consumption[2]. In many areas, increasing concentrations of arsenic may be a result of the water table dropping to levels at or just below the sulfide rich mineralized zone and then fluctuating up and down across this layer. This fluctuation can allow oxygen in the air to come in contact with and oxidize the sulfide minerals in this layer. This initial oxidation can then trigger a complex set of geochemical reactions that can eventually release arsenic into the groundwater. Once this reaction has been initiated it is likely to continue.

Recent findings from the WGNHS (Gotkowitz et al. 2003) support the hypothesis that high levels of arsenic in groundwater occur where mineralization is oxidized in well boreholes. However, two distinct geochemical mechanisms appear to contribute low to moderate arsenic concentrations to well water in this aquifer. 1) Oxidation of sulfide minerals may release arsenic to groundwater in confined portions of the aquifer; oxidation may have occurred at some time in the geologic past, or current levels of oxygen dissolved in the groundwater may be sufficient to permit slow oxidation to occur. 2) Reductive dissolution of arsenic-bearing iron oxides also seems to contribute low to moderate levels of arsenic to groundwater when the geochemical environment becomes sufficiently reducing. This occurs under typical domestic water use patterns, because increasing groundwater residence time in wells correlates to the onset of strongly reducing conditions and higher arsenic concentrations. The well borehole is a microbiologically active environment, and biogeochemical reactions likely contribute to the observed increase in arsenic concentrations. Reducing the volume of well bore storage relative to water use may help to limit arsenic concentrations in well water.

On October 31, 2001 EPA announced that the Federal Drinking Water Standard for arsenic would be lowered from 50 parts per billion (µg/L) for public water systems to 10 µg/L. The new standard became effective in February 2002 and compliance must be reached by 2006 (The state groundwater quality standards for arsenic have already been revised to reflect the lower threshold at the federal level, effective March 1, 2004.)The arsenic rule affects municipally owned water systems and those that serve an average of at least 25 people daily for six months of the year, among them schools, mobile home parks, apartment buildings, day care centers, and factories. Raw water samples submitted as part of a DNR and State Laboratory of Hygiene study indicated that approximately 80 public water systems contain arsenic levels exceeding 10 µg/L. However, some of those systems are already reducing arsenic to the federal health standard when they treat their raw water for other contaminants, such as iron. The DNR is working with schools and other public water systems to find solutions to the arsenic problem through drilling and treatment options.

The new standard also raises questions for private water supplies, particularly in regards to health risks associated with drinking water with moderate levels of arsenic (between the old and new standards). Historical data indicates that 20% of the wells in the 3-county area affected by arsenic exceed the new standard of 10 µg/L. In August 2002, the DHFS released the results of a follow-up investigation on the relationship between exposure to inorganic arsenic in water and health outcomes (Knobeloch 2002). As part of this research effort, local health departments, DNR staff, town clerks and others conducted well sampling campaigns in 19 townships in the affected

[2] Since the 1950s, groundwater consumption in northeastern Wisconsin has risen significantly due to an increase in population and per capita water use. Thousands of new private wells have been constructed in this region. Municipal and industrial groundwater use has increased. As a result, regional groundwater levels in the sedimentary bedrock aquifers of northeastern Wisconsin have shown a steady long-term decline. The decline has averaged as much as three to four feet per year in the Green Bay area and as much as two to three feet per year in the Fox Cities area surrounding the City of Appleton.

counties. Several other towns offered similar well testing programs. A number of the Towns have continued to offer sampling for the residents on a yearly basis.

2233 households submitted samples and returned health surveys, providing health and exposure information for 6669 individuals. Approximately 20% of the water supplies contained arsenic levels above 10 µg/L. Slightly more than 10% of the families consumed water that had an arsenic level greater than 20 µg/L. People over the age of 50 were more likely to report a diagnosis of skin cancer if they had consumed water that had an arsenic concentration greater than 5 µg/L for 10 years or more. Cigarette use was also associated with higher skin cancer rates: residents who both smoked and consumed arsenic-contaminated water reported the highest skin cancer prevalence rate. No association was seen between exposure to arsenic-contaminated water and the incidence of other types of cancer. However, findings from this study were consistent with previously reported associations between arsenic exposure and the prevalence of adult onset diabetes and cardiovascular disease.

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More information related to arsenic can be found on the DNR Arsenic Web Page: http://dnr.wi.gov/org/water/dwg/arsenic/index.htm

Naturally-occurring Radioactivity

Naturally-occurring radionuclides, including uranium, radium, radon, and gross alpha are becoming an increasing concern for groundwater quality, particularly in the Cambro-Ordovician aquifer system in eastern Wisconsin. The water produced from this aquifer often contains combined radium activities in excess of 5 pCi/L (picocuries/liter) in some cases in excess of 30 pCi/L. Nearly 60 public water systems exceed the drinking water standard of 15 pCi/L for gross alpha activity (**Figure 4.5**). The DNR is enforcing the radionuclide standard adopted into NR 809. The DNR has signed consent orders with 42 community water systems that will bring them into compliance with drinking water standards for radium and gross alpha by December of 2006.

Previous studies have shown that radium concentrations in excess of approximately 5 pCi/L can not be explained solely by the presence of parent isotopes in the aquifer solids. It is possible that high radium concentrations in Cambro-Ordovician water originate from downward flow of recharge water through the Maquoketa Shale. Indeed, high radium activity occurs in the Cambro-Ordovician in a band roughly coincident with the Maquoketa subcrop pattern (Grundl, 2001). This pattern extends across the entire eastern portion of the state from Brown County in the north to Racine County in the south. Radium activities have remained relatively constant from the middle 1970s to the present. High gross alpha activity also occurs in a band roughly coincident with the Maquoketa subcrop pattern extending along the entire eastern portion of the state. Gross alpha activity has been steadily rising from the middle 1970s to the present.

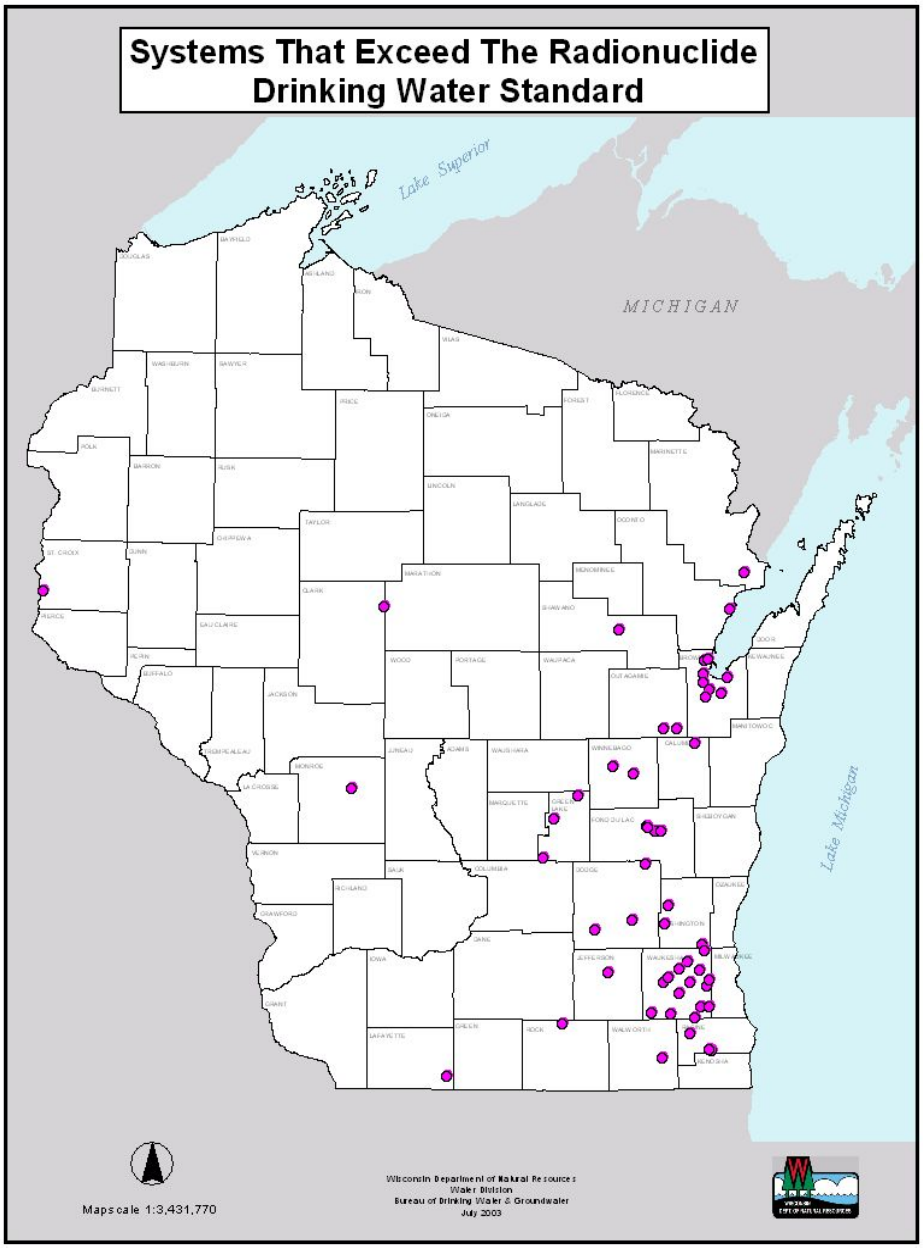

Figure 4.5 Public water systems that exceed 15 pCi/L for gross alpha activity as of July 2003. Source: WDNR

The Maquoketa outcrop pattern forms the demarcation between unconfined conditions in the underlying Cambro-Ordovician aquifer to the west and confined conditions to the east. Strong downward gradients exist across the Maquoketa and flow across the unit is maximal near the outcrop where total thickness is at a minimum. This strong downward gradient is very recent and is caused by heavy pumpage of the Cambro-Ordovician in urban areas.

The actual cause for high radium and gross alpha activities in the Cambro-Ordovician is undoubtedly a combination of multiple, sometimes subtle, processes that may differ from location to location. Determining which process(es) control the release of solid- phase radioactivity in the Cambro-Ordovician into the groundwater will require a more thorough understanding of the

system. Because the source of this radium is not fully understood, basic questions as to how best to manage this increasingly important source of drinking water may be difficult to answer.

Two additional studies have been initiated by the DNR to address concerns about radioactive compounds in groundwater. In 2000 and 2001, DNR staff collected samples from about 100 community and nontransient noncommunity public water wells. The WSLH analyzed each sample for several alpha-emitting radiochemicals (total Uranium (U-238, U-234, U-235), total Thorium (Th-228, Th-230, Th-232), Radium 226, and Polonium 210) in an attempt to identify and quantify the relative contribution of each chemical to the total gross alpha activity in the samples (Arndt and West, 2004).

Results indicate that total uranium is the major contributor to high gross alpha activities. Small quantities of polonium and thorium have also been detected but they do not appear to be major contributors to the total gross alpha activity in public water system wells. Another important finding was that total gross alpha measurements do not account for all of the radionuclides that may occur in a water sample. The WSLH has developed models to account for the discrepancy between the total gross alpha activity and measurements of individual radionuclides.

In addition, the study showed that the gross alpha activity depends appreciably on the radionuclide used as the calibration standard, the time between sample collection and sample preparation, the time between sample preparation and sample analysis, and whether a radiochemical or a gravimetric method is used to determine the total uranium activity. This is important since according to EPA regulations an adjusted gross alpha activity exceeding 15 pCi/L is considered to be a gross alpha violation. Using the model, it is shown that for some water samples the value obtained for the adjusted gross alpha activity can range from being well within compliance to being well out of compliance. Thus the use of the model developed in this work should be of assistance in helping a water utility with a gross alpha violation determine the reason for the violation, and, therefore, how to correct it.

A second study "Factors Effecting the Determination of Radon in Groundwater" will help determine the impact of expected new EPA standards for radon in drinking water. Staff from the DNR will sample about 340 noncommunity, nontransient and other than municipal water systems per year. To date, approximately 250 samples have been collected from nontransient, noncommunity wells. Preliminary results tend to support findings from earlier community water system monitoring which indicated that approximately 50% of the public water systems monitored in Wisconsin exceed the proposed radon standard of 300 pCi/L. As of July 2005, EPA has not finalized the drinking water standard for radon.

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Summaries of the gross alpha and radon studies are available on the WSLH web site at http://www.slh.wisc.edu/radiochem/research.html.

GROUNDWATER QUANTITY

Despite a general abundance of groundwater in Wisconsin, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural, and domestic use and for adequate baseflow to our lakes, streams, and wetlands. Groundwater quantity problems have occurred naturally and from human activities. In a 1997 report titled "Status of Groundwater Quantity in Wisconsin," the GCC concluded that a coordinated effort is needed to determine appropriate management options for addressing groundwater withdrawals, to prioritize information needs, and to implement information and education programs (WDNR 1997). The report also called for funding for additional data collection and research to address groundwater quantity management issues. Though funding has been scarce some progress on these objectives has been made.

Water Use

As part of the National Water-Use Information Program, the U.S. Geological Survey (USGS) stores water-use data in standardized format for different categories of water use. Information about amounts of water withdrawn, sources of water, how the water was used, and how much water was returned, is available to those involved in establishing water-resource policy and to those managing water resources. In 1978, the USGS entered into a cooperative program with the Wisconsin DNR to inventory water use in Wisconsin. Since that time, five reports have been periodically published summarizing water use in Wisconsin.

Groundwater use statewide grew from 570 to 804 million gallons per day (Mgal/d) from 1985 to 2000 (Ellefson and others, 2002). The majority of this water is used for public water supplies (330 Mgal/d), which is primarily used for domestic use, but also supplies water for some industrial and commercial purposes. Agriculture and irrigation uses are a close second (295 Mgal/d). The remainder provides water for self-supplied domestic, commercial and industrial uses.

Regional Drawdowns

The effects of groundwater withdrawals are well documented on a regional scale in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. There are substantial declines in groundwater levels in these three areas (**Figure 4.6**). The best-documented regional water quantity problem is in the Southeast part of the State. A recent study by the Wisconsin Geological and Natural History Survey and the U.S. Geological Survey shows that in the last 60 years well water withdrawals throughout southeastern Wisconsin, Illinois and Michigan were substantial enough to slow and reverse groundwater flow in some areas (Feinstein and others, 2004). In the region between Milwaukee and Waukesha County, groundwater models show that pumping water from the deep aquifers has begun to alter groundwater flow patterns extending to Lake Michigan, the Illinois border and western Waukesha County. Indeed, about 7.5 percent of the groundwater that used to flow toward Lake Michigan never reaches the coast; it's drawn into wells. Most of that water eventually reaches Lake Michigan through storm sewers and as treated wastewater, "but the location, timing and quality of the return flow is different than what it was under natural conditions," the USGS report concludes.

Quantity and Quality

An example of how reduced quantity can bring about quality concerns is seen in Southeast Wisconsin where many communities that use deep wells now have a problem with naturally occurring radionuclides present in the deep aquifer. Wells in the deep aquifer have drawn water levels down hundreds of feet. In recent years the concentrations of radionuclides and other elements have increased in many of these wells. There appear to be correlations between large

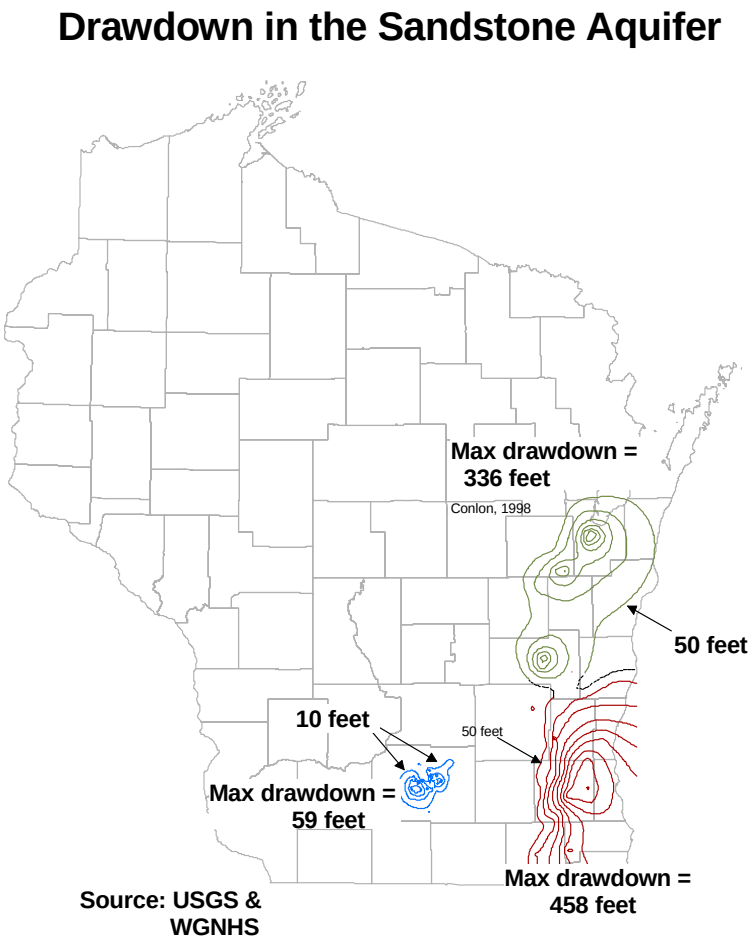

Figure 4.6 Simulated drawdown in the sandstone aquifer as of 1998-2000. Contour intervals represent levels of equal hydraulic head and are 50 feet in eastern Wisconsin and 10 feet in Dane County. Sources: USGS and WGNHS

drawdowns and radionuclide concentrations, but the scientific relationships between the two are not yet completely understood. This is a very serious problem as radionuclides are carcinogenic and very costly to treat for. Several communities facing a December 2006 deadline for reducing radium levels in their drinking water are being forced to look for alternative sources. However, the alternative of drilling shallow wells is problematic in that it may impact surface waters or other shallow wells, and shallow wells are vulnerable to contamination from near-surface sources. Fortunately several communities voluntarily went beyond what state law requires to protect surface waters and other water users in siting their wells and managing their water use.

Another example that illustrates the potential that reduced groundwater quantity has to cause groundwater quality problems is in the Lower Fox River Valley where over-pumping has resulted in increased detections of arsenic in private well water in recent years (also described above in the Groundwater Quality Section of this Chapter). Some of the arsenic concentrations found in groundwater have been quite high, with 20% of private wells sampled over the new standard of 10 µg/L. Investigations in the affected area indicate that most of the arsenic is coming from a

highly mineralized zone at the top of the St. Peter Sandstone. It appears that over-pumping in the Lower Fox River Valley has drawn down the bedrock aquifer to such an extent that the mineralized zone is exposed to the atmosphere and becomes oxidized, releasing arsenic.

Alternative Sources

Other developments have also highlighted the importance of groundwater quantity. Two communities, Green Bay and Oak Creek, have proposed aquifer storage and recovery as a method for addressing water shortages. Aquifer storage and recovery (ASR) involves injecting treated water into the aquifer during times of less groundwater use and pumping that water out when water demand is high, typically during the summer. Both communities worked with DNR to conduct pilot studies to determine if this is feasible in Wisconsin. In Green Bay it was determined that it wasn't feasible due to water quality concerns. Oak Creek has been issued a conditional approval. In addition, the communities around Green Bay have agreed to purchase water from Manitowoc where the water is withdrawn from Lake Michigan and treated.

For some communities tapping the Great Lakes is a potential solution to quantity problems. But, for some, there are bottlenecks. Governors from the eight states and premiers from the two Canadian provinces bordering the Great Lakes signed a Great Lakes Charter in 1985 setting guidelines and principles for managing Great Lakes water. A key provision of the Charter aimed to regulate large water withdrawals and diversions from metropolitan centers bordering the lakes. A supplementary agreement called Annex 2001 includes proposed provisions clarifying how, where and when water can be removed or diverted from the lakes or from groundwater that feeds them. In general it is difficult to receive permission from Great Lakes charter members to divert lake water outside of the basin which extends only some tens of miles from the Lakes in some areas. A first draft of the Great Lakes Annex Implementing Agreements was released for public comment in the summer of 2004. Public comments were received and incorporated in FY 05. On June 30, 2005, the second draft of the Implementing Agreements was released. The Council of Great Lakes Governors will hold public consultations on these new agreements in July and August 2005.

Surface Water Impacts

Localized effects from groundwater withdrawals are not as well documented as the regional effects. Cases exist around the state where wells, springs, and wetlands have gone dry; lake levels have dropped; and streamflow has been reduced. In 2000, Perrier (Nestle Waters North America) proposed installing one or more wells in the Big Springs area in southeastern Adams County to pump groundwater to be bottled and sold as spring water. Many local residents opposed the Perrier proposal because of concern about potential impacts to the spring. The WDNR issued an approval with conditions to protect the aquifer. The proposal highlighted the issue that, for high capacity wells, the WDNR only had authority to deny a high capacity well application if it determined that the new well would interfere with a municipal water supply well.

Solutions

Focusing on the state's limited authority to protect groundwater quantity the UW-Madison Department of Urban and Regional Planning issued a report reviewing Wisconsin's high capacity well law and made recommendations for its improvement (Born and others, 2000). The report discusses the potential impacts of high capacity wells on the environment, summarizes the existing law for managing groundwater in Wisconsin, reviews programs in selected states, and discusses issues and strategies for improving groundwater quantity management in Wisconsin. Some of the key recommendations included:

- Expand the public trust doctrine to groundwater
- Enforce existing statutory language regarding groundwater

- Explicitly recognize hydraulic continuity between groundwater and surface water in legislation
- Expand criteria for review and permitting of high capacity wells to consider effects on interconnected surface waters and ecological resources (springs, wetlands, rivers and streams, lakes, fish and wildlife)
- Enforce monitoring and reporting requirements for high capacity well permits
- Encourage voluntary reporting of water use information from other groundwater users
- Address cumulative impacts of wells by ensuring consistency with local or regional water management plans

Likewise, common themes reported in the GCC's summary of the 2001 Groundwater Summit, *Sharing our Buried Treasure*, included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues (GCC 2002). A large majority of Summit participants agreed that there is a need for a statewide groundwater quantity strategy in Wisconsin and that we are not doing enough to protect groundwater quantity in the state.

In 2002 and 2003, various groups proposed solutions to address groundwater quantity concerns in Wisconsin. Stakeholders from agricultural, environmental, industrial, and public utility interests worked together under the leadership of Senator Kedzie and Representative Johnsrud to produce groundwater legislation. On Earth Day, April 22, 2004, Governor Doyle signed a new groundwater protection law, 2003 Wisconsin Act 310, that expands the State's authority to consider environmental impacts of high capacity wells and institutes a framework for addressing water quantity issues in rapidly growing areas of the state. The Act recognizes the link between surface water and groundwater, and that all wells have an impact on groundwater quality and quantity. The law applies principles of adaptive management, allowing for changes in the regulation of high capacity wells as relevant information becomes available or groundwater conditions change.

Specifically, Act 310 sets new standards and conditions for approval of high capacity wells by the DNR, and creates Groundwater Management Areas to address regional drawdowns in the sandstone aquifer underlying large portions of Southeastern Wisconsin and the Lower Fox River Valley. In addition, the law creates more oversight of well construction activities, institutes a fee system for new construction, and establishes a Groundwater Advisory Committee to recommend strategies for groundwater management and future legislation. The law represents an important first step towards managing groundwater quantity at the State level.

The law also represents an opportunity to gain a much better understanding of groundwater quantity issues in the State. Collection of accurate high-capacity well construction and pumping information and detailed reviews of potential problem areas will provide a new understanding of water use and it’s impacts. Activities within the groundwater management areas to encourage coordinated management strategies should lead to a new level of cooperation among the state, local government units, regional planning commissions, and public and private users of groundwater.

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A number of other resources related to groundwater quantity are listed on the GCC website.

Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded over 320 groundwater-related monitoring and research projects since enactment of Wisconsin's comprehensive groundwater protection legislation (1983 Wisconsin Act 410) in 1984 (see *Appendix C*). Those agencies that have funded projects are the DNR, DATCP, DILHR/Commerce, and the UW System.

This chapter highlights some of the areas that have been the focus of research and monitoring projects and illustrates how agencies have used the project results to improve the management of the state's groundwater resources. Many projects have contributed to our understanding of subsurface hydrology, surface water and groundwater interactions, and geology. Some have helped to evaluate existing regulatory programs and determine if there is a need for additional regulations. Numerous studies have increased the knowledge of the movement of contaminants in the subsurface. Others have developed new methods for groundwater evaluation and protection.

Citations refer to the projects listed in the table in *Appendix C*.

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS IN GROUNDWATER

Pharmaceuticals and personal care products (PCPs) are a large group of substances present in human generated waste streams that potentially could contaminant groundwater resources. Pharmaceuticals such as antibiotics, birth control pills and various prescription medicines may be present in wastewater effluents. PCPs, including shampoos, detergents and "over the counter" medications, are found in both treated wastewater discharges and the municipal solid waste stream. Some pharmaceutical/PCP compounds may act as endocrine disruptors, adversely effecting the behavior of natural hormones in humans and other animals. New analytical methods, allowing detection of very small quantities of a substance, have helped improve investigations into the occurrence of pharmaceuticals and PCPs in the environment.

Discharges of treated wastewater through land treatment systems, leachate leaking from solid waste landfills, and agricultural/municipal biosolids landspreading activities can potentially contaminate groundwater aquifers. The mobility and fate of discharged/released substances in the subsurface is a function of a variety of factors such as adsorption properties and biodegradability of the substance, and the amount and properties of the soil material through which the substance is passing. Recent studies in other states, assessing the occurrence of pharmaceuticals and PCPs, have shown the presence of these substances in groundwater at sites where treated wastewater is used to recharge groundwater.

In Wisconsin, research has been done evaluating the occurrence, and movement in the subsurface, of pharmaceuticals and PCPs. A 2003 University of Wisconsin (UW) study, conducted by K.G. Karthikeyan and William F. Bleam, investigated the presence of antibiotics in treated wastewater effluents, and their potential fate in the subsurface. Two antibiotics, tetracycline and sulfamethoxazole, were found in all of the wastewater effluents tested for the study. A variety of other antibiotics were also detected in the tested wastewaters. Tetracycline and sulfamethoxazole were found to be present in groundwater monitoring wells located directly adjacent to some of the

study land treatment system discharge areas.

A second UW study, conducted by Joel Pedersen and K.G. Karthikeyan, has investigated the soil adsorption properties of common antibiotics. This study found that under the right soil conditions some antibiotics, such as the sulfonamide antibiotics, have the potential to be fairly mobile in the subsurface.

Several other pharmaceuticals/PCP studies are currently in progress. A study of the use of a screening assay to evaluate the occurrence of estrogenic endocrine disruptors in groundwater is currently being conducted by the State Lab of Hygiene (SLH). This study is to include testing of both high capacity water supply wells located in close proximity to surface waters (where wastewater effluent is being discharged), and water supply wells in the vicinity of home on-site wastewater treatment system discharges to groundwater. A Dane County research project, assessing groundwater impacts from on-site wastewater treatment system discharge, is also currently underway. This project will include an assessment of pharmaceuticals and PCPs in both soil water and groundwater impacted by on-site system discharges in an unsewered subdivision.

Studies comparing the levels of pharmaceutical and PCP substances in wastewater influent with those present in treatment system effluents will be useful in assessing the removal effectiveness of currently approved wastewater treatment processes. Research into the behavior of pharmaceutical and PCP substances in soil and groundwater will help the Department develop effective monitoring strategies, and studies evaluating new sampling techniques and analytical methods assures that the Department is utilizing the best available tools to assess the occurrence of these substances in the environment.

THE ATRAZINE RULE

The development of the Atrazine Rule (ATCP 30, Wis. Adm. Code) illustrates how the benefits of state-funded research and monitoring can build on one another. In the mid-1980s the corn herbicide atrazine was first detected in monitoring wells and private drinking water wells in Wisconsin. The first systematic well sampling program to characterize atrazine contamination on a statewide basis was the 1988 DATCP Grade A Dairy Farm Well Water Quality Survey (LeMasters, 1989). This state-funded well survey estimated that atrazine was present in 12% of the Grade A Dairy Farm Wells in the State.

This study left unanswered many questions regarding the sources, groundwater susceptibility, and the presence of pesticides other than atrazine. Without better information on these and other questions, it was challenging for DATCP, the agency charged with groundwater protection related to agricultural chemicals, to develop a plan of action. It was obvious that a concerted information gathering program was needed. Over the next several years, before and during the development of the DATCP atrazine rule, the Wisconsin Groundwater and Pesticide Research Program played an essential role in providing the needed information. Research and monitoring were conducted on several topics that played a direct role in the evolution of the atrazine rule.

The state research and monitoring program funded several key projects to better understand the sources of atrazine contamination. When atrazine was first found in groundwater, an argument had been made that this was the result of point sources such as spills and mishandling. One of the most important findings that allowed DATCP to begin developing the atrazine rule was that normal agricultural applications of atrazine could lead to groundwater contamination. The DATCP groundwater monitoring project for pesticides (Postle, 1986-96) used monitoring wells

located next to agricultural fields to study groundwater contamination by atrazine and other pesticides. This study showed that atrazine from field use on sandy soils could cause contamination, often above the 3 µg/L ES. The UW Water Resources Center conducted a detailed hydrogeologic study (Chesters, 1990-91) at a farm in Dane County and showed conclusively that atrazine contamination could result from both field applications and mixing/loading practices. With the knowledge that nonpoint contamination of groundwater by atrazine was indeed occurring, DATCP could develop ways to reduce this contamination.

State-funded research was essential in showing that atrazine contamination did not follow simplistic notions of groundwater contamination susceptibility. One of the most important findings was that the Central Sands and the Lower Wisconsin River Valley (LWRV), two areas that appear similar in soils and agricultural practices, had significantly different susceptibility to contamination. These differences were pointed out in several research projects conducted by the UW Soil Science Department (Daniel, 1991; Lowery, 1991; McSweeney, 1991; Lowery, 1992-3). This information had a direct influence on the atrazine rule in that there is now a use prohibition in the LWRV and managed use in the Central Sands.

Another key finding related to the susceptibility of groundwater to atrazine contamination was that many of the areas with high frequency of detections had medium textured (loamy) soils. It had previously been thought that these areas were less susceptible to leaching and groundwater contamination than areas with sandy soils. State-funded research and monitoring efforts, however, showed that the intensity of atrazine use, in addition to soil and geologic conditions, played an important role in the contamination. This finding helped to explain why many areas in south central Wisconsin, with medium textured soil and high corn production, had many wells contaminated with atrazine. This knowledge allowed DATCP to adopt management strategies for reducing atrazine contamination in these areas.

When atrazine was first discovered in Wisconsin's groundwater in the mid-1980s, DATCP was interested in managing its use based on predictive modeling of contamination processes. Modeling activities funded by the state research program, however, indicated that the behavior of atrazine and other contaminants in the environment was complex and could not be reliably predicted by modeling. In response to this finding, DATCP adopted a more empirical approach to identifying management areas. Actual well results were plotted on maps and, together with an analysis of soils and geology, management areas were delineated.

When monitoring and rule making efforts for atrazine first started, parent atrazine was the only compound that was considered. As more research was conducted, however, it was discovered that three metabolites (breakdown products) of atrazine were present in groundwater and were of health concern (Chesters, 1990-91; LeMasters, 1990; Cowell, 1990; Cates, 1991). State-funded sampling programs showed that due to the presence of atrazine metabolites, the groundwater problems were more serious than previously considered. This knowledge allowed DNR to strengthen the groundwater standard for atrazine in 1992 and allowed DATCP to strengthen the atrazine rule in 1993 and extend required use reductions to the entire state.

It is interesting to try to envision how DATCP's atrazine rule would look if it did not have the benefit of the intensive research and monitoring efforts. It is safe to say that it would not have been developed on as good an understanding of the behavior of atrazine in the environment or the geographic patterns of contamination. It is possible that without the intensive monitoring efforts, the full extent of the problem would not have been discovered and atrazine use would not have been reduced. On the other hand, it is possible that with inadequate knowledge a "broad brush" approach would have been taken. This could have resulted in unfair regulations that were not

tailored to the different geographic areas of the state.

Two important aspects of environmental regulation that promote its acceptance are that it is based on science and that it is fair. Good research is necessary to achieve these two characteristics. The Atrazine Rule has experienced a relatively high degree of acceptance due to the effort that was put into its development.

GROUNDWATER MONITORING AT SOLID WASTE DISPOSAL SITES

The DNR's Waste Management (WA) program received project funding ten times from 1985 to 2003 through the joint solicitation process. These projects have benefited the program in many ways, primarily impacting regulations and monitoring practices.

The first two studies (Friedman, 1985-87; Battista, 1988-89) revealed for the first time that groundwater around many Wisconsin landfills was contaminated by VOCs. The studies also showed that VOC contamination of groundwater was more common at unlined municipal solid waste landfills than at other types of landfills. A follow-up VOC study (Connelly 1993-94) showed that VOC levels have decreased at most of the unlined landfills, though at many of the sites VOC levels do not show continued decline. There was no VOC contamination definitely attributable to leachate migration at any of the older, engineered landfills that confirmed that these sites are performing as WA program staff had hoped. The results of the three VOC studies have been used to establish requirements for VOC sampling at new and existing landfills. These studies have also indicated that inorganic compounds could be useful in predicting VOC contamination at landfills. Therefore, until recent EPA rules required VOC monitoring, the WA program allowed sites to sample for inorganic parameters as part of routine monitoring and not sample VOCs until inorganics were elevated. The VOC studies provided valuable data that was used to convince EPA to reduce the number of VOCs required for monitoring at municipal solid waste landfills in Wisconsin. This reduction in monitoring (the use of inorganics and the reduced number of VOCs when they are required) allowed landfill owners considerable cost savings while maintaining equivalent environmental protection. Additionally, the VOC data was used to require responsible parties to define the degree and extent of contamination and remediate groundwater contamination at their landfills.

Research on methods of assessing groundwater quality data and data quality control completed in the third VOC study has been helpful to WA program staff and consultants in interpreting groundwater quality data from landfills and other facilities. This study also showed the need to require laboratories to report data between the limit of detection and the limit of quantitation.

An assessment of Wisconsin's Groundwater Monitoring Plan program (Pugh, 1992) for active non-approved landfills provided the documentation of a set procedure for selecting monitoring sites. This information has been useful in recent meetings with municipalities held to convince municipalities that they have not been singled out for further evaluation of groundwater contamination and to demonstrate that the process used for selecting landfills for monitoring is objective.

Three studies from 1991 to 1994 on the potential groundwater impacts at deer pits, yard waste sites, and construction and demolition landfills (Pugh, 1992-3; Pugh, 1994) were conducted because little or no data existed on the potential impact to groundwater from these sites. Research has provided the information necessary to revise rules and establish policy regarding monitoring and siting of construction and demolition (C/D) landfills, deer pits, and yard waste sites in

Wisconsin. The groundwater study of deer pits showed that impacts were minimal and helped the WA program to decide not to require liners and to loosen some construction and reporting requirements. Similarly, the yard waste site study showed only minor groundwater impacts, which led the WA program to encourage active management of these sites rather than stiffen regulations. The study of construction and demolition landfills showed some groundwater impacts at large sites but little or no impacts at smaller sites. These findings led to new regulations (effective June 1996) allowing lined intermediate size C/D landfills, which can provide the economic benefits of a large site without the potential negative impacts of very large sites. Based on the research, the regulations were written to require groundwater monitoring of inorganic parameters at small size C/D landfills but only require VOC sampling when establishing background. Since these studies have been conducted, many states and the EPA have contacted the WA program about the information collected.

Another study undertaken by the WA program (Connelly, 1994) was a comparison of groundwater sampling methods for collecting metals samples at monitoring wells. The study was in response to EPA's October 1991 ban on field filtering of groundwater samples that became effective in October 1994. The WA program opposed this ban because many Wisconsin monitoring wells produce very turbid water which can lead to false positive results for metals if samples are not filtered. Additionally, the new EPA-recommended procedure, low-flow pumping, requires a significant amount of additional equipment. The study showed that the low-flow pumping method was appropriate in many circumstances but could not be used to sample slowly recovering wells. The results showed that turbidity was the best indicator that a well has been sufficiently purged. The results of the investigation are being used to revise groundwater sampling procedures required by the WA program. Additionally, the study helped establish Wisconsin as one of two leading states playing a major role in advising EPA on revisions to their groundwater sampling requirements at municipal solid waste landfills.

A follow up study by the WA program (Svavarsson, 1995) compared low flow pumping and bailing for VOC groundwater sampling at landfills. The study indicated that, in contrast to what some were claiming, there was very little difference in the results when using the two different methods. These findings were incorporated into the new groundwater sampling code and allowed the use of either method for sampling VOCs. This reduced the cost that landfill owners would otherwise have had to bear to purchase and operate low flow pumping equipment.

A joint project between the Bureau and UW Stevens Point evaluated the effectiveness of chemical oxygen demand (COD) as an indicator parameter at landfills (Connelly and Stephens, 2000). One reason for evaluating COD is that mercury waste is generated when COD is analyzed in the laboratory. The DNR's overall goal was to reduce amount of mercury that gets into the environment. Eliminating COD sampling at the 400+ landfills that currently sample for it would help the agency meet that goal. Findings from the first year of the study indicated that there are potential to eliminate COD monitoring at some types of landfills. The second year of the study evaluated possible alternatives to sampling for COD. Dissolved organic carbon (DOC) appears to be an acceptable alternative in certain circumstances.

Between July 2000 and July 2001 the Bureau studied 31 landfills accepting municipal solid waste, to try to determine whether VOC contamination in groundwater at these landfills is increasing, decreasing or remaining stable (Connelly 2001). Investigators chose sites with 10 years of data and summarized the trends over this period of time. One purpose of this study was to determine whether natural attenuation is occurring in groundwater near leaking landfills. The study showed that natural attenuation processes were occurring at most of the landfills as evidenced by the large number of stable or decreasing concentration trends. However, the

concentrations took longer to stabilize and stabilized at higher levels than at other types of VOC contamination sites described in the literature.

ARSENIC MONITORING AND RESEARCH IN NORTHEASTERN WISCONSIN

Wisconsin is also a leader in groundwater monitoring for naturally occurring compounds. Two projects in the DNR Lake Michigan District (Stoll, 1992; 1994) identified the existence of lead and arsenic contamination in groundwater. Homeowners were alerted through direct mailings, public meetings and mass media news releases. Over 72,000 people were unaware of their exposure to the substances in their drinking water. In one case, the sources of metals in these drinking water supplies were given priority for removal (Door County Lead Arsenate Mixing Sites).

The DNR coordinated with the DHFS to conduct health surveys on individuals consuming locally contaminated water supplies and made appropriate health recommendations. Local County Health Departments in affected areas are also actively monitoring groundwater quality and are providing assistance to homeowners. In 2001 and 2002, DHFS staff received additional funding to conduct a follow-up investigation on the relationship between exposure to inorganic arsenic in water and health outcomes (Knobeloch 2001). As part of this research effort, local health departments, DNR staff, town clerks and others have conducted well sampling campaigns in townships in the affected counties.

2233 households submitted samples and returned health surveys, providing health and exposure information for 6669 individuals. Approximately 20% of the water supplies contained arsenic levels above 10 µg/L. Slightly more than 10% of the families consumed water that had an arsenic level greater than 20 µg/L. People over the age of 50 were more likely to report a diagnosis of skin cancer if they had consumed water that had an arsenic concentration greater than 5 µg/L for 10 years or more. Cigarette use was also associated with higher skin cancer rates: residents who both smoked and consumed arsenic-contaminated water reported the highest skin cancer prevalence rate. No association was seen between exposure to arsenic-contaminated water and the incidence of other types of cancer. However, findings from this study were consistent with previously reported associations between arsenic exposure and the prevalence of adult onset diabetes and cardiovascular disease.

As part of this study, DHFS conducted a survey of households in selected areas of northeastern Wisconsin affected by arsenic in groundwater. The goal of this survey was to assess residents' understanding of their laboratory results, learn what actions people have taken in response to their results, and to identify barriers to increased participation in well sampling campaigns. The survey revealed that more than 80% of those who perceived their well water to be unsafe had taken action to reduce their exposure to arsenic, usually by installing a treatment system or by drinking bottled water. Among those who had not sampled their wells for arsenic, confidence in the safety of their well and lack of information about how to have their water tested were the most commonly cited reasons. Many of those who had not had their wells tested had reported that they had only recently moved into their homes or into the area.

Studies conducted by DNR of the extent of the arsenic contaminated area led to the establishment of an "Arsenic Advisory Area" in the early 1990s. This area includes the strip of land five miles either side of the bedrock subcrop of the St. Peter Sandstone, extending in a northeasterly trend, from a location just southwest of Oshkosh, to a location just west of Green Bay. For this area, DNR developed special well construction specifications, more stringent than the minimum

Private Well Code requirements. DNR guidance recommends the installation of 80 feet of casing through the sandstone contact for drinking water wells in the AAA. These specifications were recommended, but not required, for new wells constructed within the "Arsenic Advisory Area". The specifications, when followed, will increase the likelihood of installing a well free of arsenic. A special casing and construction area has been established for the Town of Algoma in Winnebago County. In this area, all wells must be drilled with mud/wash rotary methods with a 10-inch upper enlarged drillhole, Bradenhead grout methods and cased to the Cambrian sandstone aquifer.

In 2002 the WGNHS completed field experiments in the Fox River Valley that evaluated mechanisms of arsenic release to groundwater from domestic wells completed in the St. Peter sandstone aquifer, including studies of arsenic exposure to residents in the area and the effects of well chlorination on arsenic levels (Gotkowitz 2001). Findings support the hypothesis that high levels of arsenic in groundwater occur where mineralization is oxidized in well boreholes. However, two distinct geochemical mechanisms appear to contribute low to moderate arsenic concentrations to well water in this aquifer. 1) Oxidation of sulfide minerals may release arsenic to groundwater in confined portions of the aquifer; oxidation may have occurred at some time in the geologic past, or current levels of oxygen dissolved in the groundwater may be sufficient to permit slow oxidation to occur. 2) Reductive dissolution of arsenic-bearing iron oxides also seems to contribute low to moderate levels of arsenic to groundwater when the geochemical environment becomes sufficiently reducing. This occurs under typical domestic water use patterns, because increasing groundwater residence time in wells correlates to the onset of strongly reducing conditions and higher arsenic concentrations. The well borehole is a microbiologically active environment, and biogeochemical reactions likely contribute to the observed increase in arsenic concentrations. Reducing the volume of well bore storage relative to water use may help to limit arsenic concentrations in well water. Results of this study were presented to DNR Drinking Water and Groundwater Program staff and used by the DNR to develop well construction guidelines for the Towns of Algoma and Omro.

Several other ongoing projects addressing arsenic issues include a study refining analytical methods for detection of arsenic compounds (Aldstadt 2001), a study of the role of chlorination in releasing arsenic (Sonzogni 2002), three projects investigating treatment methodologies for both private and public water supplies (Anderson 2001, Park 2002, McGinley 2002), and a project investigating the occurrence of arsenic in southeastern Wisconsin aquifers (Bahr and Gotkowitz 2003). These studies will help provide needed information about the occurrence, health risks, and remediation of arsenic in drinking water supplies. Results will be made available as final reports are completed.

GROUNDWATER MOVEMENT IN FRACTURED DOLOMITE

Door County has been the site of five research projects by the WGNHS to develop a framework for studying the complex groundwater flow regime in fractured rock found in many parts of the state. The first project (Bradbury, 1986-90) started as a nonpoint source watershed project investigating the hydrogeology and groundwater geochemistry in the shallow fractured dolomite aquifer in Door County. Groundwater quality was found to vary widely over time with bacteriological contamination common. The second study (Bradbury, 1992) showed that modeling results obtained from a discrete fracture model varied considerably from results produced by a continuum model for groundwater movement. The discrete fracture model estimated capture zones, groundwater flow paths, and groundwater travel times by using mathematical representations of fractures digitized from aerial photos. The third study (Bradbury,

1993-94) used a tracer for characterization of groundwater movement and contaminant transport. It revealed that hydraulic conductivity can vary widely in the same well depending on what depth interval is tested.

A fourth study applied the discrete fracture flow model above to wellhead protection at the City of Sturgeon Bay (Bradbury 1996). Municipal wells at Sturgeon Bay draw groundwater from a series of horizontal fracture planes in Door County's dolomite aquifer, and delineating wellhead protection areas in such environments is extremely challenging. This complex project has relied upon hydrogeologic information and analytical tools developed through the three research projects described above which targeted processes and models for groundwater movement in fractured rocks. Without the knowledge and experience gained through these previous projects the Sturgeon Bay Wellhead Protection Project could not have been accomplished.

During 1999, Bradbury and others began a follow-up project to attempt to verify the results of the Sturgeon Bay wellhead protection project using natural groundwater tracers (Bradbury 2000). This research is measuring the natural seasonal variations in temperature, electrical conductivity, and oxygen and hydrogen isotopes of groundwater and precipitation in order to verify the sources and velocities of groundwater moving toward Sturgeon Bay's wells. The use of such tracers is attractive because they are naturally present in the environment.

DEVELOPING NEW TOOLS FOR GROUNDWATER PROTECTION

Applications of a wide variety of tools for gathering and working with hydrogeologic and groundwater quality data have been funded. Projects involving Geographic Information Systems (GIS) and sophisticated groundwater modeling applications have been funded in the many areas of the state. The funding agencies hope to continue to develop improved methodologies to make groundwater quality, quantity and contaminant source data more readily available.

Previous support of county-wide groundwater inventory studies and of modeling methodologies (Potter, 1992-93; Anderson, 1997) has given WGNHS and USGS personnel the hydrogeologic databases and analytical tools needed for the construction of regional groundwater models such as the recently completed Dane County groundwater model. This computer model, which covers all of Dane County, simulates current and future groundwater conditions and is being used to evaluate how current and future groundwater pumping affects regional water levels and also how groundwater use affects shallow lakes, streams, and wetlands. In addition, this model has been used to delineate groundwater capture zones for all municipal wells in Dane County (Bradbury 1996).

The Dane County model, which provides a modern hydrogeologic framework for groundwater movement in Dane County, has stimulated a number of significant research projects by other investigators (Mickelson 1994-95; Bradbury et al., 2000). These investigators are using the model as a starting point for more detailed flow models of specific problems or areas of the county. One of the most significant of these is the award of a multi-year USEPA STAR grant to a team of DNR, UW-Madison, USGS, and WGNHS investigators who are investigating the water-resources impact of different land-use strategies on Madison's urban fringe. This research will support several graduate students and is will provide an integrated assessment of the hydrological, ecological, and institutional impacts of urbanization and land-use change. This research is focused on the Pheasant Branch watershed just west of Madison. Other research projects are investigating the sources of groundwater supplying important springs in the Nine Springs and Token Creek watersheds, with the goal of determining how nearby development and groundwater

use could affect the springs.

The Dane County model has now become a prototype for regional groundwater models in other parts of Wisconsin. In 2003, the WGNHS, USGS, and SEWRPC finalized a cooperative project to develop a similar model for the entire seven-county SEWRPC area of southeast Wisconsin. Other modeling projects are taking place in Sauk, Rock, and La Crosse Counties. Such models are critical tools in the planning process, and allow water managers to evaluate the impacts of various future water management and land use alternatives in order to make well-informed land-use decisions.

PREVENTION AND REMEDIATION OF GROUNDWATER CONTAMINATION

The State of Wisconsin (through the UWS Water Resources Institute) has supported many research projects emphasizing new technologies for prevention or remediation of groundwater contamination. Final reports and studies in progress provide information or products that will be important for future efforts aimed at controlling or attenuating groundwater contamination in Wisconsin. The findings cover a wide range of technologies including:

- New and enhanced physicochemical or biological methods to renovate waters contaminated by pesticides and volatile organic carbon compounds (Collins, 1997-2002), (Li, 2000), (Benson and Eykholt, 2000), (Benson, 1997-2000), (Hoopes, 1997-99), (Park, 1997-98), (Bahr, 1996-98), (Hickey, 1994-96), (Anderson, 1994-95), (Chesters and Harkin, 1991), (Harris and Hickey, 1991-92);
- Enhancements in the ability to control, monitor, and predict the movement of landfill and mine waste contaminants to groundwater (Edil and Benson, 2000), (Edil 1997), (Benson, 1995-96), (Edil and Park, 1992-93);
- Improvements in the predictability of pump-and-treat remediation applications to contaminated aquifers (Bahr, 1994-95);
- Innovative agricultural practices designed to reduce groundwater contamination by pesticides and nitrate (DeVita and Dawson, 2001-04), (Norman, 2000-03), (Bundy, 1993-94, 1997-98), (Shinners, 1995-96), (Newenhouse, 1995), (Harrison, 1992-93), (Bahr, 1991-92); and
- Development of new technologies for evaluating the integrity of water supply well and exploration borehole seals (Edil, 1996, 1998-99), (Edil and Benson, 1997-98).

DETECTION AND MONITORING OF MICROBIOLOGICAL CONTAMINANTS

The GCC has solicited research projects during the last several years that attempt to improve understanding of microbiological aspects of groundwater contamination.

Several projects have focused on developing new techniques for detecting, quantifying, and monitoring microorganisms in groundwater and soils. Researchers at the UW-Madison Soil Science Department, developed a rapid molecular method using the polymerase chain reaction (PCR) to assay soils for the presence of specific sewage-borne pathogens (Hickey 1997). PCR-based methods eliminate the need to culture organisms for detection, and remedy shortcomings of traditional techniques by allowing rapid, sensitive, and specific identification of the pathogens of concern rather than indicator organisms. The PCR protocol Hickey developed was designed to detect DNA originating from *Escherichia coli*, which is one of the major species of bacteria associated with human waste. With this method he could distinguish *E. coli* DNA from that of its closest relative, *Shigella*. The method allowed the detection of DNA equivalent to about 20 cells. Currently, he is testing the PCR method for tracking of *E. coli* in the environment.

Because they have the capacity to co-metabolize a wide variety of organic chemicals, including halogenated compounds, methanotrophic bacteria have significant potential for bioremediation. The UW-Milwaukee Department of Biological Sciences has developed methods for quantification of methanotrophs in groundwater (Collins 1997, 1999). These methods, that include competitive PCR and direct PCR, provide approaches to monitoring bioremediation and natural attenuation. In addition, this work has provided the basis of another study that applied direct PCR to the detection of pathogens in groundwater (Collins 2001).

A recently completed study by the Wisconsin State Laboratory of Hygiene (WSLH) investigated storage and handling requirements for water samples submitted for coliform and *E. coli* analysis (Sonzogni and others, 2002). Currently the USEPA has no guidelines for sample holding times and shipping temperatures for drinking water samples submitted for *E. coli* testing. The study provided evidence to expand the allowable storage time of water samples submitted for *E. coli* analysis beyond the current eight hour limit as well as supporting a single preservation protocol for both surface waters and drinking water samples. A change to a maximum holding time of chilled samples for up to 30 hours could easily be supported by the data presented in this study. The data also called into question the current practice of allowing up to 48 hours for submitting drinking water samples with no attempt to cool them. A reduction in the time period to 30 hours, or a requirement to ship the samples at less than 10 degrees C, could be supported by the data.

Another recent WSLH study developed a culture method for detecting *Helicobacter pylori* from a heterogeneous microbial population in water, and then use this method to establish a data base for its occurrence in Wisconsin groundwater (Sonzogni and others 2002). Prior to this study, there were no reliable methods for detecting viable *H. pylori* in environmental samples (water, manure, vegetables, etc.). *H. pylori* is recognized by the World Health Organization to be the primary cause of peptic ulcers, chronic gastritis and stomach cancer. About 50% of the U.S. population are thought to be symptomatic or asymptomatic carriers, even though the source of human infection is not well understood. The efforts of this study resulted in the development of a high quality plating media for selecting viable *H. pylori* from mixed microbial populations. Samples from over 400 private wells were *H. pylori*-absent, including wells used by infected residents. These results suggest that the route of *H. pylori* to humans in Wisconsin probably does not involve private well water.

The Marshfield Clinic Research Foundation has investigated the association of pathogenic viruses and bacteria in private wells with incidences of infectious diarrhea and indicators of well water contamination (Borchardt 1997, 1999). In general, infectious diarrhea was not associated with drinking from private wells, nor was it associated with drinking from wells positive for total coliform. However, wells positive for enterococci were associated with children having diarrhea of unknown etiology, which was likely caused by Norwalk-like viruses. Final results indicate that the incidence of virus contamination in private wells may affect 4-12% of private wells. Of concern to drinking water regulators is the seasonal variability of the virus occurrences and lack of correspondence between viral presence and common microbial indicators.

In another recently completed study with the US Geological Survey, Marshfield researchers found that 50% of water samples collected from four La Crosse municipal wells were positive for enteric viruses, including enteroviruses, rotavirus, hepatitis A virus, and Norwalk-like virus (Hunt and Borchardt, 2002). As with the private well study, there was no correspondence to common indicators of sanitary quality. More surprising, there was no relationship between presence of surface water in the well water samples as determined by isotope analysis and virus occurrence. These findings suggest that viruses may be more common than expected in drinking water samples, although they do not indicate whether the viruses are viable, are inactivated through

disinfection processes, or result in illness in the community. Research into the link between virus occurrence and human health is needed to answer these questions.

GROUNDWATER DRAWDOWNS

Large-scale withdrawals of groundwater are adversely affecting the environment, economy and public health in large areas of Wisconsin. These drawdowns can cause the water level in wells, streams and wetlands to drop or cause them to dry up entirely. Drawdowns can also cause the levels of arsenic, radium (the precursor to radon) and salinity in drinking water to increase.

State-supported research is using groundwater information and groundwater flow models developed at a regional scale and adapting it for use at the local level. In Washington County, researchers are working with the city of Richfield to develop a protocol for quantifying its groundwater budget (Cherkauer, 2003). That information will be coupled with projected changes in land use and pumping demand to define the effects of several development scenarios on the community's water supply. Once developed, this protocol will enable other communities to decide how to best protect vital groundwater recharge areas, local streams, lakes and wetlands.

Another project is investigating the sources of high salinity and radium in the deep sandstone aquifer that supplies water to residents of eastern Wisconsin (Grundl and Bradbury, 2003). This project is examining in detail the chemistry of the groundwater and the rock formations of this complex aquifer and determining whether high pumping rates are raising salinity and radium levels. This will help city planners and water utility directors better understand the relationship between well operations and water quality in this region, and evaluate effects of urban growth on water supplies.

Other State-supported research is investigating the viability of aquifer storage and recovery (ASR) for Wisconsin, where excess water is stored in aquifers when demand is low and withdrawn for use when demand increases (Anderson, 2003). Computer models of groundwater flow and transport in ASR systems are being developed for two representative groundwater systems in Wisconsin. A better understanding of pumping rates, storage times and other factors that affect recovery efficiency of ASR systems will help guide future decision-making about using these systems in Wisconsin.

Chapter 6 -- DIRECTIONS FOR FUTURE GROUNDWATER PROTECTION

The Groundwater Coordinating Council (GCC) is directed by statute to include in its annual report a "list and description of current and anticipated groundwater problems" and to "set forth the recommendations of the Council" (s. 15.347(13)(g), Wis. Stats.). The purpose of this Chapter is to call attention to statewide priorities in the area of research, monitoring, policy, planning, and coordination related to groundwater and to provide direction to the GCC and its Subcommittees. In addition, this Chapter sets forth the Council's recommendations for future groundwater protection and management needs to state agencies, the Governor, the Legislature, and the citizens of Wisconsin.

PRIORITY RESEARCH & MONITORING NEEDS/ISSUES

- **Restore adequate funding for groundwater monitoring and research**: State budget cuts have severely limited the number and scope of groundwater research and monitoring projects that were funded in the past three fiscal years (see Table 3 in Chapter 2). DNR's funding for projects has been cut by over two-thirds since FY 02 and has been forced to use Federal dollars with high overhead costs. The UWS budget was cut by 10% in FY 04 and FY 05. DATCP and Commerce have been unable to fund new projects in the last three fiscal years. Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. The GCC encourages its member agencies and the Legislature to restore adequate resources for groundwater monitoring and research and to seek partnerships to leverage additional funds.

- **Investigate adverse impacts from groundwater withdrawals:** Recent headlines about high capacity wells, long term water supplies in the Fox River Valley, and severe drawdowns in southeastern Wisconsin have generated many questions about the effects of groundwater withdrawals on surface waters and long-term groundwater availability. There is a need to further quantify hydrographic relationships of surface and groundwater, as well as to develop tools to evaluate the impacts of withdrawals on surface waters. The GCC should continue to encourage research efforts that will provide information useful in addressing this issue.

- **Investigate extent and causes of naturally occurring substances in groundwater:** Continued problems of elevated arsenic, low pH, and other water quality problems in domestic wells exist over large areas of northeast Wisconsin. Additionally elevated sulfate, total dissolved solids, and radium have been found in some new deep municipal wells in the Lower Fox River Valley making the wells unusable. In some other existing deep wells as far south as Milwaukee the total dissolved solids have been steadily increasing over the years. These sulfate and TDS levels pose a problem for local water managers, and the origin of the dissolved solids is not completely understood. The State needs more information about the extent and causes of these problems in order to give advice to homeowners, municipalities, and well drilling contractors. The GCC should continue to encourage research efforts that will provide information useful in addressing these issues.

- **Evaluate occurrence of recently discovered groundwater contaminants:** Recent research conducted in Europe and the U.S. indicates that traces of pharmaceuticals (including

antibiotics and hormones) and pesticide breakdown products are common contaminants found in groundwater and surface water. In addition, studies have found evidence of viruses and other microbial agents in both municipal water supplies and domestic wells. Research is needed to determine whether these substances pose a threat to Wisconsin's groundwater resource, and also to human health.

- **Research land use management and its impact on the groundwater resource:** Additional research is needed on the effect of various land uses (e.g. urbanization and agriculture) on groundwater quality and quantity. For example, recently enacted stormwater infiltration rules help reduce runoff in urban areas, but the effects on groundwater quality are largely unknown. Similarly, agricultural nonpoint source rules require nutrient management plans that protect surface water quality, but may also improve groundwater quality. Projects must be managed in such a way as to maximize their relevance to state land use problems. This issue crosses agency lines and promises to be an important issue for years to come.

- **Identify potential groundwater quality issues associated with innovative water management tools.** Aquifer Storage and Recovery (ASR) and Enhanced Aquifer Recharge are two techniques that are being explored in Wisconsin and other parts of the world to address long-term water supply needs in water-limited areas. These tools may help communities meet water demands during peak use periods or help mitigate adverse effects of long-term water withdrawals. However, the long-term effects on water quality and aquifer geochemistry are relatively unknown, especially in areas with existing water quality issues (e.g. arsenic and radium). Research is needed on a variety of levels in order to evaluate whether these tools are appropriate for Wisconsin.

PRIORITY POLICY & PLANNING NEEDS/ISSUES

- **Address groundwater quantity management issues at both statewide and regional levels:** Groundwater quantity issues came to the forefront of public discussion in FY 04, with the development and passage of landmark groundwater quantity legislation, 2003 Wisconsin Act 310. This legislation has the potential to address needs identified by two recent forums, the 2001 Groundwater Summit and the Waters of Wisconsin Initiative. Common themes included the need for a statewide management plan for water quantity, water conservation, high capacity well reform, reevaluation of water pricing structures and regional approaches to water quantity issues. The GCC will continue to serve as a resource for addressing scientific and technical questions related to groundwater quantity and facilitate further dialogue among all parties on potential approaches and solutions.

- **Provide resources to local governments for Smart Growth/Comprehensive Planning activities**. Recent legislation has required local units of government to develop a comprehensive plan by 2010 in order to undertake land use activities. This plan must address nine elements, including natural and agricultural resources, housing, utilities, and land use. This planning process presents a unique opportunity to address and implement groundwater protection at the local level. Through the Local Government Subcommittee, the GCC will seek ways to assist local communities in their planning efforts to encourage groundwater protection.

- **Find solutions to groundwater nonpoint pollution problems**: A 2002 DATCP report indicates that 37.7% of wells contain a detectable level of at least one herbicide or herbicide metabolite and 11.1% of Wisconsin's wells still contain detectable atrazine residues. In addition, 14% exceed the nitrate standard. These rates are substantially higher in agricultural

areas. More work is needed to determine how far Wisconsin groundwater will deteriorate without a substantial change in farming practices, and what practices will sustain both agriculture and groundwater quality. The GCC will support the agencies and the UWS in obtaining information pertinent to the human health implications of consuming nitrate and pesticide contaminated groundwater and the effect of discharge of this groundwater on surface waters and their ecosystems.

PRIORITY COORDINATION NEEDS/ISSUES

- **Support implementation of a Statewide Groundwater Monitoring Strategy:** Chapter 160 of the Wisconsin Statutes requires the DNR to work with other agencies and the GCC to develop and operate a system for monitoring and sampling groundwater to determine whether harmful substances are present (s. 160.27, Wis. Stats.). In FY 04, several agencies worked together to develop a Statewide Groundwater Monitoring Strategy to guide agency monitoring efforts for the next ten years. The GCC encourages agencies, the university, and federal and local partners to implement the various components of the strategy and to seek funding to support its implementation.

- **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited from the consistent educational messages that have been endorsed by the GCC. Through the Education Subcommittee, the GCC will continue to provide its leadership and assistance to state agencies that provide educational materials to the public. In 2004, the Subcommittee will launch a "Groundwater Information Network" with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection. Priorities include promoting water stewardship and awareness of water quantity issues, finding innovative ways to encourage testing of private water supplies, and providing materials for local communities to support comprehensive planning activities.

- **Promote consistency between the agencies on data management issues:** Through the DNR's groundwater data system (GRN) and the GCC's Directory of Groundwater Databases, state and local government agencies now have more convenient access to groundwater data. This effort must be maintained by continuing to identify data needs and ways to make data easily accessible. Data consistency must be promoted by use of common geographical locators and minimum data elements for use in a GIS environment. The GCC will continue to provide leadership and communication on data management through its subcommittees. This continued effort displays the GCC's commitment to management of the resource through sound scientific methods.

- **Ensure access to findings of groundwater research and monitoring projects:** More than 120 summaries of groundwater-related monitoring and research projects funded through the Wisconsin Groundwater Research and Monitoring Program are now available online. In FY 04, the WRI Water Resources Library digitized and put online the full text of most WRI and selected DNR project final reports. To maintain and enhance this resource it will be important to add new summaries and reports as they become available, create a more visually appealing set of front-end pages for the site, and publicize the web site location and content more widely. Another WRI initiative is the development of topical fact sheets to summarize research and monitoring findings relative to important groundwater issues in the state. The GCC supports development of these fact sheets and resources and will continue to promote ways to translate sound science into effective groundwater management strategies.

APPENDIX A:

Statutory Language Relating to the Groundwater Coordinating Council

Chapter 15, Wis. Stats., "Structure of the Executive Branch"

15.347 (13) Groundwater Coordinating Council.

(a) *Creation*. There is created a groundwater coordinating council, attached to the department of natural resources under s. 15.03. The council shall perform the functions specified under s. 160.50.

(b) *Members.* The groundwater coordinating council shall consist of the following members:
1. The secretary of natural resources.
2. The secretary of commerce.
3. The secretary of agriculture, trade and consumer protection.
4. The secretary of health and family services.
5. The secretary of transportation.
6. The president of the University of Wisconsin System.
7. The state geologist.
8. One person to represent the governor.

(c) *Designees*. Under par. (b), agency heads may appoint designees to serve on the council, if the designee is an employe or appointive officer of the agency who has sufficient authority to deploy agency resources and directly influence agency decision making.

(d) *Terms*. Members appointed under par. (b) 8 shall be appointed to 4-year terms.

(e) *Staff*. The state agencies with membership on the council and its subcommittees shall provide adequate staff to conduct the functions of the council.

(f) *Meetings*. The council shall meet at least twice each year and may meet at other times on the call of 3 of its members. Section 15.09 (3) does not apply to meetings of the council.

(g) *Annual report*. In August of each year, the council shall submit to the head of each agency with membership on the council, the governor and the chief clerk of each house of the legislature, for distribution to the appropriate standing committees under s. 13.172 (3), a report which summarizes the operations and activities of the council during the fiscal year concluded on the preceding June 30, describes the state of the groundwater resource and its management and sets forth the recommendations of the council. The annual report shall include a description of the current groundwater quality in the state, an assessment of groundwater management programs, information on the implementation of ch. 160 and a list and description of current and anticipated groundwater problems. In each annual report, the council shall include the dissents of any council member to the activities and recommendations of the council.

Chapter 160, Wis. Stats., "Groundwater Protection Standards"

160.27 Substances in groundwater; monitoring.

(1) The department [of natural resources], with the advice and cooperation of other agencies *and the groundwater coordinating council*, shall develop and operate a system for monitoring and sampling groundwater to determine whether substances identified under s. 160.05 (1) are in the groundwater or whether preventive action limits or enforcement standards are attained or exceeded at points of standards application.

160.50 Groundwater coordinating council.

(1) GENERAL FUNCTIONS. The groundwater coordinating council shall serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management. The groundwater coordinating council shall advise and assist state agencies in the coordination of nonregulatory programs and the exchange of information related to groundwater, including, but not limited to, agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and the appropriation and allocation of state funds for research.

(1m)FUNDING FOR GROUNDWATER RESEARCH**.** The groundwater coordinating council shall advise the secretary of administration on the allocation of funds appropriated to the board of regents of the University of Wisconsin System under s. 20.285 (1) (a) for groundwater research.

(2) SUBCOMMITTEES. The groundwater coordinating council may create subcommittees to assist in its work. The subcommittee members may include members of the council, employes of the agencies with members on the council, employes of other state agencies, representatives of counties and municipalities and public members. The council shall consider the need for subcommittees on the subjects within the scope of its general duties under sub. (1) and other subjects deemed appropriate by the council.

(3) REPORT. The groundwater coordinating council shall review the provisions of 1983 Wisconsin Act 410 and report to the chief clerk of each house of the legislature, for distribution to the legislature under s. 13.172 (2), concerning the implementation of the act by January 1, 1989.

Chapter 281.34, Wis. Stats., "Groundwater Withdrawals"

(10) Research and monitoring. To aid in the administration of this section the department [of natural resources] shall, *with the advice of the groundwater coordinating council*, conduct monitoring and research related to all of the following:

(a) Interaction of groundwater and surface water.

(b) Characterization of groundwater resources.
(c) Strategies for managing water.

APPENDIX B: Meeting Minutes

WISCONSIN GROUNDWATER COORDINATING COUNCIL
MEETING MINUTES – AUGUST 20, 2004
WISCONSIN DEPARTMENT OF TRANSPORTATION

Members Present: Todd Ambs (DNR), Nick Neher (DATCP), Fran Garb (UW-System), Jamie Robertson (WGNHS), Dan Scudder (DOT), Henry Anderson (DHFS), Bernie Mattson (Commerce)

Others Present: Jeff Helmuth, Laura Chern, Dave Johnson, Rich Roth, and Mike Lemcke (DNR), Randy Zogbaum (DATCP), Jim Hurley (UW Aquatic Sciences Center), Ken Bradbury (WGNHS), Nancy Quirk (WWA), Ed Morse (WRWA), Daniel Feinstein and Chuck Dunning (USGS)

The meeting began at 10:00 AM.

1. **General business** – Introductions were made. Meeting minutes from May 13th were approved as written.

2. **Education Subcommittee report -**Randy Zogbaum highlighted several ongoing activities of the Education Subcommittee.
   - The Subcommittee has welcomed Elizabeth Truslow-Evans as the new representative from the DHFS.
   - Groundwater Information Network (formerly the Email Advisory Group) - The Subcommittee has changed the name of this project to more accurately represent the purpose of the group. The purpose of the group is to provide an avenue to communicate with a wide variety of groups working on groundwater education rather than "advising" the Education Subcommittee. The Subcommittee also developed a response form to gauge interest of the groups that are invited to be part of the network and to provide feedback on topics for, or improvements to, the network.
   - Wisconsin Groundwater Directory - Randy handed out a copy of the nearly complete directory. The Subcommittee thanks Kevin Masarik, groundwater educator at the Center for Watershed Science and Education for putting this document together! The Subcommittee reported that the final version will be housed on the UWSP-Groundwater Center web site (http://www.uwsp.edu/cnr/gndwater/info/index.htm). It will then be linked from the GCC web site, the DNR web site, and various others.
   - Arsenic Testing and Education Activities -The Subcommittee decided to take up the topic based on discussion at the May GCC meeting. Kevin Masarik is working with Madeline Gotkowitz from WGNHS to identify "hot spots" around the state to focus testing. He has sent letters to 15 counties to offer assistance in developing a sampling program. Elizabeth Truslow-Evans shared her experience that, even though people may be willing to test for arsenic in their wells, they are not likely to change their water use based on the results. The Subcommittee decided that two messages should be the focus of future arsenic education activities:
     - Statewide testing is important due to the variability and uncertainty about locations where arsenic might be an issue.
     - Getting people to test for arsenic once is good, but testing annually would be better.

3. **Monitoring and Data Management Subcommittee report -** Jeff Helmuth reported on

subcommittee activities including:

- Priorities for FY06 Solicitation for Groundwater Proposals - Due to the declining availability of funds Jeff had asked the subcommittee for input on how DNR's priorities are specified in the solicitation. Jeff reported that the subcommittee's advice was: 1) to narrow the list of agency priorities to a brief list of specific projects or information needs, rather than a long list of topics, and 2) to have more agency input to the UW System priorities through the Groundwater Research Advisory Council (GRAC).
- Water Use Reporting - Cheryl Buchwald (USGS) solicited ideas from the group for improving data collection efforts for the next (2005) Water Use in Wisconsin poster report. Jeff Helmuth and Bill Furbish (DNR) are working with her on documenting how this has been done in the past and revising for the future.
- Statewide Groundwater Monitoring Strategy - Laura Chern helped the subcommittee identify two areas for its involvement in implementing the strategy: Data Mining (making use of existing data to guide monitoring activities) and Data Management (dealing with new data that is collected). Both will require improved data sharing capabilities among agencies. Implementation efforts will focus on:
- Assigning unique well numbers to new wells that are sampled
- Examining whether alternative locational information could be used as a unique identifier when unique well numbers are not used
- Re-examining whether there should be one common groundwater database, or a common portal or means of access (such as a web-based mapping application) that can be used to access all the databases
- Maintaining the Directory of Groundwater Databases.

4. **Groundwater Monitoring Strategy -** Laura Chern presented the latest draft of the statewide groundwater management strategy (http://dnr.wi.gov/org/water/dwg/gcc/draftmonitor.pdf). She noted that the Groundwater Summit and Waters of Wisconsin report included recommendations for developing a groundwater monitoring strategy. A year ago, DNR formed an interagency committee to assist in this effort. The group looked at existing monitoring programs and spent time looking at other states to determine what we wanted Wisconsin's strategy to look like. The draft strategy is meant to be a framework to help guide state agencies in enhancing and implementing their monitoring efforts over the next 5-10 years. It outlines specific goals and components of a groundwater monitoring network, and suggests ideas for implementation, partners, and funding. Some of the key elements of the strategy are that groundwater monitoring programs be flexible and adaptable to future needs, that data sharing among agencies is promoted, and that monitoring information is made easily available to the public.

   The GCC thanked the work group for their efforts, noting that agencies are all spending money on monitoring and better coordination would make that money go further. Todd Ambs noted that the strategy ties into many other efforts and that there is a need to look at a broader strategy for the State's water monitoring and data collection. He added that there is an opportunity with the new Groundwater Quantity Legislation to do adaptive management with respect to data management and that the monitoring strategy should be similar in that it should always be a draft. Laura pointed out that one of the key roles that the GCC could play in implementing the strategy was to help resolve lingering issues with the use of Unique Well Numbers (UWN) to enable sharing of data among agencies. *The GCC agreed to facilitate resolution of the UWN issue by the summer of 2005.*

5. **Potential Monitoring Well in SE Wisconsin -** On a related note, Mike Lemcke mentioned that he had become aware of a deep well in a DOT right-of-way in Waukesha County that the WGNHS was interested in converting into a monitoring well. With the completion of the Groundwater Monitoring Strategy, Mike pointed out that this represented a good opportunity to add a critical well to our strategy. There was general agreement that if this well was appropriately located that it would make sense to make sure that it was converted to a monitoring point. Dan Scudder said that Central Office DOT could help make this happen.

6. **2004 Report to the Legislature -** Mike Lemcke provided a handout summarizing the major changes to the 2004 GCC Report to the Legislature, due at the end of August. The GCC supported the decision to make the appendices available on the website and on CD and to minimize the amount of printed paper. The complete report will be available on the GCC website in September (http://dnr.wi.gov/org/water/dwg/gcc/rtl/gccreport.htm). Todd Ambs said that there would be a need for an Executive Summary-type document in the coming months for discussions with new Groundwater Advisory Committee appointees and for use in spending authority and position authorization requests.

7. **FY06 Solicitation for Groundwater Proposals -** Jim Hurley from the UW-WRI presented a draft timeline for this year's Joint Solicitation. At last year's GRAC meeting, the council felt that it would be better to complete the entire review and panel process by the end of February. Several investigators have contacted WRI in the past about the fact that the "signing date" for graduate students is in mid-March and PI's usually need to know if graduate student assistantships are available. In order to meet this deadline, the call deadline for proposals will be November 15, 2004, the GRAC meeting either the 17th or 18th of February, 2005 and the GCC meeting (for approval of funding package on Friday, February 25, 2005. GCC agreed with the schedule.

8. **Aquifer Storage and Recovery (ASR) Pilot Studies -** Rich Roth and Dave Johnson of WDNR presented on the status of the ASR pilot studies in Wisconsin. ASR was first proposed in 1996 as an option to economically meet peak demand needs for a water system. The DNR gave the go ahead for a pilot study at Oak Creek and began working on rules for the operation of ASR wells in the state. Four basic principals of ASR operation were established:
   - Injected water must meet federal and state drinking water standards.
   - Recovered water must meet federal and state drinking water standards.
   - Water stored around an ASR well must meet federal and state drinking water standards and cannot exceed groundwater enforcement standards at any property boundary.
   - At the end of each ASR cycle, any water remaining in the "displacement zone" around an ASR well must not exceed the Enforcement Standards for Fe, Mn, Cu, Pb, fluoride, nitrate, nitrite, asbestos, and trihalomethanes (THMs), or the Preventive Action Limits for other substances.

   Testing began at Oak Creek in 1999 and at Green Bay in 2002. The department and their external advisory committee had concerns with four key areas:
   - Introduction of contaminants into the aquifer
   - Fate of disinfection byproducts (THMs)
   - Geochemical reactions in the aquifer
   - Hydraulic control

While the first concern is handled by the Safe Drinking Water Act, Rich and Dave presented charts and data to show how each of the other concerns were valid. Pressure transducer data and breakthrough of injected water at monitoring points illustrated the lack of hydraulic control of the systems as designed. Graphs of THMs showed that they are not degrading as predicted and how they are building up in the system. Geochemical reactions at Green Bay included the release of arsenic, nickel, cobalt, gross alpha and uranium due to the high dissolved oxygen in the injected water. Both cycles at Green Bay were unsuccessful at producing any drinkable water. At Oak Creek the injection water quality has caused the dissolution of manganese to levels above groundwater standards. Changes to the operation of the system must be made if the long-term viability of the system is to be assured.

Dave and Rich noted that these studies have demonstrated that there is a delicate balance in groundwater systems that must be taken into account in the design and operation of ASR wells. Future ASR pilot studies will be required to do more thorough monitoring and prove geochemical stability before operational permits will be granted.

9. **Groundwater in the Great Lakes Basin** – Daniel Feinstein, hydrogeologist with the USGS Wisconsin District based in Milwaukee, provided an overview of modeling results in southeastern Wisconsin that illustrate the role of groundwater pumping within the Great Lakes Basin. These findings are summarized on a new website developed with funding from the Great Lakes Protection Fund (http://wi.water.usgs.gov/glpf/). Daniel made the following three points:

- **WATER FROM LAKE MICHIGAN IS *NOT* PUMPED OUT OF DEEP WATER SUPPLY WELLS IN SOUTHEASTERN WISCONSIN.** It is true that the direction of flow in the deep part of the ground-water flow system has reversed over the last 100 years so that ground water now flows away from Lake Michigan. However, water that today moves from Lake Michigan into the underlying ground water will require many hundreds, if not thousands, of years before it could ever reach a well pumping in Waukesha County.

  Some water is entering deep wells in Waukesha County from the east. However, it originated to the west as recharge in Waukesha or one of the surrounding Counties. The ground-water flowed east toward the Lake over hundreds of years of travel, and then curled back in response to pumping since around 1950.

- **PUMPING HAS REDUCED THE AMOUNT OF GROUND WATER THAT ENTERS LAKE MICHIGAN.** Pumping has reduced the amount of ground water that flows directly to the Lake across the coastline or flows indirectly to it as part of river discharge. Calculations indicate the reduction is on the order of 8.5%. Some of this diverted water is eventually returned to the Lake through sewers and water-treatment plants, but the location, timing, and quality of the return flow is different than what it was under natural conditions.

- **THE GLOBAL EFFECT OF GROUND WATER PUMPING ON THE LAKE MICHIGAN WATER BUDGET IS VIRTUALLY NIL.** While the reduction in lake-bound ground-water discharge due to pumping is not an insignificant part of the total discharge from southeastern Wisconsin, it is very small (about one part in 4000) when compared to the other items in the budget of the Lake.

Todd Ambs noted that 8 States and 2 Provinces are all watching the Waukesha situation with interest as the Great Lakes Annex public comment sessions are in September and the current draft document defines a basin by its surface water divides.

10. **The meeting was adjourned at 12:00 PM.** The next meeting is scheduled for November 12, 2004, 12:00 noon - 3:00 PM, at DATCP, 2811 Agriculture Drive in Madison.

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
MEETING MINUTES – NOVEMBER 12, 2004
WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

Members Present: Todd Ambs (DNR), Nick Neher (DATCP), Anders Andren for Fran Garb (UW-System), Jamie Robertson (WGNHS), Dan Scudder (DOT), Mark Werner for Henry Anderson (DHFS), Bernie Mattson (Commerce)

Others Present: Jeff Helmuth and Tim Asplund (DNR), Jim Hurley (UW Aquatic Sciences Center), Ken Bradbury (WGNHS), Nancy Quirk (WWA), Ed Morse (WRWA), Kevin Masarik (UWSP Groundwater Center), Jim Peterson (UW Extension), Bob Pearson (DOT), KG Karthikeyan and Joel Pedersen (UW Madison)

The meeting began at 12:10 PM.

1. **General business** – Introductions were made. Meeting minutes from August 20th were approved as corrected and distributed with the meeting packet.

2. **Education Subcommittee report -**Kevin Masarik summarized the October 6th meeting of the Subcommittee and highlighted several ongoing educational activities being coordinated through the Groundwater Center at UW Stevens Point.
   - Oct. 6th meeting - Farm Technology Days reports, the status of various DNR groundwater publications, distribution of the Wisconsin Groundwater Directory, and educational messages related to pesticides in private well water and water conservation were on the agenda for the October meeting. One clarification was the use of the term "cumulative" rather than "synergistic" in discussing health effects of multiple pesticides at concentrations below health standards (see MDMS item below).
   - Teacher Workshops - Kevin noted that he, Dave Hart (WGNHS) and Dave Lindorff (DNR) would be leading 3 workshops for teachers on the use of the groundwater sand tank model this winter in Waukesha, Eau Claire, and Madison. A total of 24 models will be distributed to schools, with the cost of the models and workshop paid for through Wellhead Protection funds.
   - Groundwater Festival - The 3rd annual festival is being planned for Friday, May 6th in Eau Claire, again targeted towards 5th and 6th grade students and teachers. Sponsors are being sought for the event.
   - Groundwater Guardian program - Kevin noted that the statewide coordinator for this program was leaving and that funding for the position would be ending on July 1st. Some of the duties will be picked up by the Groundwater Center, but there will not be as much support for the communities involved in this program in the future.
   - Drinking water testing programs - Kevin reported that the Groundwater Center conducted 17 programs in 2004, possibly a record! He noted that the contacts made through these efforts might be a good way to recruit volunteers for citizen monitoring. Kevin is also working with Madeline Gotkowitz from WGNHS to identify areas outside the usual hot spots to target arsenic testing efforts. He has sent letters to 15 counties to offer assistance in developing a sampling program.

3. **Monitoring and Data Management Subcommittee report** - Jeff Helmuth reported on the following topics discussed at the Sept. 15th meeting of the Subcommittee:
   - Further evaluation of ELISA test kits for diamino-atrazine - A recent study conducted by the State Lab of Hygiene (WSLH) demonstrated that a new ELISA test kit for the

diamino metabolite of atrazine may hold promise as an improved screening tool for the presence of atrazine in well water. DATCP, DNR, the UWSP water laboratory and WSLH are analyzing historical data and collecting additional samples to confirm the results and develop guidance on the use of the tool.

- Multiple contaminants and health effects - The Subcommittee discussed the need for improved communication and guidance on the issuance of health advisory letters in cases where multiple contaminants (especially pesticides) are detected in a private well, but at concentrations below health standards. There are internal memos and informal correspondence between DNR and DHFS on this topic, but mostly in the context of VOCs in wells near petroleum contamination sites. The Subcommittee felt that this guidance should be revised and updated with involvement from DATCP and the Groundwater Center.
- Water Use Reporting - Jeff noted that the recent groundwater quantity legislation and Annex 2001 discussions have elevated the importance of collecting accurate information on water use. DNR and USGS are working together to improve calculations and estimates of water use for the next USGS report for the year 2005. Efforts are focused on understanding where numbers came from in the past and making improvements, using real data where possible.
- Monitoring Strategy and Data Sharing - As a result of the monitoring strategy, the Subcommittee has renewed discussion on data sharing issues and trying to resolve lingering barriers and difficulties that have prevented data sharing in the past. One decision that was made was to focus on how to improve data sharing from this point forward, rather than trying to solve problems connected with historical or existing databases.

4. **Planning and Mapping Subcommittee report** - Bob Pearson begin his report by handing out the latest Official Wisconsin State Highway Map, courtesy of DOT [Thanks Bob!]. Bob reported that the Planning and Mapping Subcommittee had met faithfully since the GCC was created 20 years ago, though its roles and membership have evolved with changing needs and technology. However, Bob noted that the Subcommittee hadn't been very active in the last 2 years, partly because of a significant amount of topical overlap with other subcommittees, as well as a lack of a clear role or function. Bob felt that the Subcommittee was at a crossroads and recommended 3 options for the Subcommittee 1) Dissolve and fold into other subcommittees; 2) Refocus, possibly on planning efforts at the state level; or 3) Remain "as is" as an incubator of ideas or meeting when needed. He then suggested that the GCC hear Tim Asplund's suggestion for an alternative Subcommittee structure before making a decision. Tim noted that Bob should be commended for his work as Chair of the Subcommittee and that he would be sure to keep Bob active on another subcommittee(s) if the Planning and Mapping group were to disband.

5. **Proposal for alternative subcommittee structure** - Tim Asplund provided a handout summarizing current subcommittee functions, activities, and responsibilities. He noted the overlap between many of the Planning and Mapping functions and other subcommittees, including Monitoring and Data Management (mapping, GIS), Education, and Local Government (Smart Growth, regional planning). He also pointed out the number of tasks assigned to the Monitoring and Data Management Subcommittee. As a way of spreading out the responsibilities and functions more evenly, as well as ensuring that the right people are meeting together, he suggested combining the Mapping functions of the Planning and Mapping Subcommittee with the Monitoring and Data Management Subcommittee, and the Planning functions with the Local Government Subcommittee. He also suggested the possibility of dividing the Monitoring and Data Management Subcommittee into a

Monitoring subcommittee that would be charged with overseeing and implementing the monitoring strategy and an Information Technology subcommittee that would oversee data management and sharing, GIS issues, and mapping. In response to the handout, Jeff Helmuth noted that the Monitoring group should still be involved in the Joint Solicitation review and Jamie Robertson noted that all of the Subcommittees needed to address quantity issues. *The GCC gave its support for the proposed changes, though suggested that Tim confirm them with the Subcommittee chairs before proceeding.*

6. **Quantity Subcommittee status -** Tim Asplund noted that the Quantity Subcommittee was not included in the handouts because of the uncertain status of this group. Todd Ambs stated that while the Subcommittee had not met recently, this topic was going to continue to be a big issue in the next couple of years and that he would certainly want the GCC to play a role in the discussions. Todd noted that the statutorily created Groundwater Management Advisory Council would be evaluating the implementation of the new statute and making recommendations for groundwater management areas. In addition, the DNR had recommended that one or two technical groups be formed to provide scientific and policy expertise to the Council. Todd noted that the Quantity Subcommittee could very well evolve into one or more of these technical advisory groups.

7. **FY06 Solicitation for Groundwater Proposals -** Jim Hurley from the UW Water Resources Institute reported on the status of this year's solicitation, which closed on Monday, November 15th. Jim noted that the proposal submission website was working well, with 20 proposals in the system as of the meeting date. He noted that there would likely be a good number of submissions this year, since several 2-year projects are wrapping up and there are more funds available [Ed. Note - 29 proposals were received by the deadline.] Jim noted that in the past, the WRI has asked the GCC to pre-approve the use of USGS base funding to support the second year of projects currently being funded through the WRI. Shifting these projects to USGS base funding would allow more new projects to be funded from the current solicitation. Pre-approval is needed because the annual budget request to USGS is due prior to the February GCC meeting. This year there are 4 projects eligible (3 of them at UW Madison), one of which was not fully funded during the first year. *Dan Scudder moved and Berni Mattsson seconded a motion to "pre-approve" the second year funding of all continuing projects, contingent upon satisfactory progress of these projects. The motion passed unanimously.*

8. **Southern Lake Michigan Water Supply Planning Consortium -** Ken Bradbury provided a brief overview of this group which is being coordinated through regional planning commissions based in northeastern Illinois, southeastern Wisconsin, and northwestern Indiana. The group was formed under the recognition that regional drawdowns of the sandstone aquifer cross state lines, as do potential technical and policy solutions. Ken has been involved with the group, which has been meeting 3-4 times per year. On February 15-16, 2005, the Consortium is sponsoring a joint policy and technical conference in Chicago called "Straddling the Divide: Water Supply Planning in the Lake Michigan Region." More information can be found at http://www.nipc.org/environment/slmrwsc/conferences/.

9. **Groundwater quantity legislation implementation -** Todd Ambs noted that DNR was currently seeking the needed positions and appropriations to begin implementing the new provisions of the groundwater quantity legislation. He also noted that the Groundwater Management Advisory Council created by the legislation would likely begin meeting sometime after the first of the year. At present, the Governor's appointees have been identified, but the changes in legislative leadership have delayed the remaining appointments.

Jeff Helmuth then noted that some efforts were underway informally to begin identifying information needs and sort out procedural issues in order to evaluate impacts of high capacity wells under the new provisions. Jeff also noted that the DNR identified several priorities in this year's solicitation to encourage proposals that would be helpful in implementing the legislation, such as an inventory of springs in Wisconsin.

10. **The Occurrence and Fate of Antibiotics in Soils and Wastewater** - KG Karthikeyan, of the UW Madison Department of Biological Systems Engineering, provided an overview of research that was supported by 2 grants obtained through the joint solicitation process. One project was devoted to screening potential wastewater sources that might impact groundwater for 5 classes of antibiotics, while the other (ongoing) project focused on the fate and transformation of 2 compounds that were identified in the screening process. There is considerable interest in these studies due to the fact that antibiotics are poorly absorbed, have known toxicity, and tend to be excreted from the user in an unchanged form. In addition, national surveys have detected antibiotic compounds in over half of the streams sampled. Some of the main findings of the screening project, which included waters from 8 different wastewater treatment plants, include:
    - The maximum concentration of soluble antibiotics detected were mostly < 1 ppb
    - A total of 8 (out of 25 tested) compounds were detected in samples, with 2 (tetracycline and sulfamethoxasole) showing up in all sites
    - Most sites had 3-5 different compounds
    - Most of the detects were from wastewater sources, though 2 monitoring wells had detects
    - Reduction of TSS in the wastewater treatment process corresponded to reduction in antibiotics

    The second study focused on elucidating the mechanisms contributing to persistence of antibiotics (tetracycline and ciprofloxacin) in the environment compared to other contaminants. KG presented several details of the study and concluded that sorption of these antibiotics is strongly pH dependent and that ligand dissolution is potentially an important pathway, particularly in soils with Al hydroxides.

11. **Interactions of Sulfonamide Antibiotics with Soil Constituents**- Joel Pedersen of the UW Madison Department of Soil Science continued with another component of the project currently being funded in conjunction with KG's project. Joel noted that sulfonamides are used heavily in animal husbandry and human therapy, and that they have been detected in many settings and studies involving groundwater, wastewater, land-spreading sites, and reclaimed wastewater. The focus of his work is evaluating the adsorption characteristics of sulfonamides to three types of clay minerals as a function of pH and comparing it to sorption mechanisms of natural organic matter (NOM). Joel noted that sulfonamides appear to be weakly absorbed by clay minerals, except at very low pH, and that surface hydrophobicity appears important for sorption ability. He also noted that sorption to NOM occurred at a much higher rate, though in typical soils the relative contribution of NOM would be low. Thus sulfonamides have the potential to be fairly mobile and reach groundwater. However, Joel noted that other mechanisms involving NOM might play a role in reducing mobility, including cross-coupling reactions in the presence of catalysts. He then presented a series of experimental results that suggest that humics have the potential to bind with sulfonamides and limit their mobility and bioavailability. This finding may have important implications for developing treatment processes.

12. **Agency Updates**:

- Nick Neher handed out a report from the DATCP laboratory examining the accuracy of 2 **do-it-yourself pesticide test kits** available to consumers. The results confirmed an earlier study performed by the WSLH that identified 2 problems with the kits: 1) neither kit detects metabolites of atrazine, which means that the kit cannot indicate if a water sample would meet the regulatory standard for atrazine in Wisconsin; and 2) the kits do not detect other pesticides of concern in Wisconsin, such as alachlor and metribuzin, even though it is marketed as a "pesticide" test kit. Nick said that he would contact the consumer protection bureau within DATCP to see what steps might be taken to correct this problem and/or inform consumers about the problems with these products.
- Mark Werner noted that several talks on **pesticide degradates** at the recent FASTRAC conference given by Wisconsin and Minnesota regulatory agencies attempted to send the message to EPA that this is an issue of concern to the states.
- Jim Hurley noted that the **Sea Grant Call for Proposals** was out, and that there was some overlap with the National Water Institutes for Research program in the context of Great Lakes and Annex 2001 issues.
- Ken Bradbury noted a new **water table mapping project** starting up in **Iowa County** and the pending move of the **WGNHS cutting repository** to a warehouse in Mt. Horeb. Ken also noted that he had been getting many inquiries about groundwater/surface water interactions in the outlying areas of Waukesha County, especially involving communities wanting to tap into the shallow aquifer system. Ken noted that it may be possible to extend some of the recent modeling efforts to this system, but that there was very little information on streamflows and lake levels in this area upon which to calibrate and verify models. This may be an area for increased research and monitoring attention in the future, especially if this is to be a groundwater management area.
- Berni Mattsson noted that the joint DNR/Commerce **Site Closure Study** had wrapped up its first year of collecting background data and doing a pilot study and would be expanding to 8 additional sites in the spring. She also noted that some updates to **Comm 47** dealing with reimbursement of property owners were in the works in response to comments from consultants.

13. **Nick Neher's retirement -** Todd Ambs noted that this was Nick Neher's last GCC meeting, as he was retiring in January after 31 years of service to the state. Nick has represented DATCP on the GCC since 1989. In recognition, Todd presented a Resolution of Appreciation from the GCC to Nick, and thanked him for his dedication to the GCC and "protecting Wisconsin's Buried Treasure." Nick remarked that he still thinks of the GCC as a model for state agencies working together to promote consistent messages and efficient use of state resources and hoped that it continued to be successful in the future. Cake was enjoyed by all.

14. **The meeting was adjourned at 3:15 PM.** The next meeting is scheduled for February 25, 2005, 12:00 noon - 3:00 PM, at the UW Aquatic Sciences Center, 1975 Willow Drive in Madison.

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
MEETING MINUTES – FEBRUARY 25, 2005
UNIVERSITY OF WISCONSIN AQUATIC SCIENCES CENTER

Members Present: Todd Ambs (DNR), Fran Garb (UW-System), Jamie Robertson (WGNHS), Dan Scudder (DOT), Henry Anderson (DHFS), Eric Scott for Berni Mattsson (Commerce), and Bruce Rheineck for Kathy Pielsticker (DATCP)

Others Present: Tim Asplund and Mike Lemcke (DNR), Jim Hurley and Anders Andren (UW Aquatic Sciences Center), Randy Hunt and Chuck Dunning (USGS), Randy Zogbaum (DATCP), Nancy Quirk (WWA), Ed Morse (WRWA), and Jeff Wilcox (UW Madison)

The meeting began at 12:00 PM.

1. **General business** – Introductions were made. Meeting minutes from November 12th were approved as distributed with the meeting packet. The GCC also affirmed Resolutions of Appreciation for two long-time Subcommittee members who retired this spring - Jim Peterson, Director of the UW Environmental Resources Center and Steve Born, professor of Urban and Regional Planning at UW Madison.

2 **Groundwater Advisory Committee (GAC) -** Todd Ambs reported that the first meeting of the Groundwater Advisory Committee had been scheduled for April 1st. The GAC was created by 2003 Wisconsin Act 310 to recommend management strategies for Groundwater Management Areas created by the legislation and to fill in and further define some of its concepts. As of the GCC meeting, 11 of 14 members of the GAC had been appointed. In addition, two science/planning work groups had been formed to help the GAC evaluate site specific impacts of high capacity wells and deal with regional planning and water management concepts. The GCC will have a formal link to the GAC through Todd Ambs, who serves as a member of both groups, as well as various subcommittee members who have been asked to serve on the science/planning work groups for the GAC. More information on the GAC: http://dnr.wi.gov/org/water/dwg/gac/index.htm.

3 **Subcommittee restructuring -** Tim Asplund provided an update on the GCC Subcommittee restructuring that was discussed at the November meeting. As approved by the GCC, the Planning & Mapping Subcommittee will no longer exist, with its functions and members combined with the Local Government and Monitoring & Data Management Subcommittees. At the November meeting, the GCC had also discussed creating separate Monitoring and Information Technology Subcommittees. In consultation with the chair of the MDMS, the Subcommittee will remain together, but the tasks will be divided between two work groups focused on monitoring and data management/mapping topics. Tim handed out a table showing the new Subcommittee structure, functions, and membership based upon these changes. The new Subcommittee titles are Education, Research, Monitoring & Data Management (divided into Monitoring and Data Work Groups), and Local Government & Planning.

4. **Education Subcommittee report -** Randy Zogbaum provided a brief overview of the January Education Subcommittee meeting, noting the following 2 items:
   - The *Groundwater Information Network* is now in place, with 7 different groups on the distribution list. The idea of this network is to make connections between the GCC and non-state affiliated groups engaged in groundwater educational activities. This will be accomplished through creating a point of contact through the Education Subcommittee and

sharing of agendas and minutes. This idea was first suggested at the Groundwater Summit held in 2001.

- The Subcommittee continues to discuss ways to improve communication and educational messages about pesticides and nitrate in well water. Randy noted that one forum that may be overlooked for communicating messages is in the context of public hearings on various state regulatory activities.

Randy also noted that the Education Subcommittee would miss Jim Peterson's presence and leadership. Jim had been a faithful member of the Subcommittee almost since its inception, and was one of the most thorough and reliable editors and proofreaders of agency publications reviewed by the Subcommittee. Jim also played a key role in developing the groundwater sand tank model that is now mass produced by UW Stevens Point students and in over 125 schools around the state through the annual teacher workshops coordinated by WGNHS, the Groundwater Center, and WDNR. Jim was also a great spokesperson for UW Extension on groundwater topics in numerous public forums, workshops, meetings, etc. Fran Garb agreed to work on getting a new UW System representative for the Education Subcommittee.

5. **FY06 Solicitation for Groundwater Proposals -** Jim Hurley summarized the FY06 solicitation process, which closed on November 15, 2004. 29 projects were submitted, 28 of which were eligible for UW System funding. A total of $740,703 was requested for first year funding (with fringe benefits excluded), ranging between $12,000 and $47,000 per project. Each proposal was sent out to at least three different external peer reviewers, as well as the Research Subcommittee and Monitoring Work Group of the GCC. The GCC groups scored each proposal separately for UW System and DNR funding. The Groundwater Research Advisory Council (GRAC) received a final list of projects ranked by an overall score consisting of 75% external review average scores and 25% GCC average score, along with a synopsis of reviewer comments. The GRAC met on Friday, February 18 to discuss the proposals and make a recommendation for UW System Groundwater Research Plan.

6. **Approval of UW System Groundwater Research Plan -** Jim provided a handout detailing the proposed UW System Groundwater Research Plan for FY06. He noted that 4 projects were continuing from FY05. Two of these projects were shifted to USGS matching funds as approved by the GCC at the November meeting, leaving approximately $197,500 available for new projects after removing administrative costs and a $20,000 UW System budget cut. The GRAC selected 8 projects for funding based upon this expected funding level, the external and GCC subcommittee reviews, and the GRAC's assessment of the intent of UW System groundwater research funds. The GRAC authorized Jim to work with Randy Hunt, the Chair of the GRAC to trim $6000 from the budgets of these 8 projects to match the available funding level. Cuts were applied to faculty salaries, supplies, or travel in order to maintain graduate student funding. Jim asked for the GCC' s consent to move forward with the research plan and endorse the solicitation and review process for FY 06. *Fran Garb moved the acceptance of these recommendations and affirmed that they are consistent with the purpose of the funds. Henry Anderson seconded the motion and it carried unanimously.*

7. **Discussion of proposal solicitation and review process -** Randy Hunt, chair of the GRAC, brought up two issues for the GCC to consider based upon the recent GRAC deliberations. Because of the increasingly tight funding situation and large number of high quality proposals, the GRAC experienced difficulties in making the final decision about which projects to fund. One of the biggest issues was determining whether proposals met the definition of "groundwater research" in the context of the solicitation criteria and priorities.

The other was the potential for conflict of interest among GRAC members who also had proposals submitted for consideration. The current practice is for PI's to excuse themselves from the room when their proposal is being discussed. Randy asked the GCC to provide feedback on these two topics, as well as a process for addressing these issues.

The GCC discussed these issues at length. In terms of the definition issue, there was general consensus that it would be difficult and limiting to try to define what constitutes groundwater research in the solicitation. Instead, the GRAC should be clearer about its research priorities. One option would be to target certain priorities that rotate from year to year. Also, the GCC could play a more active role in shaping UW's research priorities to reflect agency needs, as it has traditionally done for the DNR. On the conflict of interest issue, the GCC acknowledged the need for people with expertise to sit on the GRAC, and that it would be difficult to exclude active researchers. However, there were strong sentiments that PI's with submitted proposals for a given year should not participate in the final decision-making (i.e. the GRAC meeting).

Randy will ask for additional feedback at the May GCC meeting to bring to the GRAC for a summer meeting. Also, Tim noted that the GCC Research Subcommittee would be meeting to evaluate priorities this spring or summer with possible recommendations for the GCC and GRAC to consider.

8. **Straddling the Divide: Water Supply Planning in the Lake Michigan Region -** Chuck Dunning provided an update on this conference which brought together technical and policy/planning experts from the three states bordering southern Lake Michigan to deal with groundwater pumping and supply issues in NE Illinois and SE Wisconsin. Seven people from Wisconsin were on the planning board (out of 16) and 5 presented talks. Plenary topics included a "symphonic approach to water management," case studies on the Edwards Aquifer and Atlanta area, water and cities, and regional supply issues. The key success of the meeting was to have regional planning commission folks talking to technical experts. Jim Hurley noted that lots of the technical talks were based on Joint Solicitation funded research in Wisconsin. More information can be found at http://www.nipc.org/environment/slmrwsc/conferences/.

9. **USGS Great Lakes Water Availability Pilot Study -** Randy Hunt reported that the USGS has received funding for a new study of water availability in the Great Lakes Basin. Randy and Daniel Feinstein of the Wisconsin District will be involved in groundwater recharge and modeling aspects. Randy noted that though funding came up fairly quickly, it will be helpful to leverage funds from States. The USGS wants State input and involvement, even though there may not have been a lot of input up front. This will be a 5-year project and will be up and running in the next few weeks. More details at http://www.usgs.gov/budget/2006/wateravail021405.pdf

10. **Diamino-atrazine ELISA evaluation -** Bruce Rheineck reported on a continuing interagency effort to improve upon a low-cost screening test for detecting atrazine in well water. The current "triazine screen" does not pick up all of the metabolites that make up Wisconsin's health standard. With DNR funding, the State Lab of Hygiene evaluated a new test kit designed to detect diamino-atrazine metabolite with well water samples collected by DATCP. The initial results seemed promising, with both better accuracy and fewer false negatives by using both tests simultaneously. Another benefit would be to help DATCP focus GC efforts where needed most. However, the cost of the screening test would almost double (from $25 to $45). DATCP, DNR, the State Lab, and the UW Stevens Point water testing lab

are gathering more data to establish guidelines for using both tests, as well as to decide whether the increased cost would be a barrier to people choosing to sample their water.

11. **DNR Water Monitoring Strategy** - Todd Ambs reported that the DNR had recently compiled a statewide water monitoring strategy, which lays out a framework for all types of water monitoring that occur in the state – groundwater and surface water - and includes all agencies and groups that collect water information. One of the challenges is to integrate targeted monitoring for regulatory purposes with baseline monitoring for fisheries and habitat assessment. The groundwater piece was in some ways the hardest to integrate because of lack of funds, but also the easiest because of past GCC and interagency efforts. Todd noted that citizen-based monitoring was a key feature of the strategy and that funding was being targeted to boost these efforts. The DNR has posted the strategy on the following website: http://dnr.wi.gov/org/water/MonitoringStrategy_13_V1WEB_2-4-05.pdf

12. **Monitoring and Predictive Modeling of Subdivision Impacts on Groundwater** - Jeff Wilcox, a graduate student in the UW-Madison Department of Geology and Geophysics, presented an overview of this Joint Solicitation funded project which is part of a 10-year groundwater monitoring effort involving a new unsewered subdivision in Dane County. The impetus behind the study is to assess impacts to groundwater of homes using private wells and "alternative" onsite wastewater treatment at the subdivision scale. Initial results have shown that nitrate and chloride levels are fairly elevated in background samples and are highly variable – both spatial and temporally. Thus it may be difficult to use these constituents as tracers or indicators of septic input. The focus of the project currently is on developing methods and screening tools for detecting "emerging contaminants" – PCPs, antibiotics, pharmaceuticals - that may be unique to human sources. Some of the questions the study will address: Are these emerging contaminants a concern from septic systems? Do they reach the water table or are they treated? What is the impact to surface water through groundwater flow system? The sampling effort includes septic effluent, monitoring wells & lysimeters near systems, and modeling of transport processes. More details (maps, photos, results) can be found on a web page devoted to the project: http://www.geology.wisc.edu/~hydro/SV/Index.htm.

13. **Agency Updates:**
    - DHFS: Henry Anderson noted that the budget has caused some reorganization and restructuring of groundwater functions within the agency.
    - DATCP: Bruce Rheineck called attention to upcoming public hearings on nutrient management standards (ATCP 50), and livestock facility siting (ATCP 51), noting that the new rules will include phosphorus as well as nitrate.
    - Commerce: Eric Scott reported that the agency had received 70+ pages of public comment on revisions to PECFA reimbursement rules (Comm 47), and that revisions to the storage tank rule (Comm 10) were also in progress.
    - WRI: Anders Andren is heading back to Washington to encourage lawmakers to reinstate funding for the national network of Water Resources Centers (WRCs). He is also leading an effort to develop a national plan for the WRCs, which will respond to the National Academy of Sciences report that identified water resources research needs. Jim Hurley noted that the WRI was sponsoring an international conference on mercury in August 2006 and would be publishing a new newsletter called Aquatic Sciences Chronicle jointly with the Sea Grant program.
    - DOT: Dan Scudder noted that his agency was also in the midst of reorganization and budget talks

- DNR: Todd Ambs reported that the Governor's budget included 5 new groundwater positions, and that the agency hoped to increase this to 9. Todd also noted that a revised Annex agreement was close, with one more round of public comment planned. Some of the major sticking points are regional review, complexity, and weak water conservation provisions. He noted that the next iteration will be in final form – either it will go forward as is or will die. Unfortunately the diversion issue is driving it, not consumptive use within the Great Lakes basin.

13. **The meeting adjourned at 3:15 PM.** The remaining meetings for 2005 will be as follows:

- May 13, 2005, 12:00 noon - 3:00 PM, at the WGNHS, 3817 Mineral Point Road
- August 12, 2005, 10:00 AM - 1:00 PM, at a location TBD (hosted by DNR)
- November 11, 2005, 12:00 noon - 3:00 PM, at WisDOT, 4802 Sheboygan Avenue

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

WISCONSIN GROUNDWATER COORDINATING COUNCIL
DRAFT MEETING MINUTES – MAY 13, 2005
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

Members Present: Mike Lemcke for Todd Ambs (DNR), Dan Scudder (DOT), Berni Mattsson (Commerce), Anders Andren for Fran Garb (UW-System), Ken Bradbury for Jamie Robertson (WGNHS), Liz Truslow-Evans for Henry Anderson (DHFS), and Jim VandenBrook for Kathy Pielsticker (DATCP)

Others Present: Tim Asplund and Jeff Helmuth (DNR), Jim Hurley (UW Aquatic Sciences Center), Randy Hunt and Jason Smith (USGS), Randy Zogbaum (DATCP), Ed Morse (WRWA), and George Kraft (UW Stevens Point)

The meeting began at 12:00 PM.

1. **General business** – Introductions were made. Meeting minutes from February 25th were approved as distributed with the meeting packet.

2. **Monitoring and Data Management Subcommittee (MDMS) report -** Jeff Helmuth reported that the full Subcommittee had recently met to discuss its new charge under the revised GCC subcommittee structure. In the future, meetings will alternate between a monitoring and a data management focus, with members divided between two corresponding work groups. Additional topics discussed at the meeting included DNR's water monitoring strategy, enhancing information about quantity in the groundwater monitoring strategy, compiling data for a nitrate report, follow-up to the diamino-atrazine ELISA study, and agency updates. Jeff also reported that Jason Smith of the USGS had taken the place of Chuck Dunning on the MDMS. Jason will be working with the observation well network and the USGS's water use report. Jeff expressed his thanks to Chuck for all of his past support of the Subcommittee. The next meeting is scheduled for June 8, 2005.

3. **Education Subcommittee report -** Randy Zogbaum provided a few updates on activities of the Education Subcommittee and highlights from the April meeting:
   - The Groundwater Information Network email distribution list is up and running and beginning to generate some dialogue with non-state partners. Jeffrey Potter of the Biodiversity Project indicated interest in pursuing a plan to look at groundwater educational needs in partnership with state agencies, the UW System, and nonprofits. He will be attending the next Education Subcommittee meeting on July 6th at UW Stevens Point to present his ideas.
   - Lori Severtson, with the UW School of Nursing, is working on a post-doctoral research project to develop a web-based color-coded scale to help well owners visualize and evaluate their well water test results. She presented her ideas to the Subcommittee in April and will be keeping the group updated on her project. At this point, she is looking for funding and an appropriate long-term host for the website.
   - The 3rd Groundwater Festival was held in Eau Claire on May 6th and was again well attended and received by participants. About 500 5th and 6th grade students and their teachers learned about groundwater science, protection activities, water conservation, and many other topics. The event was facilitated by the UWSP Groundwater Center and the Eau Claire Groundwater Guardians and led by students from UW Eau Claire and many past and present GCC Subcommittee members!
   - Ken Genskow has joined the Subcommittee as the UW Extension representative, replacing Jim Peterson. In addition, Tom Braun has replaced Lynita Docken as the

Commerce representative.

4. **Local Government and Planning Subcommittee (LGPS) report -** Jim VandenBrook reported that the Subcommittee had recently added "Planning" to its title and purview, as well as adding a few new members from the former Planning and Mapping Subcommittee. The LGPS met in early May with a focus on groundwater protection and comprehensive planning. Many good ideas were presented and discussed, but Jim noted that recent action by the legislature's Joint Finance Committee to remove funding for comprehensive planning might diminish efforts in the future. The LGPS also briefly discussed recent activities related to groundwater quantity, but would be taking up this topic more in depth at its next meeting in September. One area that the LGPS may consider is water conservation planning and incentives at the local level and the role of water utility rate structures. Jim also noted a couple of updates from agency representatives, including an EPA initiative to document the location of septic systems and recent attention to the issue of manure spreading and runoff impacts to wells. Finally, the LGPS continued to bring attention to the need for access and availability of source water assessment information for local planning purposes.

5. **Groundwater Advisory Committee (GAC) updates -** Ken Bradbury reported that the first meeting of the Groundwater Advisory Committee was held on April 1st. The main purpose of the meeting was to orient the GAC members about the recent legislation and their charge and bring them up to speed on groundwater quantity issues in Wisconsin. The GAC was created by 2003 Wisconsin Act 310 to recommend management strategies for Groundwater Management Areas created by the legislation and to fill in and further define some of its concepts. Two reports are due from the GAC at the end of 2006 and 2007. In addition, two science/planning work groups have been formed to help the GAC evaluate site specific impacts of high capacity wells and deal with regional planning and water management concepts. Meetings will be held bimonthly, with the next meeting on June 3rd. More information on the GAC can be found at http://dnr.wi.gov/org/water/dwg/gac/index.htm.

6. **FY06 Solicitation for Groundwater Proposals -** Jim Hurley and Mike Lemcke updated the GCC on the final status of the FY06 solicitation. Jim noted that all 8 UW System projects originally proposed to the GCC at the February meeting will be fully funded, with DNR assistance on one project. He noted that there was some uncertainty about the availability of funds along the way, but that it ended up with no further cuts. The biggest challenge was a change in UW Madison policy about including funds for tuition remission in project budgets. This will need to be taken into account in future solicitations, but not for FY06. Mike Lemcke reported that the DNR was able to pick up 8 projects this year, in addition to the one shared with the UW System. Mike noted that the DNR's funding situation was also uncertain early in the process, but that $92,000 of state funds earmarked for research were unexpectedly restored, in addition to Federal funds that were made available. Mike noted that the FY06 solicitation ended up in good shape with funding for 17 of the 29 projects submitted. Jim thanked Randy Hunt for his assistance and extra work as chair of the Groundwater Research Advisory Committee (GRAC) dealing with potential changes and cuts to project budgets.

7. **Groundwater Research Priorities for FY07 -** Randy Hunt reported that he would be convening a committee in June to revise and re-work the UW System solicitation guidelines in light of the discussion and recommendations of the GCC at its February meeting. The members of the committee will be Ron Stieglitz, Jim Hurley, and Tim Asplund. The recommendations of this group will be provided to the GRAC, who will then set the UW System priorities for the FY07 solicitation. Anders Andren suggested holding a statewide

workshop on groundwater research priorities involving members of the GCC, GRAC, and other investigators involved in groundwater research. He noted that the WRI would be willing to coordinate such a meeting or workshop.

8. **GCC Report to the Legislature plans for 2005 -** Tim Asplund handed out an outline for the 2005 Report, along with a timeline for completion and key topics to highlight. Tim noted that the report is due in August and that he would be contacting representatives from each agency and subcommittee in late May or early June to begin the process of updating and editing the sections of the report. Some of the key highlights this year might include the Groundwater Advisory Committee, implementation of the groundwater legislation, the La Crosse virus study findings, updates on pharmaceuticals and antibiotics, and the new USGS water availability study.

   Tim also offered some thoughts and suggestions for streamlining or condensing the report. One of the biggest sections that could be condensed is the Summary of Agency Activities. Tim suggested that each agency be limited to 2 pages of text, with most of the space dedicated to key highlights and accomplishments from the fiscal year. Readers can be directed to the web for more detailed information. Another section to be cut back is the chapter on Benefits of Monitoring and Research Projects, which currently includes information that has been repeated for several years. Tim suggested archiving all of the older material on the GCC website, and using this chapter to summarize 2 or 3 new research projects or topics.

   Finally, Tim presented some options for revising the format of the Report. He asked if the GCC wanted to keep the report as is, with 50-100 pages of text and a separate Executive Summary for wider distribution, or if it wanted to consider significantly reducing the size of the report itself, with supplemental material on the website. The GCC expressed its support for keeping the report as a fully developed detailed document that could be accessed from the web, but also producing something that communicates quickly the main points and highlights of the report. This latter document could be a 4-page "glossy" summary with minimal text and many photos, maps, or charts and should focus on educational and research activities of interest to a broad audience.

9. **Nitrate in Wisconsin's Groundwater**: **Status of the Resource -** Tim Asplund presented some preliminary work being done by the DNR's groundwater section in preparation for a "Status of the Resource" Report that may serve as a template for other such reports. Data from the DNR's Groundwater Retrieval Network (private wells) and the Drinking Water System (public, non-community wells) are being summarized and mapped by county and township in terms of numbers of wells exceeding the 10 mg/L enforcement standard (ES). Efforts are also being made to look at trends of nitrate concentration or exceedance rates over time using data from wells that are sampled repeatedly, as well as information on treatment costs for municipal water systems that have exceeded the ES. Maps and charts from other sources are being compiled and compared, including estimates of county and township based exceedance rates from the Groundwater Center database and more detailed sampling efforts from some county agencies. Jim VandenBrook expressed his support for this effort, noting that DATCP had also developed some statewide maps of nitrate occurrence and that it would be good to work together to produce the report and develop a common method of visualizing groundwater information. Liz Evans suggested developing some GIS maps that overlay information about potential exposure to nitrate and nitrate occurrence with census data on households with children and private wells.

10. **Penetration of Nitrate and Pesticides into Wisconsin's Aquifers -** George Kraft of the UW Stevens Point Center for Watershed Science and Education presented results from two projects funded through the joint solicitation process aimed at predicting the long term prognosis for nitrate and pesticide concentrations in two Wisconsin aquifers. George noted that it was important to understand whether aquifers will continue to degrade with increased use of ag chemicals or if they have or will achieve some sort of equilibrium because of degradation processes. These trends have implications for drinking water quality from existing sources, locating future water supplies, and long term pollutant export out of the watershed. The approach George took with these projects was to sample profiles of groundwater age, nitrate, total N, and a suite of pesticides and residues along a gradient of shallow wells in one case (Central Sands, Town of Stockton), and at discrete intervals in a deep well in another (glacial till over sandstone, Springfield Corners). In the Stockton wells, groundwater appeared to be fairly "young," with slightly older water at depth, and more or less at equilibrium with respect to nitrate and pesticides. Nitrate concentrations typically exceeded 20 mg/L, and denitrification rates were not substantial. Multiple pesticides were detected, though none exceeding standards. In the Springfield Corners profile, pesticide and nitrate concentrations declined with depth and groundwater age, while denitrification rates were fairly constant. Concentrations were lower than in the Stockton wells, but show signs of increasing. These results suggest that the aquifer is not at equilibrium and that pollutant concentrations will continue to increase and penetrate deeper over time. George noted that more of the Upper Midwest resembles the Springfield Corners setting, suggesting that land use practices must still be addressed to protect drinking water supplies from further degradation. Copies of the final reports for these projects can be found at http://dnr.wi.gov/org/water/dwg/gw/research.htm under "Completed Projects."

11. **Agency Updates**:
    - DATCP: Jim VandenBrook noted that public hearings on nutrient management standards (ATCP 50) were held in March and April, and that he had summaries of the public input available for anyone who is interested. Jim noted that the nitrate data gathering effort would be useful for educating people and supporting the new rules. The ATCP Board will act on the final rule in September.
    - WRI: Jim Hurley noted that funding for the national network of water resources research centers was restored by Congress as a result of the usual lobbying efforts. He also noted that a new quarterly newsletter called the Aquatic Sciences Chronicle had been recently distributed that combines information and news from the Wisconsin Water Resources Institute and Sea Grant. He noted that this newsletter would be a good place to summarize research findings supported by the joint solicitation process.

12. **GCC staff position -** Tim Asplund announced that he had accepted a new position within the DNR's Water Division effective June 13th, 2005. Tim will serve as the statewide Aquatic Ecologist/ Limnologist for the DNR in the Lakes & Wetlands Section. In this position Tim will support DNR regional lake coordinators, lake research scientists, citizen lake monitors, lake consultants and lake organizations to ensure lake management policies and activities maximize lake ecosystem health and reflect sound scientific principles. Tim noted that it was a difficult decision to leave the groundwater program, and that it had been a privilege to work with the dedicated network of groundwater professionals that make up the Groundwater Coordinating Council.

13. **The meeting adjourned at 2:30 PM.** The remaining meetings for 2005 will be as follows:

- August 12, 2005, 10:00 AM - 1:00 PM, at the DNR Fitchburg Service Center, 3911 Fish Hatchery Road in the Gathering Waters Conference Room.
- November 11, 2005, 12:00 noon - 3:00 PM, at WisDOT, 4802 Sheboygan Avenue

Respectfully submitted,

Tim Asplund, Water Resources Specialist
Department of Natural Resources

Appendix C : WI Groundwater Research & Monitoring Projects 1986-2004

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
1986				
Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin	Anklam	1986	DNR	31b
Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations	Boyle	1986	DNR	23
A Case Study of Nitrogen Transformations at a Rapid Infiltration System Used for the Disposal of Food Processing Wastewater	Boyle, Hoopes	1986	DNR	17b
Volatile Organic Compounds in Small Community Wastewater Disposal Systems Using Soil Absorption	Boyle, Sonzogni	1986	DNR	5
Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifer in Door County, Wisconsin	Bradbury	1986-90	DNR	12
Hydrogeology of the Wisconsin River Valley in Marathon County, Wisconsin	Bradbury	1986	DNR	22
The Prediction of Nitrate Contamination Potential Using Known Hydrogeologic Properties	Cherkauer	1986-87	DNR	10
The Effect of Construction, Installation and Development Techniques on the performance of Monitoring Wells in Fine-Grained Glacial Tills	Cherkauer, Palmer	1986	DNR	16
Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills	Friedman	1985-87	DNR	4a
Barron County Nitrate Study	Hanson	1986-87	DNR	37
Field Investigation of Groundwater Impacts from Absorption Pond Systems Used for Wastewater Disposal	Hoopes	1985-86	DNR	17a
A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone into Groundwater	Hoopes	1986	DNR	1
The Use of Groundwater Models to Predict Groundwater Mounding Beneath Proposed Groundwater Gradient Control Systems for Sanitary Landfill Designs	Hoopes	1986	DNR	6
Evaluation Techniques for Groundwater Transport Models	Hoopes	1986	DNR	7
The Occurrence of Volatile Organic Compounds in Wastewater, Sludges and Groundwater at Selected Wastewater Treatment Plants in Wisconsin	Hunger	1985-90	DNR	18

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality	Kammerer	1986	DNR	15
Fate of Aldicarb Residues in A Groundwater Basin near Plover, Wisconsin	Kraft	1986-87	DNR	3
Monitoring of Volatile Organic Compounds in Tomah, Wisconsin	Krohn	1986, 1989	DNR	31a
Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading	Portle	1986	DNR	19
Groundwater Monitoring for Pesticides	Postle	1986-97	DNR	2
Graphical and Statistical Methods to Assess the Effect of Landfills on Groundwater Quality	Potter	1986-87	DNR	14a
Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin	Saltes	1986-88	DNR	29
Filtration Preservation Study of Groundwater Samples	Sauer	1984	DNR	21a
West Bend Road Salt Use and Storage Study	Sucht	1986-91	DNR	8
Environmental Investigation of the City of Two Rivers Landfills, Manitowoc County, Wisconsin	Van Biersel	1986-87	DNR	24
Volatile Organic Compound Contamination of Private Water Supplies Adjacent to Abandoned Landfills in Marathon County	Wittkopf	1986-89	DNR	41
1987				
Plover Area Nitrate Study	Bailey	1987-88	DNR	48
Characterization of Groundwater Impacts at an Above Ground Petroleum Storage Terminal	Becker, Ham	1987	DNR	43
Research and Data Analysis of Groundwater Contamination from Municipal Rapid Infiltration Land Disposal Systems	Boyle, Hoopes, Potter	1987-88	DNR	56
Downward Movement of Water Below Barnyard Grass Filter Strips - Case Studies	Bubenzer, Converse	1987-89	DNR	39
1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin	Holman	1987	DNR	40
Flambeau Paper Sulfite Lagoon Site Contamination Study	Lantz	1987	DNR	30

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System	Norenberg, Standridge	1987	DNR	21b
Investigation of Large Scale Subsurface Soil Absorption Systems	Peerenboom	1987	DNR	42
Hydrogeologic Investigation and Groundwater Quality Assessment (Havenswood Landfill)	Singh	1987	DNR	28
Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision	Tinker	1987-90	DNR	11
Lead Migration from Contaminated Sites - Door County, Wisconsin	Wiersma, Stieglitz	1987-88	DNR	13
1988				
A Ground Penetrating Radar Study of Water Table Elevation in a Portion of Wisconsin's Central Sand Plain	Anderson (Mary), Bentley	1988	DNR	50
VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications	Battista	1988-89	DNR	4b
Assessment of Geologic Controls on Groundwater Flow and Distribution in Precambrian Bedrock, Central Wisconsin, Using Remote Sensing and Geophysical	Brown, Davidson Jr.	1988	DNR	49
Digital Simulation of Solute Transport to Green Bay and Lake Michigan by Groundwater from Door County, Wisconsin	Cherkauer	1988-91	DNR	57
Degradation of Atrazine, Alachlor, Metolachlor in Soils and Aquifer Materials	Chesters	1988-90	DNR	52
Radionuclides in Drinking Water of North central Wisconsin	Dobbins, Fitzgerald	1988-89	DNR	54
Sealing Characteristics of Sodium Bentonite Slurries for Water Wells	Edil	1988	DNR	34
Mutagenic Effects of Selected Toxicants Found in Wisconsin's Groundwater	Meisner, Belluck	1988-89	DNR	38
Mineralogical and Geophysical Monitoring Naturally Occurring Radioactive Elements in Selected Wisconsin Aquifers	Morsky, Taylor	1988	DNR	51
Evaluation of the Effect of Stormwater Disposal on Groundwater	Nienke, Shaw	1988-89	DNR	53
Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities	Potter	1988-89	DNR	14b

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Analytical Determination of Atrazine Alachlor and Their Selected Degradation Products in Contaminated Groundwater: Implication for Wisconsin Groundwater	Sonzogni	1988-89	DNR	47
Lead Contamination Study of Door County	Stoll	1988	DNR	44
Freedman Creek Hydrogeologic Baseline Report	Wilson	1988-89	DNR	45
1989				
Effect of Soil Type on Atrazine and Alachlor Movement Through Unsaturated Zone	Daniel	1989	DATCP/ DNR	62
Effects of Volatile Organic Compounds on Clay Landfill Liner Performance	Edil, Berthouex, Park, Sandstrom	1989	DNR	61
Grade A Dairy Farm Water Well Quality Survey	LeMasters, Doyle	1989	DNR	58
Groundwater Quality Investigation of Selected Townships in Jefferson County, Wisconsin	Madison	1989	DNR	60
Designs for Wellhead Protection in Central Wisconsin	Osborne, Sorenson, Knaak, Mechenich	1989	DNR	63
Pesticide Migration Study	Shaw	1989-90	DNR	55
Optimum Manure Application Rate - Corn Fertility Management and Nitrate Leaching to Groundwater in Sandy Soils	Shaw	1989-90	DNR	71
Subdivision Impacts on Groundwater Quality	Shaw, Ameson, VanRyswyk	1989	DNR	67
Demo of Low Input Strategies for Potato/Vegetable Production in Irrigated Sands	Shaw, Curwen, Kraft, Osborne	1989-90	DNR	59
1990				
A Field Evaluation of Drainage Ditches as Barriers to Contaminant Migration	Bahr, Chambers	1990-91	DNR	75
Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN)	Bohn	1990	DNR	68
Atrazine Contamination of Groundwater in Dane County, Wisconsin	Bradbury, McGrath	1990-91	DATCP/ DNR	64
Sources and Extent of Atrazine Contamination of Groundwater at a Grade A Dairy Farm in Dane County, Wisconsin	Chesters, Levy	1990-91	DATCP/ UWS/DNR	65
Follow Up to the Grade A Dairy Farm Well Water Quality Survey	Cowell, LeMasters	1990	DATCP/ DNR	70

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Report on Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells	Hutchinson	1990-91	DNR	72
DNR and DATCP Rural Well Survey	LeMasters	1990	DATCP/ DNR	69
Variation in Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology	Mickelson, Bradbury, Rayne	1990-92	DNR/UWS	74
Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells	Sonzogni, Eldan, Lawrence	1990	DNR	77
Nitrogen Isotope Monitoring at Unsewered Subdivisions	Tinker	1990	DNR	76
Volatile Organic Chemical Attenuation in Unsaturated Soil Above and Below an Onsite Wastewater Infiltration System	Tyler, Peterson, Sauer	1990-91	DNR/UWS	73
1991				
Integrated Decision Support for Wellhead Protection	Adams, Bensen	1991	UWS	
Role of Mobile Colloids in the Transport of Chemical Contaminants in Groundwaters	Armstrong, Shafer	1991-93	UWS	
On-site Nitrogen Removal Systems Research Demonstration Project: Phase I	Ayres & Assoc.	1991	DILHR	
Evaluation of Potential Phytotoxicity and Crop Residues when Using Sprayer Rinsate as a Portion of the Diluent in Pesticide Spray Mixtures	Binning	1991	DATCP	
To Expand Groundwater Sampling in the Lower Wisconsin River Valley	Cates, Madison, Postle	1991	DNR	78
Renovation of Pesticide Contaminated Rinse Waters	Chesters, Harkin	1991	UWS	
In-situ Removal of Fe, Mn, and Ra from Groundwater	Christensen, Cherkauer	1991	UWS	
Reactions of Chlorohydrocarbons on Clay Surfaces	Fripiat	1991	UWS	
The Biological Impact of Landfill Leachate on Nearby Surface Waters	Geis, Sonzogni, Standridge	1991	DNR	83
Chemical Transport Across a Sediment-Water Interface	Green	1991-92	UWS	
Adsorptive Behavior of Atrazine and Alachlor in Organic-Poor Sediments	Grundl	1991	UWS	
Effect of Complex Mixtures of Leachate on the Transport of Pollutants in Groundwater	Grundl, Cherkauer	1991-92	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Bioremediation of Herbicide-Contaminated Soil and Water	Harris, Armstrong	1991	UWS	
Near-Source Transport of Contaminants in Heterogeneous Media	Hoopes	1991-92	UWS	
Design of a Small Scale Transportable Mixing/Loading System	Kammel	1991	DATCP	
Municipal Wastewater Project	Kopecky	1991	DNR	85
Dependence of Aldicarb Residue Degradation Rates on Groundwater Chemistry in the Wisconsin Central Sands	Kraft, Helmke	1991-92	DNR	84
Using Ground Penetrating Radar to Predict Preferential Solute Movement and Improve Contaminant Monitoring in Sandy Soils	Kung, Madison	1991	UWS	
Nitrate Movement Through the Unsaturated Zone of a Sandy Soil in the Lower Wisconsin River Valley	Lowery, Kussow	1991-93	UWS	
Effect of Soil Type, Selected BMPs, and Tillage on Atrazine and Alachlor Movement Through the Unsaturated Zone	Lowery, McSweeny	1991	DATCP/ DNR	66
A Study of the Response of Nitrate and Pesticide Concentrations to Agricultural BMPs in Sandy Corn Fields	Madison, Cates	1991-94	DNR	81
Facility Plan Amendment for Wastewater Collection for Green Lake Sanitary District, Green Lake, WI	McMahon & Assoc.	1991	DILHR	
Contamination Attenuation Indices for Sandy Soils: Tools for Information Transfer	McSweeney, Madison	1991	UWS	
Tracking Contaminant Pathways in Groundwater Using a Geologically Based Computer Code for Outwash	Mickelson, Anderson	1991-92	UWS	
A Tracer Technique for Measuring Regional Groundwater Velocities from a Single Borehole	Monkmeyer	1991	UWS	
The Economic Effects of Groundwater Contamination on Real Estate	Page	1991	UWS	
Prediction of Organic Chemical Leachate Concentrations from Soil Samples	Park	1991	UWS	
Crop Rotations Effects on Leaching Potential and Groundwater Quality	Posner, Bubenzer, Madison	1991-92	DNR	80
Barnyard Management Practices: Effect on Movement of Nitrogen Through Soils and Impact on Groundwater Quality	Shaw	1991-92	DNR	9

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
A Comparative Study of Nitrate-N Loading to Groundwater from Mound, In Ground Pressure and at Grade Septic Systems	Shaw, Turyk	1991-92	DNR	82
Waupaca County Groundwater Project: Towns of St. Lawrence and Little Wolf	Wilson, Blonde	1991	DNR	79a
1992				
Effects of Transient Cross-Stratification Flow on Contaminant Dispersion	Bahr	1992-93	UWS	
Geographical Information System for Subsurface Characterization	Bosscher, Adams	1992-93	UWS	
Distribution of Radionuclides in Wisconsin Groundwater	Bradbury, Mudrey	1992	DNR	91
Evaluation of NURE Hydrogeochemical Groundwater Data for Use in Wisconsin Groundwater Studies	Bradbury, Mudrey, Shrawder	1992	DNR	90
Preliminary Comparison of a Discrete Fracture Model with a Continuum Model for Groundwater Movement in Fractured Dolomite	Bradbury, Muldoon	1992	DNR	89
GIS Mapping of Groundwater Contaminant Sources, Quality and Contamination Susceptibility for Door County	Carlson, Stoll, Hronek	1992-93	DNR	93
Distribution, Transport and Fate of Major Herbicides and Their Metabolites	Chesters	1992-93	UWS/DATCP	
Dane County Atrazine/Land Management Project	Conners, Bohn, Madison, Muldoon, Richardson	1992	DATCP/ DNR	99
Use of Tire Chips to Attenuate VOCs	Edil, Park	1992-93	UWS	
Municipal Wastewater Absorption Pond Renovation for Enhanced Nitrogen Removal	Gilbert	1992-93	DNR	97
Living Mulch Systems for Nitrate Trapping in Vegetable Production	Harrison	1992-93	UWS	
Remediation of Soils Contaminated by Leaking Underground Storage Tanks by Vapor Extraction and In-situ Biostimulation	Hickey, Jacobsen, Bubenzer	1992-93	DNR	96
Herbicide and Nitrate Movement in a Sandy Soil in the Lower Wisconsin River Valley	Lowery, McSweeney	1992-93	UWS/DATCP	
Spatial Attributes of the Soil-Landscape-Groundwater System of the Lower Wisconsin River Valley	McSweeney, Madison, Attig, Bohn, Falk	1992-93	DNR	88

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Nitrogen Removal from Domestic Wastewater in Unsewered Areas	Otis, Converse	1992-96	DILHR	
New Approaches to Measuring Biologic Effects of Groundwater Contaminants	Porter	1992	UWS	
Estimating the Spatial Distribution of Groundwater Recharge Rates Using Hydrologic, Hydrogeologic and Geochemical Methods	Potter	1992-93	UWS/DATCP	
Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits	Pugh, Connelly	1992-93	DNR	98a
Assessment of Wisconsin's Groundwater Monitoring Plan Program for Active Non-Approved Landfills (1985-1990)	Pugh, Gear	1992	DNR	92
Evaluation of Denitrification Systems for Improving Groundwater from On-Site Waste Disposal Systems	Shaw	1992-93	DNR	95a
Arsenic as a Naturally Elevated Parameter in Water Supply Wells in Eastern Winnebago and Outagamie Counties	Stoll	1992	DNR	87
Waupaca County: Towns of Lebanon and Scandinavia	Wilson, Blonde	1992	DNR	79b
1993				
Urban Stormwater Infiltration: Assessment and Enhancement of Pollutant Removal	Armstrong	1993-94	DNR	102
Trace Metal Transport Affected by Groundwater Stream Interactions	Bahr	1993-94	UWS	
Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite	Bradbury, Muldoon	1993-94	DNR	101
Evaluation of Five Groundwater Susceptibility Assessments in Dane County, Wisconsin	Bridson, Bohn	1993-94	DNR	100
Management of Sweet Corn Processing Wastes to Protect Groundwater Quality	Bundy	1993-94	UWS	
Impact of Tunnel Dewatering on Surface Water Bodies in Milwaukee County	Cherkauer	1993-94	UWS	
A Further Study of Organics at Wisconsin Municipal Solid Waste Landfills	Connelly	1993-94	DNR	104
Ultrasonic Verification Technique for Evaluating Well Seals	Edil	1993-94	UWS	
Long-Term Transformation and Fate of Nitrogen with Mound Type Soil Absorption Systems for Septic Tank Effluent	Harkin	1993-94	DNR	103

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Field Evaluation of Near Source Transport of Contaminants in Heterogeneous Media	Hoopes	1993-94	UWS	
Variability of Hydraulic Conductivity in Supraglacial Sediments	Mickelson	1993-94	UWS	
The Impact of Atrazine Management Areas Designation on Weed Control Strategies in Wisconsin Corn Production	Nowak	1993	DATCP	
1994				
Photocatalytic degradation of volatile organic carbon	Anderson (Marc)	1994-95	UWS	94REM2B2
Improved design of pump and treat systems for heterogeneous aquifers	Bahr	1994-95	UWS	94REM3B2
Herbicide contamination of soil and groundwater at a mixing and loading site	Chesters	1994-95	UWS/ DATCP	94PES2B2
An Investigation of Field-Filtering and Low-Flow Pumping When Sampling for Metals	Connelly	1994	DNR	106
Mineral phase sorption of selected agrichemicals to Wisconsin Soils	Grundl	1994-95	UWS	94PES1B2
Stratigraphy, sedimentology, and porosity distribution of the Silurian rocks of the Door Peninsula, Wisconsin	Harris	1994-95	UWS	94HGE2B2
Using 'PREDICT' to reduce herbicide usage and improve groundwater quality	Harvey	1994-95	UWS	94PES6B2
Comparative evaluation of biostimulation approaches for enhancing in situ TCE degradation in contaminated aquifers	Hickey	1994-95	UWS	94REM6B2
Leaching Potential of Imazethapyr and Nicosulfuron in Sparta Sand	Lowery	1994	DATCP	
Cover Crops to Limit Herbicide Use on Sweet Corn	Newenhouse	1994	DATCP	
Groundwater Hydrogeology of an Agricultural Watershed	Potter	1994-95	DATCP/ DNR	109
Investigation of Potential Groundwater Impacts at Yard Waste Sites	Pugh, Connelly	1994	DNR	98b
Optimization of Two Recirculating Sand Filters for Nitrogen and Organic Chemical Removal from Domestic Wastewater	Shaw	1994	DNR	95b
Factors Affecting the Determination of Radon in Groundwater	Sonzogni	1994	DNR	111

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Integrated Computerized Mapping of Point Source Contaminants and Physical Environmental Characteristics to Protect and Manage Groundwater Quality	Stoll	1994	DNR	105
The Further Incidence of Native Arsenic in Eastern Wisconsin Water Supply Wells; Marinette, Oconto, Shawano and Brown Counties	Stoll	1994	DNR	110
Groundwater Survey of Alachlor and ESA its Polar Metabolite in Southern Wisconsin	Vanden Brook, Postle	1994	DATCP/ DNR	112
The Use of Peat as an Absorptive Medium	Wiersma, Stieglitz	1994	DATCP	
1995				
Evaluating the Effectiveness of Landfill Liners	Benson	1995-96	UWS	
Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite	Bradbury	1995-96	UWS	
Application of a Discrete Fracture Flow Model for Wellhead Protection at Sturgeon Bay, Wisconsin	Bradbury, Muldoon	1995-96	DNR	113
Direct and Residual Effects of Land-applied Sweet Corn Processing Wastes on Nitrate Loss to Groundwater	Bundy	1995-96	DNR	120
Integration of Hydraulics and Geology into a Hydrostratigraphic Model for the Paleozoic Aquifer of Eastern Dane County, Wisconsin	Cherkauer	1995	UWS	
A Comparison of Low Flow Pumping and Bailing for VOC Sampling	Connelly	1995	DNR	114
A Low-Input Crop Management Plan for Wisconsin Fresh-Market Vegetable Growers	Delahaut	1995	DATCP	
Use of Heavy Nitrogen to Study Nitrate Flux from Septic Systems	Harkin	1995-96	UWS/Comm	
Agrichemical Impacts to Groundwater Under Irrigated Vegetables in the Central Sand Plain	Kraft	1995-96	DNR	116
Vertical and Horizontal Variability of Hydrogeologic Properties in Glaciated Landscapes	Mickelson	1995	DNR	119
Synergistic Effects of Endocrine Disrupters in Drinking Water	Porter	1995-96	UWS	
Development and Demonstration of an Accurate Manure Spreading System to Protect Water Quality, Improve Waste Management and Farm Profitability	Shinners	1995-96	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Geologic Constraints on Arsenic in Groundwater with Applications to Groundwater Modeling	Simo	1995	UWS	
Characterization of E. Coli and Total Coliform Organisms Isolated from Wisconsin Groundwater and Reassessment of their Public Health Significance	Sonzogni	1995	DNR	117
Evaluation of Enzyme-linked Immunosorbent Assay for Herbicide Analysis of Wisconsin Soil in Comparison to Gas Chromatography	Sonzogni	1995	UWS	
An Evaluation of Long-term Trends and a Mineralogical Interpretation of Naturally Occurring Metals Contamination and Acidification of the	Weissbach	1995-96	DNR	115
Collection of Hydraulic and Geologic Data to Improve the Quality of the Wisconsin Groundwater Monitoring Network	Zaporozec	1995-96	DNR	118
1996				
Bioremediation of Hydrocarbons Influenced by Air Sparging: A Multi-model Approach to Assess Contaminant Mass Removal	Bahr	1996	UWS	
Delineation of Capture Zones for Municipal Wells in Dane County, Wisconsin	Bradbury	1996	DNR	121
Responses of Biological Toxicity Tests to Mixtures of Pesticides and Metabolites	Chesters	1996-97	UWS	
Evaluation of Well Seals Using an Ultrasonic Probe	Edil	1996	UWS	
Iron-based Abiotic Destruction of Chlorinated Solvents and Pesticides in Groundwater	Eykholt	1996	DATCP	
Biostimulation of Trichloroethylene Degradation in Contaminated Aquifers	Hickey	1996	UWS	
Optimum Management of Ground-water Resources in the Lower Fox River Valley	Krohelski	1996-97	DNR	122
Variability of Nitrate Loading and Determination of Monitoring Frequency for a Shallow Sandy Aquifer, Arena, Wisconsin	Madison	1996-97	DNR	123
Characterization of the Role of Evapotranspiration on Groundwater Movement and Solute Chemistry in Groundwater-fed Wetlands	Potter	1996-97	UWS	
Ground-water Recharge and Contamination in Wisconsin's Driftless Area	Potter	1996	DATCP	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Land Use Effects on Groundwater and Streamwater Quality in the Little Plover River Watershed	Shaw	1996-97	DATCP	
Stratigraphic Controls on the Mobilization and Transport of Naturally Occurring Arsenic in Groundwater: Implication for Wellhead Protection in	Simo	1996	UWS	
Evaluation of Shallow-soil Absorption Fields Associated with Advanced On-site Disposal System	Stieglitz	1996-97	DNR/UWS Comm	125
GIS as a Tool to Prioritize Environmental Releases, Integrate their Management, and Alleviate their Public Threat	Stoll	1996-97	DNR	126
The Use of Azimuthal Resistivity & Self Potential Measurements to Delineate Groundwater Flow Direction in Fractured Media	Taylor	1996	UWS	
An Integrated Approach to the Management of Insects in Sweet Corn Grown for Fresh Market	Wedberg	1996-97	DATCP	
1997				
Improved Estimation of Groundwater Recharge Rates	Anderson (Mary)	1997	UWS	
Hydrogeochemical and Microbiological Studies for Enhanced Ground Water Bioremediation	Bahr	1997-98	UWS	
In situ Air Sparging: Air Plume Characterization and Removal Effectiveness	Benson	1997-98	UWS	
Groundwater Protection by Application of Modern Portfolio Theory to Microbiotesting Strategies	Blondin	1997	UWS	
Holding Tank Effluent and Fecal-Contaminated Groundwater: Sources of Infectious Diarrhea in Central Wisconsin?	Borchardt	1997-98	Comm	
Development of a Variable Rate Nitrogen Application Approach for Corn	Bundy	1997-98	UWS	
Groundwater Bioremediation: Monitoring with MMO Probes	Collins	1997-98	UWS	
Experimental Verification of Models Used to Evaluate Landfill Liner Effectiveness	Edil	1997	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Stratigraphy, sedimentology, and Porosity Distribution of the Silurian Aquifer of Ozaukee County, Wisconsin	Harris	1997	UWS	
Molecular Techniques for Detection and Identification of Sewage-Borne Human Pathogens in Soils	Hickey	1997-98	Comm	
Nitrate-Contaminated Drinking Water Followback Study	Kanarek	1997	DNR	131
Fate of Nicosulfuron in Sparta Sand	Lowery	1997	DATCP	
Treatment of Groundwater Contaminated with Chlorinated Aliphatics Using a Silicone Tubing Supported Methanotrophic Biofilm Reactor	Park	1997-98	UWS	
Evaluation of the Use of DUMPSTAT to Detect the Impact of Landfills on Groundwater Quality	Potter	1997	DNR	130
Stratigraphic Controls on Distribution of Hydraulic Conductivity in Carbonate Aquifers	Simo	1997-98	DNR	129
Improved Detection Limits for Ground Water Monitoring	Sonzogni	1997	DNR/UWS	128
Determining Compatibility Between Herbicide Release and Habitat for Karner Blue Butterfly in Red Pine Plantations	Sucoff	1997	DATCP	
A Study of Well Construction Guidance for Arsenic Contamination in Northeast Wisconsin	Weissbach	1997-98	DNR	127
1998				
Assessment of Impacts on Groundwater/Lake and Wetland Systems	Anderson (Mary)	1998	UWS	
Groundwater-Surface Water Interactions in the Nine Springs Watershed	Bahr	1998-99	DNR	137
Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin	Bradbury	1998	DNR	138
Watershed-Scale Nitrate Contamination and Chloroflurocarbon Ages in the Little Plover Basin: A Study at the Groundwater/Surface Water Interface	Browne	1998-99	UWS	
Determining Ground-Water Recharge Rates in Southern Washington County	Cherkauer	1998-99	UWS	
Characterization of the Hydrostratigraphy of the Deep Sandstone Aquifer in Southeastern Wisconsin	Eaton	1998-99	DNR	134

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Further Evaluation of Well Seals Using an Ultrasonic Probe	Edil	1998	DNR	136
Evaluation of Exploration Borehole Seals Using Time Domain Reflectometry (TDR)	Edil	1998-99	UWS	
Fate of Metolachlor, Alachlor, and Nitrate in Granular Iron/Soil/Water Systems,	Eykholt, Davenport, Wonsettler	1998	DATCP	
Investigation of Air Sparging: Numerical Modeling, Laboratory Verification and Design Guidelines	Hoopes	1998-99	UWS	
The Direct Effect of Agricultural Chemicals on Wisconsin's Declining and Endangered Amphibians	Karasov	1998-99	UWS/DATCP	
Relationships Between Water Quality in Stream Base Flow and Private Wells and Land use in the Tomorrow/Waupaca River Watershed	Shaw	1998-99	DNR	132
Impact of Ginseng Production on Groundwater Quality,	Shaw, De Vita	1998	DATCP	
Northeast Region Public Water Supply Location Utilizing Geographic Information Systems and Global Positioning Systems	Stoll	1998	DNR	133
Effects of Fosamine, Picloram, and Triclopyr on Reducing Aspen in Prairie Bush Clover Habitat,	West	1998	DATCP	
Evaluation of Geology and Hydraulic Performance of Wisconsin Ground-Water Monitoring Wells	Zaporozec	1998	DNR	135
1999				
On-line SFE/GC for Improved Detection of Trace Organic Pollutants in Ground Water Monitoring	Armstrong	1999	UWS/DATCP	
A Rational Design Approach for Permeable Reactive Walls	Benson	1999-2000	UWS	
Viral Contamination of Household Wells Near Disposal Sites for Human Excreta	Borchardt, Sonzogni	1999-2000	DNR	144
Groundwater Flow and Heat Transport in Wetlands: Transient Simulations and Frequency-Domain Analysis	Bravo	1999-2000	UWS	
Monitoring: Evaluation of the Abundance, Diversity, and Activity of Methanotroph Populations in Groundwater	Collins	1999-2000	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Mechanical Controls on Fracture Development in Carbonate Aquifers: Implications for Groundwater Flow Systems	Cooke	1999-2000	DNR	142
Acute and Chronic Toxicity of Nitrate to Brook Trout (Salvelinus fontinalis)	Crunkilton	1999-2000	DNR	140
Maquoketa Shale as Radium Source to the Cambro-Ordovician Aquifer System	Grundl	1999-2000	DNR	141
Sedimentology, Stratigraphy, and Porosity-Conductivity Relations of the Silurian Aquifer of Ozaukee County, Wisconsin	Harris	1999-2000	UWS	
Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers	Hickey	1999-2000	DNR	143
Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems	Kung	1999-2000	DATCP	
Using Geographic Information Systems and Soil Landscape Models to Predict Critical Sites for Nonpoint Source Pollution	Lowery	1999-2000	DATCP	
Water and Land Use: Interpretation of Existing Data to Foster Constructive Public Dialogue and Policy Formulation	Read	1999	UWS	
Natural Attenuation of Fuel and Related Groundwater Contaminants - A Measurement Method	Sonzogni	1999	UWS	
Fate of the Herbicides Atrazine, Cyanazine, and Alachlor and Selected Metabolites	Stoltenberg	1999	DATCP	
Hydraulic Conductivity and Specific Storage of Maquoketa Shale	Wang	1999	UWS	
2000				
A groundwater model for the Central Sands of Wisconsin: Assessing the environmental and economic impacts of Irrigated agriculture	Anderson (Martha), Bland, Kraft	2000	DATCP/ DNR	146
Remediating groundwater using reactive walls containing waste foundry sands	Benson, Eykholt	2000-01	DNR/UWS	147
Field verification of capture zones for municipal wells at Sturgeon Bay, Wisconsin	Bradbury, Rayne, Muldoon	2000	DNR	148
Refinement of two methods for estimation of groundwater recharge rates	Bradbury, Anderson, Potter	2000	DNR	150

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Causes of historical changes in ground-water recharge rates in southeastern Wisconsin	Cherkauer	2000-01	UWS	
Evaluating options for changing groundwater and leachate monitoring requirements for landfills to reduce mercury used by laboratories	Connelly, Stephens, Shaw	2000-01	DNR	151
Compatibility of containment systems with mine waste liquids	Edil, Benson	2000-01	UWS	
Time domain electromagnetic induction survey of eastern Waukesha County and selected locations	Jansen, Taylor	2000	UWS	
Admicelle-catalyzed reductive dechlorination of PCE by zero valent iron	Li	2000-01	UWS	
Development of neural network models for predicting nitrate concentration in well water	Lin, Shaw	2000-01	UWS	
Field monitoring of drainage and nitrate leaching from managed and unmanaged ecosystems	Norman, Brye	2000-01	UWS	
Macropore flow: A means for enhancing groundwater recharge or a potential source of groundwater contamination	Potter, Bosscher	2000-01	UWS	
Hydraulic Conductivity and Specific Storage of Maquoketa Shale	Wang	2000	UWS	
Improvement of Wisconsin groundwater monitoring network	Zaporozec	2000	DNR	149
2001				
Development of analytical methods for comprehensive chemical and physical speciation of arsenicals in groundwater	Aldstadt	2001-02	DNR	154
Removal of As(III) and As(V) in Contaminated Groundwater with Thin-Film Microporous Oxide Adsorbents	Anderson (Marc)	2001-02	UWS	
The Spatial and Temporal Variability of Groundwater Recharge	Anderson (Mary), Potter	2001	UWS	
Importance of Groundwater in Production and Transport of Methyl Mercury in Lake Superior Tributaries	Armstrong	2001-02	UWS	
A study of microbiological testing of well water quality in Door County and incidence of illness in humans	Braatz	2001	DNR	159
A Basin-Scale Denitrification Budget for a Nitrate Contaminated Wisconsin Aquifer: A Study at the Groundwater/Surface Water Interface	Browne, Kraft	2001-02	UWS	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
New approaches to the assessment of microbes in groundwater: application to monitoring bioremediation and detection of pathogens	Collins	2001-02	DNR	155
VOC trend analysis of WI solid waste landfill monitoring data: A preliminary analysis of the natural attenuation process	Connelly	2001-02	DNR	153
Evaluation of pathogen and nitrogen movement beneath on-site systems receiving domestic effluent from single pass sand filters	Converse	2001	Comm	
Effectiveness of phytoremediation and hydrogeologic response at an agricultural chemical facility in Bancroft, WI	DeVita, Dawson	2001-02	DATCP	
Effect of Clean and Polluted Groundwater on Daphnia Reproduction and Development	Dodson	2001-02	UWS	
Verification and characterization of a fracture network within the Maquoketa shale confining unit, SE Wisconsin	Eaton	2001	DNR	157
Groundwater Modeling: Semi-Analytical Approaches for Heterogeneity and Reaction Networks	Eykholt	2001	UWS	
Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin	Gotkowitz	2001-02	DNR	152
Screening of agricultural and lawn care pesticides for developmental toxicity using the mouse embryo assay	Greenlee	2001	DATCP	
Public health impacts of arsenic contaminated drinking water	Knobeloch	2001-02	DNR	158
Pesticide and nitrate leaching in soils receiving manure	Lowery, Arriaga, Stoltenberg	2001	DATCP	
An analysis of arsenic replacement wells to determine validity of current DNR well construction guidance	O'Connor	2001-02	DNR	156
Remediation of Soil and Groundwater Using Effectively and Ineffectively Nodulated Alfalfa	Turyk, Shaw	2001-02	UWS/DATCP	
2002				
Groundwater-lake interaction: Response to climate change Vilas County, Wisconsin	Anderson (Mary)	2002	UWS	02-GSI-1
Impacts of privately-sewered subdivisions on groundwater quality in Dane County, WI	Bradbury	2002-3	UWS	02-OSW-1
Chloroacetanilide and atrazine residue penetration and accumulation in two Wisconsin groundwater basins	DeVita, McGinley, Kraft	2002-3	DATCP	

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
Effect of clean and polluted groundwater on reproduction and development of Daphnia	Dodson	2002	UWS	02-BEP-1
Monitoring contaminant flux from a stormwater infiltration facility to groundwater	Dunning, Bannerman	2002-3	DNR	168
Removal of heavy metals and radionuclides from soils using cationic surfactant flushing	Evans, Li	2002-3	UWS	02-REM-3
Impacts of land use and groundwater flow on the temperature of WI trout streams	Gaffield, Wang	2002-3	UWS	02-GSI-3
Delineation of high salinity conditions in the Cambro-Ordovician aquifer of eastern Wisconsin	Grundl, Taylor	2002	DNR	170
Investigation of changing hydrologic conditions of the Coon Creek watershed in the driftless area of Wisconsin	Hunt	2002	UWS	02-GSI-2
Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions	Hunt, Borchardt	2002	DNR	165
Occurrence of antibiotics in wastewater effluents and their mobility in soils. A case study for Wisconsin	Karthikeyan, Bleam	2002-3	DATCP/ DNR	169
Nitrate loading history, fate, and origin for two WI groundwater basins	Kraft	2002-3	DNR	171
Monitoring and Scaling of Water Quality in the Tomorrow-Waupaca Watershed	Lin, Browne	2002-3	UWS	02-SAM-1
Co-occurrence and removal of arsenic and iron in groundwater	McGinley	2002-3	UWS	02-REM-2
Agrochemical leaching from sub-optimal, optimal, and excessive manure-N fertilization of corn agroecosystems	Norman, Brye	2002-3	DATCP	
Removal of arsenic in groundwater using novel mesoporous sorbent	Park	2002-3	UWS	02-REM-5
Field evaluation of raingardens as a method for enhancing groundwater recharge	Potter	2002-3	UWS	02-BMP-1
Importance of disinfection on arsenic release from wells	Sonzogni, Bowman Standridge, Clary	2002-3	DNR	172
Preservation and survival of E. coli in well water samples submitted for routine analyses	Sonzogni, Standridge, Bussen	2002	DNR	173
Development of a culture method for detection of Helicobacter pylori in groundwater	Sonzogni, Standridge, Degnan	2002	DNR	167
Time domain electromagnetic induction survey of the sandstone aquifer in the Lake Winnebago area	Taylor, Jansen	2002	DNR	173

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
2003				
Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters	Anderson (Marc)	2003	UWS	03-WSP-02
Role of the Hyporheic Zone in Methylmercury Production and Transport to Lake Superior	Armstrong, Babiarz	2003-4	UWS	03-CTP-02
Arsenic Contamination in Southeast Wisconsin: Sources of Arsenic and Mechanisms of Arsenic Release	Bahr, Gotkowitz	2003-4	DNR/ UWS	174/ 03-HDG-01
Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility	DeVita, Dawson	2003-4	UWS	03-REM-06
F Test for Natural Attenuation in Groundwater: Application on Benzene	Evangelista, Pelayo	2003	UWS	03-REM-08
Determination of Aquitard and Crystalline Bedrock Depth Using Time Domain Electromagnetics	Hart, Alumbaugh	2003	UWS	03-HDG-03
An Experimental and Mathematical Study of the Alpha-Particle Activity of Wisconsin Ground Waters with High Gross Alpha	Sonzogni, Arndt, West	2003	DNR	176
Evaluation of Enzyme Linked Immunosorbent Assay for Analysis of Di Amino Atrazine in Wisconsin Groundwater in Comparison to Chromatography	Strauss, Sonzogni	2003	DNR	175
2004				
Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters	Anderson (Marc)	2004	DNR	179
An Assessment of Aquifer Storage Recovery for Selected Generic Hydrogeologic Settings in Wisconsin	Anderson (Mary)	2004	UWS	04-HDG-01
Development of a groundwater flow model for the Mukwonago River watershed, southeastern Wisconsin	Bahr	2004-5	DNR	180
Monitoring and predictive modeling of subdivision impacts on groundwater in Wisconsin	Bradbury, Bahr	2004-5	DNR	178
Providing communities with the groundwater information needed for comprehensive planning.	Cherkauer	2004-5	UWS	04-WSP-01
What happens when the confined Cambrian-Ordovician aquifer in SE Wisconsin is "dewatered"?	Eaton	2004	UWS	04-HDG-02
Evaluation of Contamination of Groundwater Around Landfills	Edil, Benson, Connelly	2004-5	UWS	04-CTP-04

Title	Principal Investigator(s)	Years Funded	Funding Agency	Project # (if assigned)
A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County area, WI	Grundl, Bradbury, Feinstein, Hart	2004-5	UWS	04-WSP-02
Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide And Tetracycline Antibiotics In Subsurface Environments	Karthikeyan, Pedersen	2004-5	UWS	04-CTP-02
Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	Kraft, Browne	2004-5	DNR	181
Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Li	2004-5	UWS	04-REM-04
Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	Potter	2004-5	UWS	04-BMP-01
Coupled Modeling of Gravity and Aeromagnetic Data For Analysis of the Waukesha Fault, Southeastern Wisconsin	Skalbeck	2004	UWS	04-HDG-03
2005				
Mercury Speciation along a Groundwater Flowpath	Armstrong, Babiarz	2005-6	UWS	05-CTP-01
Delineation of Flow Paths, Capture Zones and Source Areas, Allequash Basin, Vilas County, Wisconsin	Mary Anderson	2005	UWS	05-HDG-01
A Comparison of USEPA Approved Enzyme-based Total Coliform/E.coli Tests for Microbiological Groundwater Monitoring and Laboratory Consultation	Schauer, Olstadt, Standridge, Kluender	2005	UWS	05-SAM-01
Occurrence of Estrogenic Endocrine Disruptors in Groundwater	Sonzogni, Hemming, Barman, Geis	2005-6	UWS	05-BEP-01
Development of Tools to Address Groundwater in Comprehensive Planning	Markham, Dunning, Tang	2005	UWS	05-BMP-01
Hydrostratigraphy of west-central Wisconsin: A new approach to Groundwater Management	LePain, Bradbury	2005	UWS	05-HDG-02
Monitoring Environmental Effects at an Established Phytoremediation Site	DeVita, Dawson	2005-6	UWS	05-REM-01
Foundry Slag for Treating Arsenic in Groundwater and Drinking Water	Benson, Blowes	2005-6	UWS	05-REM-02

Appendix D: FY 06 Joint Solicitation for Groundwater Research and Monitoring Proposals

September 2004

The University of Wisconsin System (UWS) and the Wisconsin Departments of Natural Resources (DNR), Agriculture, Trade, and Consumer Protection (DATCP), and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems. Up to $440,000 will be available for groundwater-related monitoring and research in fiscal year 2006 (FY 06) for new and continuing projects. The four programs, which are collectively called the Wisconsin Groundwater Research and Monitoring Program (WGRMP), are summarized as follows:

1. UWS Groundwater Research - The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. Projects may be of a fundamental or applied nature on selected aspects of groundwater research in the natural sciences, engineering, social sciences, or law. Through FY 04, the UWS has invested $4.4 million on 122 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and 11 were co-funded through the National Institutes for Water Resources program (US Geological Survey). The UWS will have $300,000 to fund new and continuing projects in FY 06.

2. DNR Groundwater Monitoring and Research - The DNR has been funding groundwater "management practice monitoring" projects since FY 86. The intent of these studies, funded through the Groundwater Account of the Environmental Fund, was to identify appropriate management practices to reduce the impacts of potential sources of contamination. In recent years, the DNR has used funds from alternative state and federal sources, and has targeted funds at specific issues of concern, including arsenic, emerging contaminants (viruses, antibiotics), and groundwater quantity. Through FY 04, the DNR has spent approximately $5.6 million on 173 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS. The DNR may have up to $140,000 to support groundwater research and monitoring studies in FY06, depending upon availability of funds.

3. DATCP Pesticide Research - From 1989 to 2002, DATCP had approximately $135,000 available annually to fund research on pesticide issues of regulatory importance. This money came from fees paid by pesticide manufacturers to sell products in Wisconsin. Through FY 03, the DATCP spent about $1.8 million on 42 pesticide projects. Some of these projects were co-funded with DNR and/or UWS. Due to budget constraints, DATCP will not have money to fund any new projects in FY 06. DATCP will, however, take part in the proposal review process.

4. Department of Commerce Private Onsite Wastewater Treatment System Research – The Division of Safety & Buildings (formerly in the Department of Industry, Labor, and Human Relations) received an annual appropriation of $50,000 from 1990 to 1993 to fund research on alternatives to current private sewage-system technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on private sewage systems. Through FY 04, Commerce has spent approximately $600,000 on eight projects. Two projects were co-funded with DNR and UWS. As of September 2004, Commerce has indicated that no funds will be available for research projects in FY 06.

The Wisconsin Groundwater Coordinating Council (GCC) provides consistency and coordination among the four state agencies in funding groundwater monitoring and research to meet state agency needs. See the "Research and Monitoring" page on the GCC website: http://dnr.wi.gov/org/water/dwg/gcc/index.htm. The reasons for this solicitation to be made jointly are to:

- Facilitate proposal writing
- Streamline the review process
- Curtail duplication
- Improve coordination among agencies and researchers
- Enhance communication among the agencies and among principal investigators (P.I.)

Joint funding of some projects may be appropriate, but joint funding is not the purpose of this solicitation because each agency has its own designated mission and priorities. Although all proposals received will be distributed to each agency, each investigator is asked to identify the agency whose mission and priorities best match their project.

Please read the solicitation carefully; it contains a description of the priorities for each agency program and other pertinent information, including a new online proposal submission process. Capital items may not be purchased with these funds, and faculty salaries plus fringe benefits will be limited to a maximum of 10% of an individual grant (e.g., for a $20,000 grant, a maximum of $2,000 can be allotted to faculty salaries and fringe benefits).

Investigators who are new to this program are encouraged to solicit an example proposal from the agency contacts listed below.

If you have questions please call the following appropriate agency contacts.

James Hurley, UW Water Resources Institute: (608) 262-0905; hurley@aqua.wisc.edu
Tim Asplund, Dept. of Natural Resources: (608) 267-7449; tim.asplund@dnr.state.wi.us
Jeff Postle, Dept. of Agriculture, Trade and Consumer Protection: (608) 224-4503; jeff.postle@datcp.state.wi.us
Harold Stanlick, Department of Commerce: (262) 521-5065; hstanlick@commerce.state.wi.us

Eligibility

Please note that each agency has separate requirements for eligibility. Review the agency-specific sections carefully. In general:

UWS:	Funds are restricted for use by faculty within the UW System or by academic staff who have achieved nomination to P.I. status.
DNR & Commerce:	Funds are restricted to use by UW System and state and county agency contractors.
DATCP:	Any college or university, research foundation or individual having a demonstrated capacity in pesticide or other applicable research may submit proposals.

Investigators who are not affiliated with the state and therefore not eligible for funding by UWS, DNR, or Commerce may wish to collaborate on a proposal with a UWS investigator or state agency staff member.

A principal investigator with unfinished Groundwater Research and Monitoring Program-funded final reports that are significantly overdue (in the case of UWS by more than six months) with respect to initially specified or understood completion dates will not be eligible for new funding. The Groundwater Coordinating Council may consider extenuating circumstances on a case-by-case basis.

Online Submission of Proposals

(Complete instructions for online submission can be found at the UW Water Resources Institute Web site.)

Proposals for the Wisconsin Groundwater Research and Monitoring Program will be submitted entirely online, through the University of Wisconsin Water Resources Institute's (WRI) Web site at http://wri.wisc.edu. The Web site will be ready for principal investigator registration and proposal uploads after October 15, 2004. **The deadline for submittal of proposals is 5:00 PM Monday, November 15, 2004.**

Please note that investigators will be required to register on the Web site prior to submitting a proposal. Once an investigator has registered, he or she may begin submitting information about one or more proposals, and may update and add new information at any time prior to the proposal deadline. Once all of the information has been provided and checked for accuracy, the investigator will be required to approve the final package for official submission. **Access to the online submission Web site will be closed after 5:00 PM (CST) on November 15, 2004.**

Investigators should be prepared to provide the following information when submitting a proposal online at the WRI Web site (see *Guidelines for Proposal Submission* on page 5 for more details):

- Title
- Investigators
- Abstract (condensed version of project summary separate from the Project Narrative)
- Location of Research
- Target agency ranking
- Adobe Acrobat file (.pdf) of proposal text
- Budget information
- Names and email addresses of three qualified reviewers of proposal, including their disciplines and specialties (at least two must be from outside of Wisconsin)

Investigators will be required to upload a .pdf version of their proposal to the WRI Web site. In order to create a .pdf file, investigators will need to either use Adobe Acrobat software or go online to Adobe's site to create a .pdf file. Adobe offers a monthly subscription for .pdf file creation or a free trial period that enables creation of 5 .pdf files at https://createpdf.adobe.com.

Proposals should be no longer than 18 pages. All pages should be 8.5" x 11". The project summary, narrative, curriculum vitae, and support pages should start on a new page, be double-spaced (except for Figure and Table legends), and use no smaller than 11-point font. All margins should be no less than 0.75 inches. The proposal must be consecutively paginated on the bottom of the page. Include literature citations in the proposal where appropriate (single-spaced within, double-spaced between). **A Word and WordPerfect template will be provided on the WRI web site. We encourage all investigators to use these pre-formatted files for their proposal text.**

Any section of a proposal that exceeds the specified maximum page limits will be grounds for returning the proposal to the author. A *Proposal Guideline Checklist* is provided on page 7 to assist proposal authors.

All proposals must be submitted online. No facsimiles of proposals and no hand-written proposals will be accepted. Special attachments (maps, brochures, etc.) will be accepted, noted, and kept on file, but will not be included in the package of materials submitted to reviewers.

Review of Proposals

All proposals received through the Wisconsin Groundwater Research and Monitoring Program (WGRMP) joint solicitation process receive reviews from the following four groups:

1. External peer review: The UW Water Resources Institute solicits a minimum of four external peer reviews of all proposals. (As part of this peer review process, investigators should provide the names, addresses and email of three suggested reviewers with expertise in the field of the proposal.)
2. The Research and Monitoring & Data Management Subcommittees of the GCC
3. The Groundwater Research Advisory Council (GRAC)
4. Staff from the funding agencies

The two most important considerations of the reviewers are 1) whether the proposal meets agency priorities as outlined in this solicitation and 2) whether the proposal is well written and scientifically sound. Other criteria include:

- project cost
- proposed timeline
- whether the proposed project methodology meets the stated objectives
- whether the resources requested are adequate to carry out the project
- whether the project investigators have the abilities to complete the proposed project
- if applicable, how the proposed project relates to past WGRMP-funded projects and how it may extend our knowledge

Additional review criteria may be applied by individual agencies (see agency-specific sections that follow).

Funding decisions will be made in March 2005. Proposals that are not chosen for funding through this solicitation may be referred to other funding sources for their consideration with permission of the investigators. Likewise, other funding organizations may refer proposals to the funding agencies involved in this solicitation.

Administration of Projects

Proposals that are funded become the property of the granting Wisconsin state agency. Please note that each agency has separate mechanisms for administering funds, and separate requirements for reporting. However, all investigators will be asked to submit a 2-page Project Summary upon completion of the project to be posted on the Water Resources Institute web site, and to make a copy of the final report available to the Water Resources Institute Library. For more information on these requirements, please contact Tim Asplund or James Hurley.

Dissemination of Project Findings

Final reports are required for each project funded through Wisconsin's Groundwater Research and Monitoring Program. Reports from UWS funded projects are kept in the Water Resources Institute Library. DATCP, Commerce, and DNR funded reports are kept on file with the respective agencies, but many are provided to the WRI Library for public distribution as well. All project investigators must submit a 2-page Project Summary upon completion of the final report. These summaries are made available on the WRI web site (http://www.wri.wisc.edu/wgrmp/wgrmp.htm).

Previously, only summaries of the funded projects were available online. During the past year, the Water Resources Library partnered with UW Libraries' Digital Collections Center to digitize and put online most WRI and selected DNR final project reports. The WRI Web site now links to the full-text reports, which are included in the University of Wisconsin Ecology and Natural Resources Digital Collection at http://uwdc.library.wisc.edu/collections.html.

Guidelines for Proposal Submission

(See WRI web site (http://wri.wisc.edu) for complete submission details)

I. Register online at the WRI web site anytime after October 15, 2004. (Each investigator must register.)

A. Name of investigator

B. Title/Position

C. Affiliation

D. Mailing Address

E. Phone number

F. Fax number

G. Email address

II. Enter information about each proposal.

A. Title

B. Investigators (from drop-down menu of investigators previously-registered on the site)

C. Abstract (condensed version of project summary)

D. Location of Research

E. Ranking of agencies in order of preference or relevance for funding (note that the selected order does not exclude consideration of a proposal by any of the agencies, but does assist the reviewers in evaluating the proposal)

III. Upload proposal text as Adobe Acrobat .pdf file. (Please use Word or WordPerfect templates provided on Web site to develop this section.)

A. Title, Investigators, Affiliations of Investigators (top of first page)

B. Project Summary (begin on same page, **not to exceed 2 double-spaced pages**)

1. Specific groundwater or related problem addressed by research/monitoring proposal.

2. What will findings contribute to problem solution or understanding?

3. Project objectives.

4. Project approach to achieve objectives including methods and procedures.

5. Users of project findings.

C. Proposal Narrative (begin on new page, **not to exceed 10 double-spaced pages**)

1. Objectives

2. Background information describing prior research/monitoring relevant to objectives, and if applicable, relationships to other projects funded through the WGRMP; references to ongoing projects and how they relate to proposed investigation; information gaps which will be filled by the proposed project.

3. Project plan outlining experimental design and schedule

4. Methods detailed enough to convince the reviewer that the investigators are up-to-date on modern techniques; a general statement alluding to techniques is not acceptable.

5. Relevance to groundwater and related problems

6. Citations

7. Training support (if any) provided by the project and information dissemination plan.

D. Curriculum vitae of Principal Investigators (begin on new page, **not to exceed 4 pages**)

Include curriculum vitae (including recent publications) of each investigator and state the time each will spend on the project.

E. Current or pending support (begin on new page, **not to exceed 2 pages**)

IV. Enter budget information (entered online at WRI web site).

A. Salaries and wages

B. Fringe benefits (include percentage of grant to be used for faculty salaries, wages, and benefits)

C. Tuition remission charges (if applicable).

D. Supplies and publication costs: list office, laboratory, computer and field supplies separately.

E. Travel to support field operations only. Travel to meetings is excluded because of the limited funding.

F. Other costs: e.g., equipment maintenance and fabrication, subcontracts, rentals, etc.

G. Total direct costs.

V. Submit names and email addresses of three qualified reviewers, including their areas of expertise. (Two of the reviewers must be from outside Wisconsin.)

VI. Review the accuracy of the information provided and submit final proposal package. **(This step must be completed by 5:00 PM on Monday, November 15, 2004.)**

PROPOSAL GUIDELINE CHECKLIST

ITEM	GUIDELINE	THIS PROPOSAL
GENERAL PRESENTATION		
Font	Minimum of 11 point	
Margins	Minimum of 0.75”	
PAGE LIMITATIONS		
Project Summary	Maximum of 2 pages	
Narrative and supplements	Maximum of 10 pages	
Curriculum Vitae	Maximum of 4 pages total and 2 for 1 P.I.	
Current and Pending Support	Maximum of 2 pages	
Entire Proposal	Maximum of 18 pages	
PAGINATION		
Project Summary	Page 1 and 2	
Narrative and supplements	Begin on new page, paginate starting at 3	
Curriculum Vitae	Begin on new page, paginate consecutively	
Current and Pending Support	Begin on new page, paginate consecutively	
LINE SPACING		
Project Summary	Double spaced	
Narrative Body	Double spaced	
Figure Legends	Single spaced	
Tables / Titles	Single spaced	
Citations	Single within, double between	
Training and Info Transfer	Single spaced	
Curriculum Vitae	No specific guidelines	
Current and Pending Support	No specific guidelines	

UNIVERSITY OF WISCONSIN SYSTEM (UWS)
PROJECTS FUNDED
THROUGH THE GROUNDWATER RESEARCH ADVISORY COUNCIL

The UWS, through its Water Resources Institute (WRI) and its Groundwater Research Advisory Council (GRAC), seeks projects of a fundamental or applied nature on any aspect of groundwater research in the natural sciences, engineering, social sciences or law. Projects funded in the current cycle are listed on the WRI web site at http://wri.wisc.edu. The UWS has approximately $200,000 available in FY 06 to fund new projects. The remainder of the UWS groundwater research funds has been committed to ongoing projects.

Applicant Requirements: Most often the principal investigator will be a faculty member on any campus in the UWS. However, academic staff who has achieved nomination to P.I. status by endorsement of the relevant academic dean may serve in this capacity. Projects that appear to be continuations of previously funded projects with two years of UWS support and projects that have been twice rejected will not be considered. The UWS also strives to avoid funding situations where a P.I or co-P.I.'s name appears on more than two UWS projects during any given fiscal year.

Budget Considerations: Projects will not be approved in any one budget cycle for a period of more than two years and then contingent on satisfactory progress. No capital equipment (more than $5,000 per item) may be purchased. Travel for attendance at scientific meetings will not be accepted. Faculty salaries and fringe benefits to be paid from any project may not exceed 10% of the total individual grant (including fringe benefits). Overhead costs are not allowed. Supplies should not exceed 20% of individual grant.

Review of Proposals: Recent literature citations are required for all proposals seeking support from the UWS. Funding decisions are based on ratings by GCC subcommittees and reviews solicited from an international list of experts in the field of the proposed work. The GRAC, which consists of university, state agency, and public representatives, meets as a body to discuss the results of the review process and thereupon to recommend a priority list of projects that the UWS should strive to fund in accordance with budgetary resources. A suitable UWS Groundwater Research Program is then assembled by the WRI and submitted to the GCC before the Department of Administration can release UWS research funds upon passage of a State budget.

UWS Groundwater Research Priorities:
(Presented in no particular order of importance)

- Research on the development and evaluation of groundwater protection and practices.
- Chemical and biological degradation of pollutants in surface soils, subsoils, and groundwater, including identification, toxicity, and persistence of degradation products.
- Transport of pollutants in soil and groundwater, including elucidation of soil and hydrologic factors controlling movement and development or validation of predictive models.
- Impact of waste, and agricultural (including agricultural feeding operations), industrial, or municipal management practices on groundwater quality.
- Characterization of geologic factors affecting groundwater movement, contamination, and aquifer recharge.
- Interactions of groundwater and surface water including chemical transformations in the hyporheic

zone; impacts of groundwater withdrawal on surface waters; influence of groundwater discharge on water quality.

- Wetland impacts on water quality and the interaction of groundwater with wetlands.
- Investigations on the development, understanding, improvement, cost-effectiveness, or utility of innovative biological, chemical or physico-chemical technologies for remediation of contaminated soils and/or groundwater.
- Biological, ecosystem, and human health effects of common groundwater pollutants.
- Field validation of effects of new technologies for on-site wastewater and groundwater treatment on groundwater quality.
- Investigations into the best methods for optimizing groundwater use in Wisconsin, and strategies for long-term management of groundwater.

FY 06 WISCONSIN DEPARTMENT OF NATURAL RESOURCES
GROUNDWATER MONITORING AND RESEARCH PROGRAM

The Wisconsin Department of Natural Resources (DNR) supports a limited amount of monitoring and research on drinking water and groundwater related topics. Funding for these projects has historically come from a variety of state and federal sources and has supported a wide variety of topics (see DNR's Groundwater Research and Monitoring web page at http://dnr.wi.gov/org/water/dwg/gw/research.htm). Recent state budget shortfalls have required the DNR to focus its priorities on projects that fill an immediate need or that more closely match available funding sources. Currently, projects must generally fit under one of the following categories:

1. Management Practice Monitoring: Management practice monitoring is defined as groundwater monitoring or support activities associated with groundwater monitoring, such as laboratory technique development or geologic resource description, for establishing or improving management practices necessary to meet the state groundwater quality standards of NR 140, Wis. Adm. Code.

2. Groundwater Protection Act Monitoring and Research: Recent legislation has directed the DNR to conduct monitoring and research related to interaction of groundwater and surface water, characterization of groundwater resources, and strategies for managing water. These efforts will assist in implementing new requirements for high capacity well approvals and provide information for groundwater quantity management statewide.

3. Wellhead Protection: The state receives funding from the Federal government to implement wellhead protection activities as part of the Safe Drinking Water Act. This category includes activities that support wellhead protection, including groundwater flow modeling, promoting groundwater education and protection at the local level, delineating source water areas, assessing vulnerability of municipal wells to contamination, and encouraging comprehensive planning efforts that include groundwater protection.

The DNR may have up to $140,000 to fund new monitoring and research projects in FY 06 (July 1, 2005 through June 30, 2006), depending upon available funds. In addition, the Department will actively participate in the review of proposals and make recommendations to the other agencies participating in the solicitation to help meet Department priorities. Outstanding proposals may also be considered for funding through other sources. Contact Tim Asplund (608-267-7449) for more information if you intend to submit a proposal.

Applicant Requirements: Funds are restricted to use by UWS investigators and state agency contractors. Others may submit proposals if they include a state-affiliated co-principal investigator. Due to limited funds, the Department encourages applicants to include a UW System eligible investigator to maximize funding options.

Budget Considerations: Proposals will be considered for a maximum of two years. Contracts will be approved on an annual basis. Projects costing less than $35,000 annually will be given greater consideration than more expensive projects. Budget items to be identified should include such things as personnel costs, supplies, equipment, necessary travel, and other appropriate items. State funds cannot support indirect costs or the purchase of capital equipment.

In preparing the budget be aware of the following contractual requirements.

Contractual Requirements: Projects must meet all departmental requirements and guidelines related to groundwater monitoring wells (installation, documentation, and abandonment), sampling, laboratory analysis, and data management. See chapters NR 141 and 149, Wis. Adm. Code for more information.

Investigators shall submit quarterly project status reports to the DNR project manager within 30 days of the end of each quarter. A final report and a 2-page project summary shall be submitted to the project manager within 60 days of the end of the contract period. The final report must contain a thorough discussion of how the results of the project can and should be used by decision-makers.

Review of Proposals: All proposals will be reviewed and rated by DNR staff, and the Monitoring & Data Management and Research Subcommittees of the Groundwater Coordinating Council.

Two important criteria in evaluating each proposal are: 1) whether the proposal addresses a priority issue or an ongoing need as listed below; and 2) whether the project fits under one of the monitoring and research categories specified above. Proposals should contain a clear discussion of the expected practical application of the project results. This will help the reviewer understand the importance of the proposed research, and will ensure that the researcher designs the project with practical application of results in mind.

In making final funding decisions, the DNR's Groundwater Section will formulate its recommendations based on input from all project reviewers and available funds. The Director of the DNR's Bureau of Drinking Water and Groundwater will make the final funding decisions.

DNR Groundwater Monitoring and Research Priorities for FY 06

Priority Issues

Department staff have identified the following priority issues as being of the highest importance for groundwater monitoring and research for FY 06. Unlike the ongoing monitoring needs that follow the priority issues, these are specific ideas for projects for which state groundwater experts see an immediate need. Funding preference will be given to project proposals that address one or more of these priorities.

1) **Information to Support Implementation of 2003 Wisconsin Act 310, the Groundwater Protection Act.** In May of 2004, the state statutes were modified to better manage the use of groundwater resources and provide increased protection to surface waters affected by over-pumping (see summary at http://www.legis.state.wi.us/lc/act_memo/2003/act310-ab926.pdf). The law requires DNR staff to consider the environmental impact of high capacity wells (greater than 70 gpm) if the proposed well would be located near large springs or other sensitive, high quality waters. The law directs the DNR to establish Groundwater Management Areas (GMAs) around Brown and Waukesha counties, where water drawdown is already a significant problem and where over-pumping is creating water quality problems with arsenic, radium and salinity. In order to implement these provisions, the DNR needs additional data and information on the following topics:

   - Identification and mapping of springs - The legislation requires the DNR to review proposed wells that may impact a spring with a flow of > 1 cfs. However, existing information about location and flow rates of springs is limited. An inventory of large volume springs in the state is needed, along with maps and characterization of groundwater flow to these springs. In addition, better information about spring hydrology is needed to better assess impacts of high capacity wells on spring flow rates.

   - Impacts of high capacity wells on surface waters and public water supplies - The DNR is directed to evaluate whether proposed high capacity wells in the vicinity of certain high quality surface water resources (Outstanding and Exceptional Resource Waters, trout streams, large springs) will have a significant adverse impact upon those resources. In addition, wells are restricted if they

impact an existing public water supply well. More information is needed to help the DNR define "significant adverse impact" as well as establish criteria for evaluating proposed wells, including impacts on water quality, flow rates, habitat needs, and existing public water supply wells.

- Evaluation of other potential GMAs - The legislation directs the department to establish GMAs based upon the 150-foot drawdown contour in NE and SE Wisconsin. However, the Groundwater Advisory Committee created by the legislation is directed to identify other areas of the state that may benefit from GMA designation. The DNR is interested in funding projects which gather or use existing information and modeling tools to evaluate potential designation of other areas of the state as a GMA, as well as cumulative impacts of pumping on water resources. Examples may include Dane County, the Little Plover River or other areas in the Central Sands.

2) **Implementation of Statewide Groundwater Monitoring Strategy.** In 2004, the GCC facilitated the creation of a statewide groundwater monitoring strategy. The purpose of the strategy is to provide a common framework for state and federal agencies to use in developing specific groundwater monitoring programs (http://dnr.wi.gov/org/water/dwg/gcc/draftmonitor.pdf). Several components of the strategy require further development in order to enable DNR and others to fully implement the phases of the monitoring strategy. Specific needs include:

- Compilation of existing data on groundwater contaminants - A comprehensive look at existing data for parameters of concern is a starting point for implementing each phase of the groundwater monitoring strategy. Existing databases (Groundwater Retrieval Network, DATCP, UWSP Groundwater Center and others) should be mined for parameters such as nitrate, arsenic, radium, VOCs, and pesticides. Public, private and monitoring well data should be inventoried and assessed on a basin level, aquifer level, or both. Information compiled as part of this component will be used to produce a "Condition of the Groundwater Resource" report.

- Evaluation and expansion of water level monitoring network - The current water level monitoring network (including observation wells and stream flow gaging stations) is not adequate for assessing acute and chronic impacts of groundwater pumping on groundwater levels and stream baseflows. An assessment of the existing network has been completed, along with identification of locations where new observation wells and surface water gaging stations would be beneficial. The next step is to develop a protocol for adding new wells to the network, including an inventory of unused water supply wells that may be suitable for water level and quality monitoring. Another need is to evaluate available methods and estimate or collect stream flow information on small to medium streams not currently included in the network.

3) **Research and Monitoring to Support Wellhead Protection.** The DNR is completing source water assessments for all public water systems in Wisconsin. These assessments include a delineation of the source water area, an inventory of potential sources of contamination, and an assessment of the susceptibility to contamination for each well in the system. Communities will be encouraged to use the information in developing or modifying their wellhead protection plans, as well as in comprehensive land use and water supply planning. Additional research is needed in the following areas to assist communities in this endeavor:

- Hydrogeologic studies to support characterization of vulnerability of municipal drinking water systems to viruses and other emerging contaminants - Limited information exists on the occurrence, transport, and fate of viruses, pharmaceuticals, personal care products, and other emerging contaminants that may impact groundwater-supplied public water systems. Projects are needed that help understand the occurrence and transport of these emerging contaminants, the threat they pose to drinking water systems, and ways to manage contaminant sources within a

source water area.

- Incorporating groundwater and wellhead protection in comprehensive planning efforts - Legislation adopted in 2000 requires all communities that make land use decisions to base those decisions on a comprehensive plan by January 1, 2010. These efforts provide an important opportunity to incorporate wellhead and groundwater protection into land use planning. Studies are needed to identify and evaluate land use planning and management practices that achieve groundwater protection at the local level. In addition, there is a need to develop or evaluate simple tools for local communities to use to understand how land use decisions impact groundwater supplies.

Ongoing Needs

The following topics represent ongoing needs as determined by the Research and Monitoring & Data Management Subcommittees of the Wisconsin Groundwater Coordinating Council, a number of state agency staff, and university researchers. While the Department will give precedence to proposals that meet its priority issues, these needs will be considered in the Department's evaluation of proposals for funding by other agencies. Further information on any of these topics may be obtained by contacting Tim Asplund (608-267-7449).

Groundwater Withdrawals and Connections to Surface Waters – Continued understanding of the implications of groundwater use on groundwater quality, groundwater quantity, and surface water resources is needed. Information needs include estimates of current and projected water use rates, basin-scale groundwater budgets, and quantification of environmental, social and economic impacts of groundwater withdrawals.

Emerging Groundwater Contaminants - Research is needed to determine whether certain emerging substances (pharmaceuticals, antibiotics and hormones, pesticide breakdown products, viruses and other microbial agents) pose a threat to Wisconsin's groundwater resource, and also to human health.

Naturally Occurring Substances in Groundwater - The Department needs more information about the extent and causes of elevated arsenic, sulfate, total dissolved solids (TDS), and radium, low pH, and other naturally occurring water quality problems in order to give advice to homeowners, municipalities, and well drilling contractors.

Land Use Impacts on the Groundwater Resource - Research is needed on the effect of various land uses (e.g. urbanization and agriculture) and management practices on groundwater quality and quantity.

Health Effects of Groundwater Contaminants - Research is needed to better characterize the impact of contaminated groundwater on public health. Pathogenic microorganisms, radionuclides, toxic chemicals (both naturally-occurring and synthetic), and their metabolites are of interest. In addition, the synergistic impacts of contaminant mixtures are of concern to the Department.

Resource Definition – The DNR supports studies that propose to better describe the geologic, hydrogeologic, and geochemical conditions that affect groundwater quality and quantity in specific aquifer or area of the state (e.g. groundwater flow and/or contaminant transport in karst areas).

New Technology - Projects that propose to develop or use new laboratory or field techniques for assessing groundwater quality are encouraged. New applications of existing technologies are also encouraged (for example, characterizing hydrogeologic and geologic formations for management purposes).

Data Management and Integration – The DNR encourages projects that improve existing methods for managing and integrating groundwater monitoring data. Examples include working with state agencies to identify existing archives of data related to groundwater quality and quantity (e.g. monitoring wells, springs); developing a framework for a statewide karst feature database; and improving the system for reporting of water use.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION (DATCP)
PESTICIDE RESEARCH PROGRAM

RESEARCH GRANT PROGRAM FOR FY 06
SOLICITATION OF APPLICATIONS

The DATCP Pesticide Research Program is administered by the Agricultural Resource Management Division. Due to budget constraints, DATCP will not have money to fund any new projects in FY 06. DATCP will, however, take part in the proposal review process and recommend funding for projects that meet their research objectives. Contact Jeff Postle (608-224-4503) for more information about DATCP research priorities if you intend to submit a pesticide-related proposal to another funding agency. Investigators should note that the focus of the DATCP program is on pesticide and nutrient research, which includes but is not limited to groundwater issues.

DATCP Research Priorities for FY 06

1. **Evaluation of Nutrient Management Practices on Water Quality.**

   This research should focus on the effects of nitrogen and phosphorus management practices on groundwater or surface water quality, evaluate models for predicting nutrient impacts on water resources, or evaluate the success of nutrient management planning.

2. **Evaluation of the Environmental Fate Investigation Strategies and Remediation Alternatives for Contaminated Soil and Water at Pesticide Spill Sites.**

   Research should investigate the degradation and movement of pesticides at spill sites, develop criteria on the need for and appropriate extent of remedial actions, and evaluate various methods for investigation and remediation of contaminated soil and water.

3. **Development of Methods for Cleaning Pesticide Mixing/Loading Pads and Disposing of Pesticide Rinsates.**

   Projects should evaluate methods of decontaminating pesticide mixing/loading pads and disposing of or treating pesticide-contaminated rinsate water.

4. **Evaluation of Factors Influencing the Patterns of Groundwater Contamination by Pesticides and Pesticide Metabolites in Wisconsin.**

   This topic involves examining factors which influence pesticide leaching to determine areas of the state that are susceptible to groundwater contamination by specific pesticides.

5. **Use Related Monitoring of Pesticides and Pesticide Metabolites in Groundwater.**

   This project should study groundwater contamination by field application of pesticides in key environmental settings such as fractured bedrock areas.

6. **Use Related Monitoring of Pesticides in Surface Water and the Effect of Management Practices on Contaminant Levels.**

Projects on this topic should determine the impacts of pesticide use practices on surface water quality and evaluate the ability of various management practices, such as stream setbacks, to reduce contamination.

7. **Evaluation of the Effect of Pesticide Use on Endangered Species and their Habitat.**

   This topic should explore how the use of specific pesticides affects the habitat and survival of endangered species in Wisconsin and how alternative pest control methods could reduce problems.

DEPARTMENT OF COMMERCE

ONSITE WASTEWATER TREATMENT RESEARCH OBJECTIVES

The Department of Commerce supports research focused on the performance of onsite sewage system designs, products, and management practices that can be incorporated into the administrative rules regulating onsite sewage systems. These designs, products, or management practices must be:

- Directed toward protecting public health, groundwater and surface water quality;
- Result in onsite sewage treatment that is consistent with the provisions of the Groundwater Protection Law;
- Be affordable by the average owner of an onsite sewage system; and
- Be practical for the climate and soils of Wisconsin.

The Department also intends to monitor on an ongoing basis, the performance of various onsite sewage system methods and technologies. The purpose of the performance monitoring is to provide additional information on the long-term performance of the various onsite sewage system methods and technologies, to confirm their reliability, to provide data for improvements and to monitor long-term compliance with the groundwater standards.

As of September 2004, the Department has indicated that it will not have funds available to fund projects in FY 06. However, the Department will actively participate in the review of proposals and make recommendations to the other agencies participating in the solicitation to help meet Department priorities.

Commerce Research Priorities for FY 06

1. Developing a correlation between dry and wet unit measurements for monitoring treatment in soil absorption units - e.g. Fecal count per gram of dry soil versus Fecal count in cfu's/100ml.

2. Research on treatment efficiency of traditional septic tank/septic absorption systems.