Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August 2007

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Department of Commerce - **Berni Mattsson**
Department of Health and Family Services - **Henry Anderson, MD**
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State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

Jim Doyle, Governor

101 South Webster Street
Box 7921
Madison, Wisconsin 53707
FAX 608-267-7650
TDD 608-267-6897

August, 2007

To: The Citizens of Wisconsin
The Honorable Governor Jim Doyle
Senate Committee on Environment and Natural Resources
Assembly Committee on Natural Resources
Secretary Frank Busalacchi - Department of Transportation
Secretary Mary Burke - Department of Commerce
Secretary Rod Nilsestuen- Department of Agriculture, Trade & Consumer Protection
Secretary Kevin R. Hayden - Department of Health and Family Services
Secretary Scott Hassett - Department of Natural Resources
President Kevin P. Reilly - University of Wisconsin System
State Geologist James Robertson - Geological and Natural History Survey

The Groundwater Coordinating Council (GCC) is pleased to release its 2007 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 23 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 07 (July 1, 2006 to June 30, 2007) and provides an overview of the condition of the groundwater resource. See the *Executive Summary* for highlights and the GCC's recommendations in *Directions for Future Groundwater Protection*. The full report will be made available online.

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

- New research priorities on manure management resulted in four projects related to manure management selected for funding in FY 08.
- The second year of implementation of 2003 Wisconsin Act 310 – the Groundwater Quantity Law - resulted in a Groundwater Advisory Council report to the Legislature identifying issues and making recommendations related to management of groundwater resources within Groundwater Management Areas.
- Key groundwater information and education efforts including teacher workshops, and several publication revisions
- The UW Water Resources Library accelerated efforts to put online groundwater monitoring and research project final reports - see *http://digital.library.wisc.edu/1711.dl/EcoNatRes.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

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) 2007. The full report along with several appendices can be accessed online.

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.

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 07. Examples include:

Setting research priorities on manure management - Responding to numerous groundwater concerns related to improper manure management in FY 06 the GCC Research Subcommittee completed a review of research and monitoring related to the issue and formulated recommendations on related research priorities, data sharing and interpretation. The subcommittee targeted specific research and monitoring topics to be prioritized in the FY 08 joint solicitation. Those priorities were incorporated into the solicitation package and stimulated numerous proposals on the topic. Out of fifteen projects ultimately funded in FY 08 by UWS and DNR, four projects are related to manure management.

Centralizing Access to Groundwater Information for Use in Comprehensive Planning - An interagency team of federal, state and local agencies assisted numerous Wisconsin communities in their comprehensive ("Smart growth") planning by providing groundwater information and data in an accessible and user-friendly manner. The team prepared a centralized website that provides a suggested process for integrating groundwater information into comprehensive plans and webpages for each of Wisconsin's 72 counties.

Information dissemination

- Over 10,000 copies of the popular DNR publication, *Groundwater: Wisconsin's Buried Treasure* were distributed around the state.
- Three groundwater workshops for teachers were taught jointly by staff from the DNR, WGNHS and CWSE at UW Stevens Point. The workshop leaders instructed teachers on using a groundwater sand tank model and provided other groundwater teaching aids. Teachers from 21 different schools and nature centers attended the workshops and received a free model for their school or center.

Coordination of Research and Monitoring- 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 FY 08 solicitation for groundwater research and monitoring proposals was sent out in September 2006 (see *Appendix D*). A total of 22 project proposals were received. A comprehensive review process resulted in the selection of 15 new projects for funding for FY 08, eight by UWS and seven by the DNR. The GCC approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 08 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 07.

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, *Wis. Stats.* in FY 07:

Groundwater Protection Act Implementation – The Groundwater Protection Act (2003 Act 310) expanded DNR's authority to consider environmental impacts on critical surface water resources when considering approval of high-capacity well applications. In FY 07, five groundwater quantity staff began implementing the new programs created by the law. Staff are handling workload associated with high-capacity well registration, fees, application review, data management, inspections, providing staff support for the Groundwater Advisory Committee (GAC), and development of a new rule – NR 820. The new rule was developed by DNR staff with concurrence from the GAC and adopted by the Natural Resources Board. The rule creates a mechanism for evaluating proposed high capacity wells to determine whether the well will have a significant environmental impact on springs, trout streams, outstanding and exceptional resource waters. The rule also defines the extent of Groundwater Management Areas as required by Act 310.

Groundwater project reports online - The UW Water Resources Library disseminates the results of more than 130 groundwater research projects funded since 1989 by UWS, DNR, DATCP and the 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*. 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/1711.dl/EcoNatRes.Groundwater*. Inclusion in the UW Ecology

and Natural Resources online collection should make a wider audience aware of this important groundwater research.

Continued Remediation and Redevelopment of Contaminated Properties

- The DNR approved 586 cleanups of contaminated properties raising the total of approved cleanups (excluding spills and abandoned container responses) to more than 14,000.
- DNR awarded 47 Site Assessment Grants totaling approximately $1.7 million to 30 communities across the state. The grants will provide funds for site assessments and investigations and the removal of tanks, drums and other abandoned containers.
- $4.6 million in State Environmental Fund dollars were used to initiate or continue environmental cleanup actions at over 60 sites where groundwater contamination is known or suspected and the responsible party is unknown, unable or unwilling to conduct environmental restoration.
- In a Wisconsin's Urban Reinvestment Initiative partnership with the city of Milwaukee and the 30th Street Industrial Corridor Corporation, the DNR, continued work on redevelopment of this economically and environmentally distressed area of the state. Site investigations have occurred on more than 30 sites in the Corridor since 2004.

New wellhead protection plans. In FY 07, 21 communities received DNR approval of required WHP plans (for new wells) and 16 submitted voluntary plans to the DNR. There are now 315 communities who have a WHP plan for at least one of their wells. The list is online at dnr.wi.gov/org/water/dwg/gw/whp/communities.pdf.

CONDITION OF THE GROUNDWATER RESOURCE

Major groundwater quality and quantity concerns in Wisconsin include:

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.

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.

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. This combined dataset from DNR's Groundwater Retrieval Network (GRN) database, the Center for Watershed Science and Education database and DATCP's groundwater database, 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 10 mg/L standard.

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.

Radionuclides: Naturally-occurring radionuclides, including uranium, radium, and radon 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. Approximately 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.

Arsenic: Naturally occurring arsenic has been detected in wells throughout 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 practical treatment technologies.

Groundwater quantity. Despite a general abundance of groundwater in Wisconsin, there is a 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 both 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 noted throughout the state. Groundwater quantity legislation enacted in 2004 was the first step towards managing groundwater quantity on a comprehensive basis. The DNR began to implement the provisions of the new law in FY 06 and FY 07.

BENEFITS OF MONITORING AND RESEARCH PROJECTS

The GCC provides consistency and coordination among state agencies in funding groundwater monitoring and research to meet state agency needs. Approximately $13.9 million has been spent by DNR, UWS, DATCP, and Commerce through FY 07 on 342 different projects dealing with groundwater or related topics. While the application of the results is broad, this report describes topic areas where the results of state-funded groundwater research and monitoring projects have been successfully applied to groundwater problems in Wisconsin. These areas include:

- Pharmaceuticals and personal care products
- The Atrazine Rule
- Groundwater monitoring at solid waste disposal sites
- Arsenic monitoring and research in Northeastern Wisconsin
- Groundwater movement in fractured dolomite
- Developing new tools for groundwater protection
- Prevention and remediation of groundwater contamination
- Detection and monitoring of microbiological contaminants
- Groundwater drawdown
- Comprehensive planning
- Microbiological groundwater monitoring
- Rain garden design and evaluation
- Methylmercury formed in groundwater
- Estrogenic endocrine disruptors in groundwater

DIRECTIONS FOR FUTURE 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 limited the number and scope of groundwater research and monitoring projects that were funded in the recent years (see Table 3 in Chapter 2). Cuts continue to hamper the State's ability to address critical groundwater monitoring and research needs in the future. Most of these research and monitoring needs are targeted at identifying strategies to prevent subsurface problems and their costly remediation and thus result in a net savings for the State. 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. **Acute and chronic impacts to groundwater from manure management:** Groundwater contamination resulting from manure disposal has been an increasing problem in recent years for private well owners. A statewide assessment is needed to understand the scope and magnitude of the problem. Mechanisms, pathways, and timing of movement into groundwater, the influence of landscape settings and climatic factors, the applicability of new analytical tools and methods of vulnerability assessment and best management practices (BMPs) and the threat of associated contaminants (bacteria, nitrates, pharmaceuticals, viruses, other pathogens, etc.) all need to be understood better to address the problem. Several projects on this topic have been funded for FY 08. New projects should be sought to address issues and geographic areas not covered by this new research and monitoring.

3. **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 several key groundwater quantity issues. However, questions remain on issues including: water conservation, high capacity well reform, reevaluation of water pricing structures, regional approaches to water quantity issues, and a statewide management plan for water quantity. 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.

4. **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 multi-agency Groundwater Monitoring Workgroup has set up a process and developed some priorities for implementing this strategy. 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.

5. **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. Most of this work has been accomplished by the GCC Education Subcommittee which works with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection and building a groundwater constituency. The GCC will continue to use this network and other means to promote water stewardship and awareness of water quantity issues, find innovative ways to encourage testing of private water supplies, and provide materials for local communities to support comprehensive planning activities.

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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 2007 (FY 07).

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 07. *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 intentionally 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:

- Wells located in a “groundwater protection area” (an area within 1,200 feet of an Outstanding or Exceptional Resource Water or Trout Stream).

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

- 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 directed the DNR to establish two groundwater management areas in Southeastern Wisconsin and the Lower Fox River Valley. These areas 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 includes 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 established the Groundwater Advisory Committee (GAC). The Committee is required 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 directed the 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 is allowed to identify other parts of the state that should be designated as groundwater management areas, and recommend how and when this designation may be removed. In 2005, GAC members were appointed by the Governor and Legislature to represent municipal, environmental, agricultural and industrial interests. The GAC has met regularly from April 2005 through August 2007 and issued a report to the Legislature in December, 2006 regarding groundwater management areas. A second report to the Legislature is required by the GAC by December 31, 2007 regarding its review of the implementation of the new regulations.

The DNR received appropriations and positions to begin implementing the new legislation in the 2005-2007 biennial budget and hired five staff to implement the new law in late-FY 06. In FY 07, these staff began implementing the new programs created by the law. Workload is associated with high-capacity well registration, fees, application review, data management, inspections, providing staff support for the Groundwater Advisory Committee (GAC), and development of a new rule authorized by Act 310. The rule creates a mechanism for evaluating proposed high capacity wells to determine whether the well will have a significant environmental impact on springs, trout streams, outstanding and exceptional resource waters. The rule also defines the extent of Groundwater Management Areas as required by Act 310.

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 07, 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 at least half of its responsibilities related to coordination of the GCC. In FY 06 and FY 07, due to budget cutbacks there was less GCC support than in previous years.

The GCC took an active role in many groundwater issues and activities during FY 07, 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 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*.

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 continued to make linkages to a broader base of people involved in groundwater education (*Key Theme 8)*. Members of the Monitoring and Data Management Subcommittee began implementing a long term groundwater monitoring strategy (*Key Theme 9)*. Several research priorities identified at the Summit were incorporated into agency research and monitoring priorities that yielded projects funded for FY08 *(Key Themes 2, 3 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 making groundwater information more accessible to local governments for use in comprehensive plans.

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 has continued 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

In 2004 a Groundwater Monitoring Strategy was developed by the Groundwater Monitoring Workgroup composed of representatives from the DNR, DATCP, USGS, WGNHS, and UW Stevens Point. The objective of the monitoring strategy is to coordinate groundwater monitoring between all state agencies that regulate groundwater to assess groundwater quality and quantity in

the state. In FY 06 and FY 07 a process for prioritizing wells for addition to the Wisconsin Groundwater Observation Network was developed. In FY 07 the Groundwater Monitoring Workgroup used this process to propose additions to the network.

In the next several 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.

Information and Outreach Activities

In conjunction with the GCC, the UW Water Resources Institute launched an information and outreach project designed to document the accomplishments, impacts and benefits of the GCC and the Groundwater Research and Monitoring Program (GRMP) since their creation 20 years ago. The project will produce an illustrated pamphlet about the activities of GCC and GRMP, plus a series of fact sheets on Wisconsin's most important groundwater resource issues. The pamphlet is planned to be published in August or September 2007. The fact sheets will be produced over the next year. The pamphlet and fact sheets are designed to provide a complementary packet of information with long-term usefulness. Coordinated by the GCC Education Subcommittee, this project represents a truly collaborative effort involving all GCC members.

For the seventh 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 (CWSE) at UW Stevens Point. The workshop leaders instructed teachers on using a groundwater sand tank model and provided additional resources to incorporate groundwater concepts into their classroom. Educators from 21 different schools or nature centers attended the workshops and received a free model for their school. With funding from an EPA grant, 162 groundwater models have been given to schools or nature centers since 2001.

Drinking Water Education programs continue to offer communities across Wisconsin the opportunity to have private wells tested and attend a program to learn more about their community's groundwater quality. In FY 07, nearly 1,000 private well owners in 12 different counties took part in this educational opportunity.

Groundwater: Wisconsin's Buried Treasure a very popular DNR publication, was revised, and printed in FY 06. In FY 07, about 10,000 copies were distributed to educators.

In FY 07, the DNR revised and reprinted *Better Homes and Groundwater* which describes actions that individuals can take to protect groundwater. It is available online at dnr.wi.gov/org/water/dwg/gw/pubs/bhgw.pdf. Another publication that was revised was *Improving Your Private Well Water Quality.*

Centralizing Access to Groundwater Information for Use in Comprehensive Planning

An interagency team of 16 federal, state and local agencies has assisted numerous Wisconsin communities in their comprehensive ("Smart growth") planning by providing groundwater information and data in an accessible and user-friendly manner. Specifically, the interagency team provided personalized assistance for three pilot counties in the form of a 20-30 page report and a locally-tailored presentation for the citizen plan commissioners. The same interagency team prepared a centralized website that provides a suggested process for integrating groundwater information into comprehensive plans and webpages for each of Wisconsin's 72 counties that include current, local data about groundwater susceptibility, sources of drinking water,

groundwater quality, potential sources of contaminants, groundwater quantity, money spent on cleanup and ground-water protection strategies. Agencies involved included USGS, DNR, UWEX, WGNHS, WRWA, DOC, DATCP, Center for Land Use Education, Central Wisconsin Groundwater Center, UW-Madison's Center for Integrated Agricultural Systems, Southwest Wisconsin Regional Planning Commission, private planning consultants and county planning and zoning offices.

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 08 Solicitation for Proposals in August of 2006 (see *Appendix D*). In January 2007, 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.

The GCC help set research priorities on manure management. Responding to numerous groundwater concerns related to improper manure management in FY 06 the GCC directed the Research Subcommittee to complete a review of the issue and to formulate recommendations on related research priorities, data sharing and interpretation. The subcommittee completed its extensive review of manure management monitoring and research in early FY 07. Based on this review and discussion at the August 2006 GCC meeting the subcommittee targeted specific research and monitoring topics to be prioritized in the FY 08 joint solicitation. Those priorities were incorporated into the solicitation package and stimulated numerous proposals on the topic. Out of fifteen projects ultimately funded in FY 08 by UWS and DNR, four projects are related to manure management.

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:

- Research Subcommittee evaluation of research and monitoring related to manure management
- Impacts of manure management on private well water quality
- Acute and chronic groundwater impacts of manure management in Wisconsin
- Groundwater information database for comprehensive planning
- UWS FY 08 groundwater research plan
- FY 08 joint solicitation for groundwater proposals
- WGNHS/USGS Southeastern Wisconsin Groundwater Flow Modeling
- Proposed changes to the triazine screen for the SLOH and Water and Environmental Analysis Lab
- DATCP Lead Arsenate Task Force
- Arsenic well website

- DATCP Well Construction Report image search tool
- UW research on using foundry slag to remove Arsenic in Groundwater
- Groundwater quantity update - including Groundwater Advisory Committee progress
- Great Lakes Compact
- WGNHS Water use project
- UW research on sources of antibiotic resistance in the environment
- WRI Education/Outreach project
- Agency updates

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 formed 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.

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 2007 to review proposals that were submitted in response to the FY 08 solicitation. Subcommittee members made recommendations that were used by the UWS in deciding which groundwater-related proposals to fund for FY 08. The projects to be funded in FY 08 are listed in Table 2.

To address the need for more dissemination of research and monitoring findings, and to ensure that future proposals address pressing state needs, the subcommittee addressed groundwater research and monitoring needs related to manure management at a special topic meeting held in July 2006. The subcommittee concluded that manure management should be elevated to a priority issue in the FY 08 Joint Solicitation. Specific research issues targeted by the subcommittee include the following:

- Impacts of liquid manure, manure digestion, and other new agricultural practices

- Impacts of specific climatic conditions such as drought, floods, or climate change
- Application timing
- Flow and transport mechanisms, and in particular rapid flow paths through fractures or macropores
- New analytical tools such as isotopic methods or microbial source tracking
- Social science aspects; barriers to implementing best management practices
- New contaminants such as pharmaceuticals, microbial pathogens, and viruses

These issues were included as a priority DNR monitoring and research priority in the joint solicitation distributed in October 2006. Four projects related to manure management were selected for funding in FY 08 (two funded by UWS, two funded by DNR). This meeting and other similar future meetings will help efficiently focus limited research and monitoring funds on high priority project areas, 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. Key monitoring and data management items in FY 08 include a new DATCP well construction report mapping tool, a WGNHS Waukesha and Sauk County water use study; and new digital products from WGNHS and DNR;

Subcommittee members evaluated and discussed the 22 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 08.

The subcommittee continued to be a forum for information exchange to prevent duplication of efforts and increase the utility of monitoring data. In FY 07 the MDMS met three times to update one another on their agencies' activities. This year's topics included: DATCP's Atrazine Prohibition Area Repeal/Reuse Study**,** DNR's implementation of groundwater quantity legislation; UWSP Modeling of Little Plover River Basin Groundwater Flow, an interagency **s**prings inventory reporting form, and DNR's well abandonment form scanning.

Education Subcommittee
The Education Subcommittee's 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 in Wisconsin. At each meeting, representatives share information about current agency activities related to groundwater and discuss current and future ideas for informational needs and educational activities.

The subcommittee met four times during FY 07. The members of the subcommittee were involved in a number of collaborative efforts related to groundwater education (See Information and Outreach Activities section of this report). This year the subcommittee has been working with a graduate student hired by the WRI to develop a brochure highlighting the GCC accomplishments over the last 20 years. The subcommittee will continue to work with this student over the next year to develop groundwater related fact sheets for current groundwater issues. Members provided inputs into revisions of popular groundwater publications such as *Improving your private well water quality, Better Homes and Groundwater, Nitrate in Drinking*

Water, and Arsenic in Drinking Water; as well as the Wisconsin Groundwater Directory. During the next year the subcommittee will continue to identify and respond to educational needs on emerging groundwater issues in the state.

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 2004 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 Subcommittee did not meet in fiscal year 2007**.**

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 $13.9 million has been spent through FY 07 on approximately 345 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:

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 07, the DNR has spent approximately $6.3 million on 196 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 07, the UWS has spent $5.3 million on 148 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and 11 were co-funded with WRI through the U.S. 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 07, 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 FY 02. Through FY 07, 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, GRAC, and 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 07 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 07 was distributed in September 2005. A total of 12 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 2006 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 FY 07 funding, by the DNR and UWS. Fourteen ongoing projects were carried over into FY 07. A total of 22 projects were funded through the joint solicitation at a cost of approximately $605,856 (see Table 1).

FY 08 Proposal Solicitation. The SFP was distributed in September 2006 for funding in FY 08. 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 13, 2006.

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 22 proposals were submitted, requesting a total of $781,470 in funding. A minimum of three 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 2007 to rank the proposals. In

addition, the GRAC met in February 2007 to select projects to recommend to the GCC for UWS funding.

A total of fifteen new projects were selected for funding; seven by DNR and eight by UWS. Together, DNR and UWS will fund twenty projects during FY08 for a total of $702,159. DATCP and Commerce will not be funding new projects in FY 08. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 07 will be funded through FY 08. The projects to be funded in FY 08 are listed in Table 2.

State budget shortfalls have limited the number of new projects that were selected for funding during recent years. Commerce has been unable to fund new projects since 2001; DATCP, since 2003. The UWS budget was cut by 10% in FY 04 and again in FY 05. DNR's state groundwater funding for projects has been cut significantly since FY 02 (see Table 3) but the DNR Groundwater Monitoring and Research program has recovered in FY 06 and 07 because of the addition of Federal Wellhead Protection and State Act 310 Groundwater Quantity funds to State Groundwater Management Practice Monitoring funds.

Continued cuts will hamper the state's ability to address critical groundwater monitoring and research needs in the future. Research and monitoring can be extremely cost-effective in that once a problem is established in the subsurface it is much more time, labor-, and cost-intensive to remediate than to use prevention strategies. Without adequate funding for research and monitoring, the best prevention strategies cannot be identified. 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 compiles 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 UW-Madison 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 two-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). More than 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/1711.dl/EcoNatRes.Groundwater*. Inclusion in the UW Ecology and Natural Resources online collection should make this important groundwater research available to a much wider audience.

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 07

Agency	Code	Title	Investigators	University	Cost
DNR	06-DMA-01	Centralizing Access to Groundwater Information for Use in Comprehensive Planning	Markham, Tang and Dunning	UW-Stevens Point, USGS	$23,349
DNR	06-GSI-02	A Survey of Baseflow for Groundwater Protection Areas Western Fox-Wolf Watershed	Kraft	UW-Stevens Point	$29,138
DNR	06-GSI-06	Groundwater Mounding and Contaminant Transport Beneath Stormwater Infiltration Basins	Thompson	UW-Madison	$31,859
DNR	06-GSI-07	Mapping and Characterization of Springs in Brown and Calumet Counties	Fermanich, Stieglitz, Zorn	UW-Green Bay	$4,000
DNR	07-SAM-01	Use of Human and Bovine Adenovirus for Fecal Source Tracking	Pederson, McMahon, Kluender	UW-Madison	$41,262
DNR	06-SAM-01	Evaluating drinking-well vulnerability to viruses	Hunt, Borchardt	USGS, Marshfield Clinic	$32,485
DNR	06-WSP-03	Disinfection of Enteric Viruses in Wisconsin Municipal Groundwater Systems	Harrington, Borchardt, Xagoraraki	UW-Madison, Marshfield Clinic	$13,385
DNR*	07-HDG-01	Precambrian Basement Surface Estimation using Coupled 3D Modeling of Gravity and Aeromagnetic Data in Fond du Lac County and Southeastern, Wisconsin	Skalbeck	UW-Parkside	$14,601
DNR*	07-HDG-03	Groundwater recharge through a thick sequence of fine-grained sediment in the Fox River Valley, east-central Wisconsin	Hooyer, Hart, Bradbury, Mickelson	UW-Ext	$37,997
DNR*	07-CTP-01	Mineral transformation and release of arsenic to solution under the oxidizing conditions of well disinfection	Gotkowitz, Roden, Schreiber, Shelobolina	UW-Ext	$32,137
DNR*	07-WSP-01	Knowledge Development for Groundwater Withdrawal Management around the Little Plover River	Clancy, Kraft	UW-STP	$55,093

The total cost for all FY 07 DNR-funded projects selected through the joint solicitation was $315,306.

UWS*	06-CTP-03	Arsenic Species (III,V) Distribution in Wisconsin Groundwaters: Field Measurements and Prediction Using Multivariate Analysis of Geochemical Data	Shafer, Ellickson, Schauer	UW-Madison	$28,666
UWS**	06-CTP-05	Measuring and Modeling Macroporous Soil Water and Solute Flux Below the Root Zone of a Plano Silt-Loam Soil (on 104B)	Lowery, Norman, Lepore	UW-Madison	$23,560
UWS*	06-CTP-06	Validation of Transport of VOCs from Composite Liners	Edil, Benson, Carlson	UW-Madison	$34,868
UWS*	06-CTP-07	Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer	Kraft, Browne	UW-Stevens Point	$31,784
UWS*	06-GSI-09	Assessing the Ecological Status and Vulnerability of Springs in Wisconsin	Zaber, Swanson, Bradbury, Hart	UW-Madison, WGNHS	$14,143
UWS**	06-GSI-09	Assessing the Ecological Status and Vulnerability of Springs in Wisconsin	Swanson	Beloit College	$14,110
UWS*	06-GSI-10	Climate signals in groundwater and surface water system: Spectral analysis of hydrologic processes	Bravo	UW-Milwaukee	$35,195
UWS*	06-WLA-01	Transient functioning of a groundwater wetland complex, Allequash basin, Wisconsin	Anderson	UW-Madison	$32,772
UWS	07-REM-02	Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses	Hickey, Payne	UW-Madison	$35,670
UWS	07-HDG-05	Application of LSQR to Calibration of a Regional MODFLOW Model: Trout Lake Basin, Wisconsin	Anderson, Zhang	UW-Madison	$32,927
UWS	07-SAM-02	Multi-Parameter, Remote Groundwater Monitoring with Referencing Using Crossed Optical Fiber Fluorescent Sensor Arrays	Geissinger	UW-Milwaukee	$6,855
The total cost of all FY 07 joint solicitation projects funded through the UWS (including fringe benefits and USGS contribution) proposals is $305,723 ($268,053 without USGS, and incl. 6% administration)					

* Continuing project

** UWS continuing project funded with USGS 104 B funds

Table 2: Groundwater Research and Monitoring Projects to be Funded in FY 08

Agency	Code	Title	Investigators	University	Cost
UWS	08-BEP-03	Transport and Survival of Pathogenic Bacteria Associated With Dairy Manure in Soil and Groundwater	Li and Yang	UW-Milwaukee	$31,927
UWS	08-CTP-01	Is phosphorus-enriched groundwater entering Wisconsin streams?	Browne	UW-Stevens Point	$29,505
UWS	08-CTP-03	Occurrence and generation of nitrite in ground and surface waters in an agricultural watershed	Stanley	UW-Madison	$23,956
UWS	08-GCP-01	Geochemical characterization of sulfide mineralization in eastern Wisconsin carbonate rocks	Luczaj and McIntire	UW-Green Bay	$8,554
UWS	08-OSW-01	Monitoring Septic Effluent Transport and Attenuation using Geophysical Methods	Fratta, Hart and Masarik	UW-Madison	$25,132
UWS	08-SAM-03	A thermal remote sensing tool for mapping spring and diffuse groundwater discharge to streams	Loheide	UW-Madison	$30,632
UWS	08-WLA-02	Influence of wetland hydrodynamics on subsurface microbial redox transformations of nitrate and iron	Bahr and Roden	UW-Madison	$34,907
UWS	08-WLA-03	Controls on methylation of groundwater Hg(II) in hyporheic zones of wetlands.	Shafer, Babiarz, Armstrong and Roden	UW-Madison	$38,134
UWS*	07-SAM-02	Multi-Parameter, Remote Groundwater Monitoring with Referencing Using Crossed Optical Fiber Fluorescent Sensor Arrays	Geissinger	UW-Milwaukee	$4,928
UWS**	07-REM-02	Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses	Hickey and Payne	UW-Madison	$37,037

The total cost of all projects funded through the UWS (including fringe benefits and USGS contribution) through the FY08 Joint Solicitation for proposals is $307,171 ($277,171 without USGS -- including 6% administration)

DNR *	07-SAM-01	Use of Human and Bovine Adenovirus for Fecal Source Tracking	Pederson, McMahon, Kluender	UW-Madison	$43,858
DNR*	07-WSP-01	Knowledge Development for Groundwater Withdrawal Management around the Little Plover River	Clancy, Kraft	UW-STP	$43,075
DNR*	07-HDG-01	Precambrian Basement Surface Estimation using Coupled 3D Modeling of Gravity and Aeromagnetic Data in Fond du Lac County and Southeastern, Wisconsin	Skalbeck	UW-PKS	$14,611
DNR	08-HDG-05	Water Balance Modeling for Irrigated and Natural Landscapes in Central Wisconsin	Lowery and Bland	UW-Madison	$39,510
DNR	08-BEP-02	Assessment of virus presence and potential virus pathways in deep municipal wells	Bradbury , Gotkowitz, Borchardt and Hunt	UW-Extension	$52,960
DNR	08-HDG-02	Hydrostratigraphy and Groundwater Flow Model: Troy Valley Glacial Aquifer, Southern Waukesha Co., WI	Mickelson and Anderson	UW-Madison	$48,031
DNR	08-HDG-01	Understanding the Effects of Groundwater Pumping on Lake Levels	Kraft, Clancy and Mechenich	UW-Stevens Point	$34,853
DNR	08-HDG-03	Assessing Seasonal Variations in Recharge and Water Quality in the Silurian Aquifer in Areas with Thicker Soil Cover	Muldoon and Bradbury	UW-Oshkosh	$35,410
DNR	08-HDG-04	Investigating groundwater recharge to the Cambrian-Ordovician aquifer through fine-grained glacial deposits in the Fox River Valley, Wisconsin	Hooyer, Hart, Mickelson and Bradbury	UW-Madison	$52,390
DNR	08-BEP-01	Assessing the Potential of Hormones from Agricultural Waste to Contaminate Groundwater	Hemming, Landreman and Hedman	UW-Madison	$25,041

The total cost of all projects funded through the DNR through the FY08 Joint Solicitation for proposals is $394,988

* Continuing project

** UWS continuing project funded with USGS 104 B funds

Table 3: Groundwater Research and Monitoring Projects Funded from FY 99 through FY 07

Fiscal Year	Total		DNR		UWS		DATCP		Commerce	
	#	$	#	$	#	$	#	$	#	$
New projects										
1999	17	438,689	5	186,766	8	160,333	4	91,590	0	0
2000	16	327,338	6	115,321	9	196,266	1	15,751	0	0
2001	20	578,895	8	276,090	7	165,924	4	78,881	1	58,000
2002	22	626,068	9	281,259	10	252,619	3	92,190	0	0
2003	8	180,621	2	17,864	6	162,757	0	0	0	0
2004	13	375,918	4	124,495	9	251,423	0	0	0	0
2005	8	130,502	0	0	8	130,502	0	0	0	0
2006	18	482,471	9	246,363	9	236,108	0	0	0	0
2007	10	250,930	7	175,478	3	75,452	0	0	0	0
Continuing Projects										
1999	9	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	9	179,441	2	60,623	7	118,818	0	0	0	0
2002	12	234,913	5	155,026	4	37,077	3	42,810	0	0
2003	14	311,237	4	110,198	7	121,039	3	80,000	0	0
2004	3	15,170	0	0	3	15,170	0	0	0	0
2005	9	256,280	3	92,580	6	163,700	0	0	0	0
2006	4	43,485	0	0	4	43,485	0	0	0	0
2007	11	332,429	4	139,828	7	192,601	0	0	0	0
All Projects										
1999	26	676,589	8	289,126	13	281,980	5	105,483	0	0
2000	27	648,509	11	301,542	13	283,266	3	63,701	0	0
2001	29	758,336	10	336,713	14	284,742	4	78,881	1	58,000
2002	34	860,981	14	436,285	14	289,696	6	135,000	0	0
2003	22	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
2006	22	525,956	9	246,363	13	279,593	0	0	0	0
2007	21	583,359	11	315,306	10	268,053	0	0	0	0
Total	214	5,323,458	76	2,270,472	116	2,531,921	21	463,065	1	58,000

2001 DNR figures do not include 71K from Federal 106 funds applied toward FY02 projects

2001-07 UWS figures do not include matching USGS funds (approximately $46 K per year)

Chapter 3 -- SUMMARY OF AGENCY GROUNDWATER ACTIVITIES

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:

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 and Source Water Protection programs.

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

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.

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.

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 NR 140.

The Drinking Water and Groundwater Program (DG) maintains a table listing NR 140 health based enforcement standards, NR 809 state drinking water standards, and established health advisory levels (HALs) for substances in water. 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 it is also 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 with Remediation and Redevelopment program (RR) staff to identify policy issues, develop guidance, and provide training related to the implementation of chs. NR 720, NR 722, NR 724 and NR 726, Wis. Adm. Code. DG staff provide advice and assistance on site investigations, soil and groundwater remediation, and 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 also work with Runoff Management Program staff to ensure that the performance standards for stormwater infiltration established in ch. NR 151, Wis. Adm. Code, comply with groundwater quality standards in NR 140. DG staff participated on a team writing stormwater management guidance for developers, land use planners and government agencies to help assure that stormwater practices meet performance standards while preserving groundwater quality.

Revisions to NR 140 groundwater quality standards were adopted by the Natural Resources Board. These revisions included revised NR 140 groundwater quality standards for butylate, dacthal and naphthalene, and new NR 140 groundwater quality standards for molybdenum. These revisions to NR 140 were adopted by Legislature and are now in effect.

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. Prior to 2004, when the operation of a high capacity well was anticipated to have an adverse impact on the quality or quantity of water available to a public utility well, the DNR was 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 (i.e. Groundwater Protection Areas)
- 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.

In FY 07, five groundwater quantity staff began implementing the new programs created by the law. Staff are handling workload associated with high-capacity well registration, fees,

application review, data management, inspections, providing staff support for the Groundwater Advisory Committee (GAC), and development of a new rule.

Act 310 authorized the creation of an administrative rule to implement the statutory requirements. The new rule – NR820 – was developed by DNR staff with concurrence from the GAC and adopted by the Natural Resources Board. Legislative committee hearings were held April 25 and May 1. The rule creates a mechanism for evaluating proposed high capacity wells to determine whether the well will have a significant environmental impact on springs, trout streams, outstanding and exceptional resource waters. The rule also defines the extent of Groundwater Management Areas as required by Act 310.

Designation of Groundwater Management Areas and required water supply planning for water users in areas with water quantity problems were addressed by the GAC in their December 2006 Report to the Legislature. The GAC and work groups are meeting monthly to evaluate DNR's implementation of Act 310 and prepare their required 2007 Report to the Legislature, due at the end of December.

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.

Representatives of the Private Water Supply Program worked with the Wisconsin Water Well Association and members of the Wisconsin legislature to draft revisions to ch. 280, Wis. Stats. that should result in increased protection of groundwater (as well as increased public health protection.) The changes will go into effect in June, 2008. The significant changes include:

- Well abandonment must be performed by a licensed well driller or pump installer, or someone employed by a licensed well driller or pump installer—homeowners may not abandon their own wells. There is an exemption for wells under the authority of municipal abandonment ordinances.

- Well and pressure system inspections conducted as part of real estate transactions must be done by an individually-licensed well driller or pump installer (not an employee of a licensed person.) Inspection details will be specified in department rules and will require a diligent search for any wells that need to be abandoned.

- Drill rig operators must register with the department and will be required to complete additional training and/or testing requirements prior to becoming eligible to receive a well driller license. Each rig must have a licensed well driller or registered rig operator present onsite to supervise during all drilling activities.

- The department will have authority to issue citations for some violations that don't rise to the level of referral to the Department of Justice, e.g., work done without a license; work on substantially noncomplying existing pump installations (pits, short-cased wells); improper well abandonment; or repeated failure to collect water samples and/or submit well construction reports.

The Private Water Supply Program is currently working with the Well Driller and Pump Installer Advisory Council to develop draft administrative rules to implement the revisions to ch. 280, Wis Stats.

DG continues to promote electronic management of well construction, well abandonment and other information through its website and through semiannual releases of a Water Well Data CD.

The Private Water Supply program continued its surveillance, investigation, and referral of well drilling and pump installation violators to the Department of Justice for prosecution. During the past year violations have included falsification of water samples, failing to notify well owners of repeated unsafe water test results, failing to grout, short casing wells, and unlicensed contractors. Falsification of water samples involves collecting a water sample from a known safe source and claiming it was collected from the newly constructed well. Failure to notify involves well water owners who were not told about the unsafe results for the water they were consuming. 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. Short casing well involves installing less than the code minimum amount of casing, and then reporting and billing for casing that was not installed.

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 trigger the release of naturally occurring arsenic into 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 Chien 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 Department is working with the WGNHS to update and refine the geologic mapping and improve the accuracy of the special casing requirement depths.

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 & Materials, 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. Training for department staff on monitoring well construction and sampling was given at 8 locations around the state last Fall.

Aquifer Storage & Recovery (ASR). Aquifer storage and recovery (ASR) is a technique that involves the direct injection of water into an aquifer for storage and later recovery. Use of the technique was proposed in Wisconsin as a solution to the problem that water utilities face in managing peak seasonal water demand. ASR is offered as a lower cost alternative to more traditional water management approaches that involve construction of additional water storage facilities and the expansion of water treatment plant capacity.

State administrative rules have been established by the DNR to regulate the use of ASR in Wisconsin. Chapter NR 811, Wis. Admin. Code, limits the use of the technique to municipal water systems and establishes standards for developing and operating ASR wells as part of a

municipal water supply system. Demonstration testing is required before routine operation of an ASR well can be approved.

To date, only the municipalities of Oak Creek and Green Bay have attempted to develop ASR wells. Demonstration testing of an ASR well at Green Bay was terminated after significant concentrations of arsenic and other contaminants were mobilized during the injection and storage phases of the ASR well pilot study.

Pilot testing of ASR at Oak Creek has shown that the technology may be viable, although, manganese appears to have been mobilized from aquifer bedrock during the ASR pilot test and levels of this substance in groundwater have increased. Oak Creek has been issued a conditional approval to use ASR, as pilot tested, provided that mobilized substances do not exceed state groundwater quality enforcement standards. Initial sampling results associated with the first Oak Creek ASR system operational cycle after pilot testing shows apparent increased aquifer manganese and iron levels. The levels of both substances in groundwater at the Oak Creek ASR site appear to be significantly above background concentrations, and above state groundwater quality standards. The Department is currently reviewing the submitted Oak Creek ASR site monitoring results.

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 community 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 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) Program. The specific goal of Wisconsin's program is to achieve groundwater pollution prevention in public water supply wellhead areas (area contributing groundwater recharge to a well) 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. The DNR has prepared a video and several publications to assist

communities in their wellhead protection efforts. The DNR also maintains a web page (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 wellhead protection activities in the DNR's Drinking Water System database. The DNR uses this information to report annually to EPA on WHP progress. During FY 07, wellhead protection staff responded to over 30 requests for information. Staff answered questions, sent publications, and reviewed draft plans and ordinances to assist communities in their WHP efforts.

Other highlights include:

- *New wellhead protection plans*. In FY 07, 21 communities received DNR approval of required WHP plans (for new wells) and 16 submitted voluntary plans to the DNR. There are now 315 communities who have a WHP plan for at least one of their wells. The list is online at dnr.wi.gov/org/water/dwg/gw/whp/communities.pdf.

- *Teacher training*. For the seventh 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. Forty educators from 21 schools or nature centers took part in the workshops held at Treehaven (near Tomahawk), Beaver Creek Reserve (near Eau Claire) and Nature's Classroom Institute (near Mukwonago) and were able to take a free groundwater model back to their school. Besides learning how to use the groundwater model, the educators received groundwater resources to incorporate groundwater concepts into their classroom. The intent of the workshops is to provide information for teachers to educate students – and their parents – on the importance of protecting groundwater in their own communities. With funding from an EPA grant, groundwater models have been given to 162 schools or nature centers since 2001.

- *Working with Wisconsin Rural Water Association.* The DNR continues to work with the Wisconsin Rural Water Association (WRWA) in providing assistance to local communities in their protection efforts. WRWA staff work on both plans for individual communities and areawide plans for multiple water supply systems. The DNR and WRWA staff share information and meet as needed to discuss progress and priorities. WRWA staff also helped with the teacher workshops noted above.

- *Providing information*. Information was shared with local communities through a fall newsletter. The DNR also updated the WHP website to make current information available to communities interested in wellhead protection. Among the significant changes were placing the WHP video (*An Ounce of Prevention*) online and updating the example WHP ordinances to eliminate a potential conflict with state statutes regarding pesticide regulation.

- *CRP in wellhead protection areas*. The DNR worked with the federal Farm Service Agency to identify 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.

Groundwater Information and Education. In the spring of 2006, the DNR, with help from other state agencies, revised two widely used groundwater publications. *Groundwater: Wisconsin's*

*Buried Treasure***,** is a 32-page color publication with information on Wisconsin aquifers, the water cycle, groundwater quantity and quality and groundwater protection programs. Over the past year, about 10,000 copies have been distributed to educators.

The *Groundwater Study Guide* booklet and activity sheets were also revised to replace versions last updated in 1990. The booklet contains 13 groundwater exercises for students in grades 6-9 plus introductory information, other groundwater activity ideas, and DPI Wisconsin Model Academic Standards; activity sheets correspond to the exercises. The 2006 version of these 2 documents has been added to the DNR Environmental Education for Kids (EEK!) website and the groundwater education website. Training in the use of these materials was provided at the Wisconsin Association for Environmental Education Conference in the fall of 2006 and the teacher workshops noted above. These materials are also being incorporated into Project Wet training. Between 400 and 500 copies of the booklet and activity sheets have been distributed as part of a packet of groundwater education materials.

In FY 07, the DNR revised and reprinted *Better Homes and Groundwater* which describes actions that individuals can take to protect groundwater. It is available online at dnr.wi.gov/org/water/dwg/gw/pubs/bhgw.pdf.

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. See Chapter Two for more information on the DNR's monitoring studies.

During FY 07, $315,306 was spent on ten projects. Seven new projects were selected for funding in FY 08. More details on the DNR's groundwater monitoring and research activities can be found online.

Final reports and 2-page research summaries are available for many projects from the Water Resources Institute website: *http://wri.wisc.edu/wgrmp/wgrmp.htm*.

In FY 07, DG staff worked with representatives from the DATCP, USGS, WGNHS, and UW Stevens Point on implementing the statewide groundwater monitoring strategy developed in FYs 05 and 06. The objective of the strategy is to coordinate groundwater monitoring between all agencies that assess groundwater quality and quantity in the state. Key components of the strategy include:

- A fixed network of groundwater level monitoring locations
- A statewide assessment of groundwater quality
- A fixed network of groundwater quality monitoring sites
- Surface water monitoring stations, and
- Water use reporting

Over the next eight to 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.

Groundwater data management. Groundwater data from the DNR's consolidated Groundwater Retrieval Network (GRN) system is available online. GRN accesses groundwater data from three database systems in the Waste Management and Drinking Water and Groundwater programs including information on approximately 300,000 wells. These wells represent public and private water supply wells, piezometers, monitoring wells, non-potable wells, and groundwater extraction wells. In FY 07, DG staff continued to improve the locational data associated with GRN's wells and the ease with which the data can be accessed.

The DNR continued to make progress on several other groundwater-related data initiatives in FY 07. DG continued to improve its public water supply well data and coordinated efforts with the RR, WMM, 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 numerous program uses. Work continued to refine and update DGs Mapping Application which is a Geographic Information System that maps locations of public wells, their source water areas, and potential contaminant sources in a format consistent with vulnerability assessment program, WHP, and other DNR needs. Another application, 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 and Materials Management Program

The Bureau of Waste and Materials Management (WMM) 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 by comparing results to groundwater standards over time.

WMM only accepts electronic submittal (via diskette or CD) of environmental monitoring data from landfill owners, labs and consultants. As of January 2006, WMM provides facilities and the public access to the environmental monitoring data contained in its Groundwater and Environmental Monitoring System (GEMS) database. In the future, 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.

WMM 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 most of the identified sites. A more in-depth screening of all closed landfills occurred in November 2006.

In FY 01, WMM 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. One purpose of this study was to determine whether natural attenuation is occurring in groundwater near leaking landfills. The study showed a 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.

Another study in FY 00-01 was done to evaluate the effectiveness of chemical oxygen demand (COD) as an indicator parameter at landfills. Mercury waste is generated when COD is analyzed in the laboratory so the overall goal was to reduce that amount of mercury. 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. WMM staff incorporated the recommendations of this study into code changes that went into effect in February 2006.

A study was done in FY 03 to study groundwater quality at solid waste landfills to determine whether they are a source of pesticide contamination. Eleven sites were sampled and analyzed for 14 common Wisconsin pesticides. 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 have not been 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, Leaking Underground Storage Tanks (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.

Cleanup of groundwater contamination. The program used $4.6 million in Environmental Fund dollars to initiate or continue environmental cleanup actions at over 60 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 over $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 substances threatens 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 and soil are 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 07, DNR awarded 47 Site Assessment Grants totaling approximately $1.7 million to 30 communities across the state. Small grants up to $30,000 make up 38 of the awards, while nine are large grants between $30,000 and $100,000. Local governments have also pledged more than $1 million 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 195 acres of land. Activities include 78 site assessments and investigations, the demolition of 79 buildings or structures and the removal of 230 tanks, drums and other abandoned containers. Since 2000, 352 grants have been awarded to 180 communities around the state for work on 1,185 acres of land.

In addition to the Site Assessment Grants, the RR Program granted funds to local governments through the Brownfields Green Space and Public Facilities Grant program to pay for the remediation of contaminated soil and groundwater at properties that will be reused as parks and public facilities. In FY 07, the RR program awarded grants for the cleanup of 8 different brownfields sites and awarded $995,000.

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. An example of this type of assistance is the DNR's Wisconsin Urban Reinvestment Initiative partnership with the city of Milwaukee and the 30th Street Industrial Corridor Corporation. Through this partnership the RR program initiated work on redevelopment of this economically and environmentally distressed area of the state. The partners have begun site investigation activities on more than 30 sites in the Corridor since 2004,.

In FY 07 the partnership continued with significant progress by:
• Finishing Phase I environmental site assessments at the first 15 properties;
• Continuing Phase II work at a number of these 15 sites as well as other properties; and
• Identifying additional sites for Phase I or II assessment work.

In addition, the partners were also competively awarded an additional $400,000 in site assessment funding from EPA, May 2007. The DNR Urban Reinvestment web page.

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 91 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 07.

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 07, DNR issued a Certificate of Completion at 10 properties for completed cleanups and 21 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 dry-cleaning solvents. Fees paid by the dry-cleaning industry provide program funding. Environmental cleanups at dry cleaner sites are conducted following the NR 700 rule series. To date, there are more than 130 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.

Tracking System and GIS Applications. The program's main database on the status of sites undergoing investigation and/or cleanup is the Bureau of Remediation and Redevelopment Tracking System (BRRTS). In 2000, the program created *BRRTS on the Web*, making the DNR's main database for contaminated properties accessible via the Internet at *http://botw.dnr.state.wi.us/botw/Welcome.do*.

In 2001, revisions to NR 726, 716, 749, and 811/812 implemented a Geographic Information System (GIS) Registry of Closed Remediation Sites to replace the requirement to record groundwater use restrictions at the County Register of Deeds Office. In 2002, additional rule revisions required the inclusion of sites with residual soil contamination on the GIS Registry. The GIS Registry currently includes locational information on sites closed with residual groundwater contamination above the NR 140 enforcement standards and sites closed with soil contamination above NR 720 soil 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. In 2006, new legislation in WI Act 418 replaced the use of deed restrictions for certain sites with residual soil contamination with conditions of closure and placement on the GIS Registry.

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, as well as any responsibilities of the property owner (or occupant in some cases) to comply with any conditions of closure. The site specific information is attached to each site by a link to a .pdf. The GIS Registry can be accessed on the Internet.

The GIS Registry 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 is 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 to determine if additional casing or other construction techniques may be required.

In 2005, an expanded GIS application was made available, called the RR Sites Map. This application shows the locations of the majority of sites available on BRRTS (open and closed), or provides an address for those sites for which geolocational coordinates have not yet been obtained. The RR Sites Map can also be accessed on the Internet. In 2007, programming of additional layers regarding

financial tools and liability clarification actions was conducted, so RR Sites Map will provide more information on redevelopment and cleanup activities.

The GIS applications are linked to *BRRTS on the Web* and are all useful for locating potential contamination sites when evaluating new municipal well placement or for property transactions. 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 *BRRTS on the Web, the GIS Registry and RR Sites Map.*

The RR Program continues to make improvements to both BRRTS and the GIS applications. In addition to the ongoing programming efforts, work continues on quality assurance and quality control (QA/QC) of existing data.

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. DNR has issued specific permits for 357 municipal and industrial facilities that discharge directly to land disposal (groundwater) systems.

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 biosolids, 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 its delegated NPDES (WPDES) permit program, in July of 2000.

Wisconsin Act 347 became effective April 29, 2006 and provides incentives for more wastewater treatment plants to accept and treat septage. This is accomplished through the offer of a zero percent Clean Water Fund loan for the planning, construction of receiving facilities, and additional capacity provided for septage. Facilities whom are upgrading capacity by more than 20% must evaluate septage generation and available disposal options in their planning area during facility planning. Although they are not mandated to provide such capacity they are offered the zero percent loan if they do so. Structures are provided by which Publicly Owned Treatment Works establish costs for receipt of septage and a process is laid out for dispute resolution when such costs are questioned. Land application also remains a viable option when appropriate and the Act provides explicit pre-emptive authority to the state by disallowing restrictive local ordinances if they are not identical to state regulations.

Agricultural runoff. Chapter NR 243 Wis. Adm. Code covers the permitting requirements for livestock operations and contains provisions to protect surface water, groundwater and wetlands in Wisconsin. DNR has revised ch. NR 243, Wis. Adm. Code to address revisions to federal rules that govern the operation and permitting of large concentrated animal feeding operations (CAFO) that were promulgated in April 2003. The revisions to NR 243 improve groundwater protection from CAFOs by increasing setback requirements from community and non-community wells and karst features and further restricting winter applications of manure. The Natural Resources Board adopted the final revisions to NR 243 in January 2007 and it became effective on July 1, 2007.

There are currently 160 WPDES permits issued for livestock operations (85% dairy; 8% 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 larger-scale livestock operations is expected to continue, possibly significantly, due to recent high milk prices.

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 and require construction sites down to one acre of land disturbance to have permit coverage to control erosion during construction. Permit holders are also 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. Provisions to implement NR 243 changes were included in two revised general permits. The general permit for municipal stormwater discharges was reissued on January 19, 2006 (expires on December 31, 2010) and the general permit to regulate stormwater discharges from construction sites was reissued on September 29, 2006 (expires on September 30, 2011).

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. Additional revisions to NRCS Standard 590 were made in September of 2005 that provide additional protections for waters of the state. Although the implementation of the performance standards is limited by the amount of cost share that is available for most livestock operations, NRCS has provided extensive support of nutrient standards implementation through the EQIP cost share program. The state is also looking to provide additional funds for implementing nutrient management planning activities. In addition, nutrient management planning is required whether or not cost-sharing is provided by DNR permits for larger-scale livestock operations and DATCP's Livestock Siting Rule impacting medium-scale livestock operations.

For more information, visit the following website (http://dnr.wi.gov/) or contact Todd Ambs at 608-264-6278 (Todd.Ambs@wisconsin.gov) or Mike Lemcke at 608-266-2104 (Michael.Lemcke@wisconsin.gov), 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. DATCP regulates storage, handling, use, and disposal of pesticides, and the storage and handling 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.

Nonpoint Source Activities

Pesticides. DATCP's primary effort related to nonpoint contamination 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 Environmental 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 06 approximately $90,000 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. $520,000 was budgeted and allocated in FY 06 to provide cost-sharing to write nutrient management plans. In 2005 the total reported acres with nutrient management plans was 772,661 acres. 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 2004, DATCP began operating and managing the state's household hazardous waste program. Approximately $731,500 was made available during 2005 for both agricultural and household programs and more than 600,000 pounds of waste were collected.

DATCP's rules for minimizing environmental damage from agrichemical storage and handling were put in place in 1988. Fourteen 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 farms. To date, more than 600 cases involving soil and/or groundwater remediation related to improper storage and handling have been initiated at pesticide and fertilizer handling facilities or farms. Over this same time period DATCP has also cleaned up over 750 acute spills of agrichemicals.

The ACCP also provides funding for pesticide and fertilizer cleanup activities. Since the program began in 1994, the ACCP has reviewed over 975 reimbursement applications and provided over $30 million in reimbursement payments.

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 FY07.

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 52,000 wells and nearly 300,000 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 GIS 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 or Duane Klein, DATCP, 2811 Agriculture Drive, PO Box 8911, Madison, Wisconsin, 53708-8911; phone: 608-224-4567; e-mail:kathy.pielsticker@datcp.state.wi.us or duane.klein@datcp.state.wi.us.

DEPARTMENT OF COMMERCE

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

Within the Division of Safety and Buildings, 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 (Chapter Comm 82, Wis. Admin. Code) and private onsite wastewater treatment systems by the Private Onsite Wastewater Treatment Systems Program (Chapter Comm 83, Wis. Admin. Code).

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 (Chapter Comm 10, Wis. Admin. Code). The Bureau of PECFA reimburses owners and operators of leaking petroleum storage tanks (Chapter Comm 47, Wis. Admin. Code) and has regulatory jurisdiction of petroleum sites determined to be a low or medium risk to the environment (Chapter Comm 46, Wis. Admin. Code).

Within the Division of Housing and Community Development, one program provides financial assistance for the cleanup and redevelopment of contaminated properties (Chapter Comm 110, Wis. Admin. Code). The Blight Elimination and Brownfield Redevelopment (BEBR) Program provides grants of up to $1.25 million to assist local governments, businesses and individuals with the assessment and remediation of the environmental contamination at abandoned, idle or underused industrial or commercial facilities or sites.

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. The Department plumbing code includes standards for reuse of gray water and stormwater. Currently, with revised stormwater rules, plumbing will be integrally involved with the design and installation of storm systems complying with Chapter NR 151, Wis. Admin. Code.

Private Onsite Wastewater Treatment Systems (POWTS). The Department continues to communicate with the Department of Natural Resources regarding mutual issues of interest such as large onsite sewage systems, mixed wastewater treatment systems and Underground Injection Control (UIC) regulations. The Department also communicates with the USEPA Region 5 office regarding POWTS related matters. Department staff continue to participate 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 Chapter Comm 10, Wis. Admin. 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. Chapter Comm 10, Wis. Admin. Code 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 Chapter Comm 10, Wis. Admin. Code has increased from 143,681 to 210,907 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 June 20, 2007, the database reflects 80,815 federally regulated tanks with only 12,421 tanks in use and 296 in temporary-out-of-service status. In order to maintain a federally regulated tank in use, the tank must have a valid "permit-to-operate." Permit renewal administrative review includes compliance assessment of the owner's financial responsibility. Federally regulated and large fuel oil USTs are subject to periodic inspections involve verification of leak detection, spill and overfill protection, and record keeping.

Program tank permit initiatives have resulted in approximately 92% 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.

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. Mandates required in the Federal Energy Bill of 2005 should have significant positive impact on release reduction as the requirement for secondary containment and owner/operator training is implemented with revisions to the administrative code. 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 $1.47 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 spending authority was $37.6 million in FY07 and is $20 million for FY08. In FY06, the PECFA program reimbursed $21.3 million to 825 claimants. In FY07, the PECFA program reimbursed $21.2 million to 917 claimants. The Program currently reimburses claimants within three months of receiving a claim.

The previous budget bill eliminated the PECFA bonding authority and reduced the Petroleum Inspection Fee from three to two cents per gallon of product sold. The Program's current bond obligation is $272 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.

Blight Elimination and Brownfield Redevelopment (BEBR) Grants
The BEBR program typically receives $7 million each fiscal year to award in grants of up to $1.25 million. Funds may be used for the environmental activities (investigation, remediation or groundwater monitoring), site acquisition, demolition, building rehabilitation or infrastructure improvements.

Since 1998, the BEBR program has reviewed over 290 applications for program funds with grant requests totaling over $150 million. The program has provided over $57 million in grants to assist in the redevelopment of 146 properties with contaminated soil or groundwater.

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. Last year, the PECFA Bureau introduced web reporting to the environmental consulting industry. Environmental consultants will provide data regarding groundwater and soil contaminant levels via the Internet. The data is directly entered into the Department's database and is available immediately to staff for review. The database also stores information on activities associated with on-site sewage system design, installation and maintenance. 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. Governmental units continue to enhance their maintenance reporting abilities. More are expected to follow in the future as the department begins implementation of POWTS program related provisions contained in 2005 Wisconsin Act 347.

For more information, visit the following web site 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 33 rest areas and 75 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 - Environmental Services 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 1,256 salt storage sites listed in the database and 2,403 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 58 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).

Well Access
For the past several decades, DOT has provided access to wells used in the Wisconsin Groundwater Observation Network maintained by USGS and WGNHS. Currently there are 24 wells in the network that are on DOT property.

For more information, visit the following web site (http://www.dot.state.wi.us) or contact Bob Pearson, Environmental Services Section, Room 451, 4802 Sheboygan Ave., P. O. Box 7965, Madison, Wisconsin 53707-7965; phone: 608-266-7980, or e-mail robert.pearson@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 07
Over the past four years, DHFS has worked on developing environmental public health tracking (EPHT) modules to create data systems that link health outcome information with relevant information on hazards and exposures. 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. As part of this cooperative agreement, DHFS has identified and developed environmental public health indicators of priority drinking water contaminants such as total trihalomethanes (TTHMs) and arsenic in community water supplies, and county-level indicators of nitrate contamination of private wells. Additional county-level indicators describing the proportion of the total population served by private or public wells, and surface or groundwater drinking water sources have also been developed. All indicators serve as tools to assist in developing future targeted environmental health analyses.

Other partners in this initiative include DATCP, the Wisconsin State Laboratory of Hygiene, and the UW's Division of Information Technology (DoIT) and School of Medicine and Public Health.

Throughout the project, DHFS has overseen the implementation of multiple environmental public health projects relating to groundwater-related issues. DHFS staff developed a screening-level tool that uses a hazard risk score to estimate where the potential for exposure to agricultural pesticides in groundwater is greatest. The algorithm integrates datasets from DNR and DATCP to characterize the potential for exposure at various geopolitical boundaries. DHFS also worked with DATCP to use previous survey sampling results to explore the relationship between nitrates and pesticides in private wells. The analysis showed a clear trend towards a higher proportion of pesticide detections as the concentration of nitrate-N increases in wells; however, the strength and magnitude of the relationship varied by agricultural regions. This suggests that the relationship is also dependent upon variations in agricultural practices, crop production, geology and soil type.

In 2006-2007, DHFS partnered with DATCP in their groundwater survey of private wells throughout the state by adding a survey questionnaire component. The survey focuses on drinking water consumption and treatment of homes using private wells. It is anticipated that results from the survey will contribute to an increased understanding of drinking water consumption patterns of private well owners within the state, and provide information about the mechanisms by which some private well owners are treating their water.

In 2006-2007, DHFS has also been integral in national CDC-supported initiatives to explore the utility and feasibility of incorporating consistent and comparable drinking water contaminant measures onto a national environmental public health tracking (EPHT) network. DHFS staff co-chair the drinking water workgroup of the State Environmental Health Indicators Collaborative (SEHIC), in which state Safe Drinking Water Information Systems (SDWIS) data have been evaluated for development of state-level public health indicators. Through SEHIC, DHFS established partnerships with the U.S. Geological Survey (USGS) to map and explore geological predicators of groundwater contamination in the state. DHFS has also been an active participant in a national Drinking Water Exposure Methods Workgroup, which has sought to improve methods of estimating community-level contaminant exposures based on monitoring data and water distribution system parameters. The workgroup developed an online tool to survey water utilities and wrote guidance to identify relevant drinking water data and critical data gaps for estimating exposures and using existing data resources in public health assessments. Based on these efforts, DHFS now co-chairs the national content workgroup of the environmental public health tracking program that will be making final recommendations for specific drinking water data and measures to be incorporated into the national EPHT network.

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, 53701.

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 07 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 140 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 pumping from high-capacity wells, 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 FY 07, the Survey initiated or carried out geologic and/or groundwater studies in the following counties: Dane, Calumet, Fond du Lac, Iowa, Outagamie, Pierce, St Croix, Sauk, Washington, Walworth, 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 FY 07 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/*). This work included completion of groundwater flow models for the City of West Bend and the Village of Eagle as well as work in support of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) Regional Water Supply Plan.

b. Continued 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.

c. Geologic mapping and groundwater investigations. 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 Iowa, Pierce, Polk, St Croix, and Waupaca 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 research areas during FY07 include the following:

a. *Aquitard investigation and mapping.* 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 2005 the WGNHS completed two reports funded by the American Water Works Association Research Foundation (AWWARF) for evaluation of the properties of aquitards. See *http://www.awwarf.org/research/topicsandprojects/execSum/2780.aspx*. In 2007 the Survey completed a study of groundwater movement through the Maquoketa Shale, an important aquitard in eastern Wisconsin, and also continued a project evaluating the properties of shallow clayey aquitards in east-central Wisconsin.

b. *Viruses in groundwater*. During 2005 WGNHS hydrogeologists, working with researchers at the Marshfield Clinic, detected human enteric viruses in water from three deep municipal wells in Madison, WI. Detection of infective viruses in such deep bedrock wells was unexpected and has important implications for protection of groundwater quality and human health. The virus presence suggests that the deep wells may be more vulnerable to contamination than previously believed. In FY07 the WGNHS successfully proposed a follow-up study to sample additional wells in the Madison area and to evaluate the pathways and mechanisms of virus transport to the deep wells.

c. *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.

d. *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.

e. *Fluid flow in fractured rocks.* Fractured rocks (limestone, dolomite and crystalline rocks) 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. During FY 07 the WGNHS conducted large-scale inventory work and site-specific studies on fractured dolomite in Pierce, St Croix, and Lafayette Counties.

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.

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.uwex.edu/wgnhs/pdfs/staffpdf/WilcoxBradburyetal2005.pdf

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, is also evaluating methods for tracking groundwater pumping in Wisconsin.

h. *Springs in Wisconsin.* WGNHS scientists are recently participated in a comparative study of springs in Iowa and Waukesha Counties. This study examined the differences between the distributions of the number, locations, and sizes of springs in these two counties as related to geology, land use, population, and development.. A second study, funded by the Wisconsin Coastal Management Program and undertaken in Door County, is delineating the areas contributing recharge to springs that provide critical habitat for the endangered Hine's emerald dragonfly. During FY07 the WGNHS also contributed to the understanding of springs in Wisconsin by providing office space, records, and other assistance to an employee of the Wisconsin Wildlife Federation who is developing a statewide springs inventory that currently contains over 10,000 springs. This work is an outgrowth of the 2003 Groundwater Quantity Legislation (Act 310) and seeks to determine the numbers and types of springs that would be protected under that legislation.

Groundwater data management

During FY 07 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. 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. *WGNHS Research Collections and Education Center (RCEC)*. The WGNHS archives geologic records, rock samples, core samples, and other materials in Mt Horeb, Wisconsin. Currently the RCEC contains over 2.5 million feet worth of drill hole cuttings, more than 600,000 feet of drill core, and more than 51,000 individual hand samples of rock from across the State. Examination tables and basic laboratory facilities at the RCEC allow convenient analysis and study of these materials. 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. Some of these materials are primarily DNR products, but it has proven to be convenient and effective to use our map and publication sales and distribution system.

In FY 08 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, the potential groundwater implications of proposed quarries, gravel pits, and high-capacity wells, and groundwater issues relevant to comprehensive planning have been popular topics recently and probably will continue to provide educational opportunities in FY 08. Several staff members will contribute to professional short courses that educate professionals (such as consultants, regulators, and officials) on technical aspects of well hydraulics, wellhead protection, aquitards, and other hydrogeologic topics..

WGNHS maintains a long commitment to continuing education of water well drillers, pump installers, and plumbing contractors through participation in the programs of the DNR and the Wisconsin Water Well Association. Geologic and hydrogeologic field trips for DNR water staff and new DNR employees have been held in the past and will continue as requested in FY 08. We also provide a collection of representative Wisconsin rocks for teachers to use, which include samples of our major aquifers.

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Gotkowitz, M.B., 2007, Well water for rural residential subdivisions: Using groundwater flow models to evaluate options for water supply, 8 p.

Gotkowitz, M.B., and Gaffield, S.J., 2006, Water-table elevation and aquifer susceptibility maps of Calumet County, Wisconsin: Digital information: Wisconsin Geological and Natural History Survey Miscellaneous Map 56-DI, 1 CD-ROM.

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Hart, D.J., Bradbury, K.R., and Feinstein, D.T. 2006. The vertical hydraulic conductivity of an aquitard: an evaluation of the Maquoketa Formation at two spatial scales. *Ground Water*. v 44, no 2. p 201-211.

Hart, D.A., K.R. Bradbury, D. Feinstein, and B. Tikoff. 2006. Mechanisms of groundwater flow across the Maquoketa Formation. Final Report submitted to Wisconsin Groundwater Research Program at completion of grant number 144-NP30. 47 p.

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Wisconsin Geological and Natural History Survey, 2006, Bedrock stratigraphic units in Wisconsin: Wisconsin Geological and Natural History Survey Open-File Report 2006-06, color plot, available in two sizes: 17.5 x 23 inches and 35 x 46 inches; also available on 1 CD-ROM.

For more information, contact Ken Bradbury, Wisconsin Geological and Natural History Survey, 3817 Mineral Point Road, Madison, Wisconsin, 53705-5100; phone: 608-263-7389; email: **krbradbu@wisc.edu;** ***Web site:*** ***http://www.uwex.edu/wgnhs/.***

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 FY07 included studies aimed at determining arsenic speciation in natural waters (essential to determine toxicity), assessing key ecological characteristics of springs, and determining if climate change signals can be detected in groundwater.

During FY 06, the WRI directed a wide-ranging program of priority groundwater research consisting of 12 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 better understanding of groundwater flow through a fen-stream complex in northern Wisconsin;
- Determining the processes affecting water infiltration through the uppermost soil levels;
- An investigation of the links between antibiotics leaching from onsite wastewater treatment systems and antibiotic resistance of microbes in groundwater;
- A study of speciation of arsenic in groundwater arsenic and its relationship to geochemical characteristics of the surrounding sedimentary deposits;
- Determination of permeability of volatile organic compounds through composite liners in landfills;
- Better understanding the ecological importance and determining indicators of springs in Wisconsin;
- Understanding how pesticides and fertilizers penetrate soils and enter subsurface aquifers in the unglaciated region of Wisconsin;
- Understanding how groundwater responds to climatic fluctations in the upper Midwest;
- Evaluating conditions optimal for biodegradation of organic contaminants in groundwater;
- Better calibration of groundwater flow models to enhance predictive capabilities; and
- Development of fiber-based sensors for real-time monitoring of contaminants in groundwater.

These 11 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 Beloit College.

The UWS selected eight new groundwater research projects from this year's Solicitation for Proposals for support during FY 08 (July 1, 2007–June 30, 2008) (see Table 2). Two projects, selected from the previous year's solicitation, will receive continuation support during FY 08. The new projects are based at UW-Madison,. UW-Milwaukee, UW Stevens Point and UW Green Bay.

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 08 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.

Water Resources Publications

In February 2006, WRI and the UW-Madison Department of Civil & Environmental Engineering published "Design Guidelines for Stormwater Bioretention Facilities" by Dustin Atchison, Ken Potter and Linda Severson. This manual provides design guidelines and a numerical model (RECARGA) that can be used for creating bioretention facilities for small-scale stormwater management that promotes infiltration of storm water in order to reduce its volume, improve its quality and increase groundwater recharge. A basic bioretention facility is commonly referred to as a rain garden. It is a landscaped garden in a shallow depression that receives storm water from nearby impervious surfaces. This document has been extremely popular as our ASC Publications Store has recorded 10,006 downloads (and distributed 265 printed copies) during a period from 3/1/06 through 5/31/07. This has certainly been the most popular document on our web site.

UW Water Resources Library Outreach Activities

During the past year, the UW Water Resources Library maintained its involvement in outreach while continuing to serve university system faculty, staff and students. A highlight of the past year was the launch of a new library outreach Web site, **Wisconsin's Water Library for Kids** (*aqua.wisc.edu/waterlibrary/kids*). From Dr. Seuss to a simple explanation of the water cycle, "Wisconsin's Water Library for Kids" features children's books with aquatic themes that have won awards or appeared on best books lists. Most books are for preschool through second grade children, although there are also materials for older kids. Besides fiction and nonfiction books, the Web site also has ideas and resources for story hours. Users can browse recommended

reading lists by topic (frogs, fish and fishing, Great Lakes, water pollution, etc.) and age group. Any adult Wisconsin resident can check out books online and pick them up at their local public library. Library staff involved three students from the UW School of Library and Information Studies in the development of the site. Tina Yao, the ASC Art Director, used pictures from the Water Library's Allied Drive Story Hour series to design the site.

Library staff also continued to be involved in the "Allied Drive Story Hours" with a story hour in July 2005 based on picture books about frogs. Allied Drive is a neighborhood of Madison, Wisconsin, which is pocket of poverty and crime. The "Allied Drive Story Hours" began during the summer 2004 when the Water Resources Library launched the first of a series of story hour programs. The project has since become a partnership between six other specialized campus libraries, the UW-Madison School of Library and Information Studies, and the Madison School and Community Recreation Safe Haven Childcare Program. The library's July story hour received local television coverage.

Web Sites
WRI maintains several other Web sites in addition those described above. The **UW Water Resources Institute Web Site** (*wri.wisc.edu*) introduces users to the Wisconsin program and includes a variety of information for those interested in water-related issues and research. During the past year, the following sections were updated: project listing, groundwater research database, funding opportunities and conference information.

The **ASC Publications Store** (*www.aqua.wisc.edu/publications*) features publications from both the Water Resources and Sea Grant Institutes. During the reporting period, the publication described above, "Design Guidelines for Stormwater Bioretention Facilities" was added to the online store (see above). Our fact sheets on arsenic in groundwater (1,335 downloads), groundwater drawdown (3,845 downloads) and Wisconsin's groundwater resources (347 downloads) have also been popular. This brings our total distibution of all WRI publications for the reporting period to 16,159.

The **Wisconsin Water Policy Inventory** (*www.aqua.wisc.edu/waterpolicy*) is a web-based tool for researching the state's major policies pertaining to water. This project enables Wisconsinites to browse state policies by category or to search using keywords.

Library Web Sites
In addition to the new **Wisconsin's Water Library for Kids** described above, the Water Resources Library maintains several Web sites, all of which were updated during the past year. The **Water Resources Library Web Site** (*wri.wisc.edu/library*) introduces UW-Madison faculty, staff and students to the library services tailored to them. Two of the most popular pages on that site are "Guide to Finding a Water-Related Job" (*wri.wisc.edu/library/finding_jobsall.html*) and "Guide to Finding Water-Related Information" (*library.wisc.edu/guides/WaterResources/index.htm*).

Wisconsin's Water Library (*aqua.wisc.edu/waterlibrary*) continues to make the books and other materials of the Water Resources Library available to any Wisconsin resident. During the past year, staff updated the entire site and added several special features or annotated reading lists on popular topics, including "Great Lakes Ships and Shipping,""Did you know? Learn more about Wisconsin Waters and the Great Lakes", and "Aquaculture, A Resource Guide." The most popular pages on the Water Library are "Wisconsin Water Facts" (*aqua.wisc.edu/waterlibrary/facts.asp*), "Native Americans and the Environment"

(*aqua.wisc.edu/waterlibrary/nativeamericans.asp*) and "Environmentally-friendly Lawn and Garden Care" (*aqua.wisc.edu/waterlibrary/lawn.asp*).

The popularity of the library Web sites continues to grow. From August 2003 to April 2006, the number of visits per day to the Water Library Web site has grown from 45 to about 300. The average user likes what he sees and spends about 10 minutes on the site. Our library sites (Wisconsin's Water Library + Water Resources Library + our material on the UW-Madison Libraries site) currently receive over 500 unique visits per day.

Information and Outreach Activities

The UW Water Resources Institute has launched a one-year information and outreach project designed to document the accomplishments, impacts and benefits of Wisconsin's nationally unique Groundwater Coordinating Council (GCC) and Groundwater Research and Monitoring Program since their creation 20 years ago. The primary goal of the project is to develop an illustrated booklet about the activities of GCC and GRMP, plus a series of fact sheets on Wisconsin's most important groundwater resource issues, to illustrate the crucial role of the GRMP and GCC in addressing those issues. The booklet—*Saving Wisconsin's Buried Treasure: Twenty Years of Coordinated Groundwater Research and Monitoring*—will be published in August 2007 and distributed statewide with a news release presenting the highlights of the GCC's 2007 Annual Report to the State Legislature.

The booklet and fact sheets are designed to provide a complementary packet of information with long-term usefulness. It is hoped this effort will draw greater attention from state and federal government officials, news media and citizens to the impacts and benefits of the GCC and GRMP over the last two decades. Coordinated by the GCC Education Subcommittee, this project represents a truly collaborative effort involving all GCC members.

UW System Publications Resulting from Recent Wisconsin Groundwater Research and Monitoring Program Projects

Water Resources Institute Reports

2005

Armstrong, D.E. 2005. Role of the hyporheic zone in methylmercury production and transport to Lake Superior. Water Resources Institute, University of Wisconsin, Madison. 21p.

Anderson, M.P. and M.D. Masbruch. 2005. Delineation of Flow Paths, Capture Zones, and Source Areas in Allequash Basin, Vilas County, Wisconsin. University of Wisconsin Water Resources Institute, Madison. 16p.

Cherkauer, D.S. 2005. Providing Communities with the Ground Water Information Needed for Comprehensive Planning. Water Resources Institute, University of Wisconsin, Madison. 11p.

Eaton, T.T., and K.R. Bradbury. 2005. What happens when the confined Cambrian Ordovician aquifer in Southeastern Wisconsin begins to be dewatered? Water Resources Institute, University of Wisconsin, Madison. 19p.

Klett, N., T. B. Edil, C. H. Benson and J. Connelly. 2005. Evaluation of Volatile Organic Compounds in Wisconsin Landfill Leachate and Lysimeter Samples. Water Resources Institute, University of Wisconsin, Madison. 595p.

LePain, D. L., K.R. Bradbury and M.K. Kobb. 2005. Hydrostratigraphy of West-Central Wisconsin: A new approach to groundwater management. Water Resources Institute, University of Wisconsin, Madison. 11p.

Li, Z. 2005. Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation. Water Resources Institute, University of Wisconsin, Madison. 15p.

Markham, L. 2005. Development of Tools to Address Groundwater in Comprehensive Planning. Water Resources Institute, University of Wisconsin, Madison. 26p.

Schauer, J.J., J. Olstadt, J. Standridge, S. Kluender. 2005. A Comparison of Ten USEPA-Approved Enzyme-Based Total Coliform/E. coli Tests for Microbiological Groundwater Monitoring and Laboratory Consultation. Water Resources Institute, University of Wisconsin, Madison. 15p.

2006

Atchison, D., K. Potter and L. Severson. 2006. Design Guidelines for Stormwater Bioretention Facilities. Madison: University of Wisconsin Water Resources Institute. 33p.

Armstrong, D.E., C.L. Babiarz, M.M. Shafer and S.C. Kerr. 2006. Mercury Speciation Along a Groundwater Flowpath. Water Resources Institute, University of Wisconsin, Madison. 20p.

DeVita, W.M. and M. Dawson. 2006. Monitoring Environmental Effects at an Established Phytoremediation Site - Phase III. Water Resources Institute, University of Wisconsin, Madison. 11p.

Grundl, T., K. Bradbury, D. Feinstein, S. Friers and D. Hart. 2006. A Combined Hydrologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI. Water Resources Institute, University of Wisconsin, Madison. 72p.

Karthikeyan, K.G. and J.A. Pedersen. 2006. Fate of Representative Fluoroquinolone, Macrolide, Sulfonamide and Tetracycline Antibiotics In Subsurface Environments. Water Resources Institute, University of Wisconsin, Madison. 17p.

Metz, S.E. and C.H. Benson. 2006. Iron Foundry Slags for Removing Arsenic from Water. Water Resources Institute, University of Wisconsin, Madison. 10p.

Sonzogni, W., J. Hemming M, Barman and S. Geis, 2006. Occurrence of Estrogenic Endocrine Disruptors in Groundwater. Water Resources Institute, University of Wisconsin, Madison. 13p.

Theses

Eberhardt, M. 2006. Metals Leaching from Gray Iron Slags Used in Permeable Reactive Barriers. M.S. Thesis. Department Civil and Environmental Engineering, University of Wisconsin-Madison.

Masbruch, M.D., 2005, Delineation of Source Areas and Characterization of Chemical Variability using Isotopes and Major Ion Chemistry, Allequash Basin, Wisconsin, MS Thesis, Department of Geology and Geophysics: Madison, WI, University of Wisconsin - Madison, 131 pp.

Metz S. 2006. Using Gray Iron Slags for Treating Arsenic in Groundwater M.S. Thesis. University of Wisconsin-Madison Dept. of Geological Engineering.

Root, T.L. 2005. Arsenic in groundwater in southeastern Wisconsin: sources of arsenic and mechanisms of arsenic mobilization. Ph.D. thesis, University of Wisconsin-Madison, Department of Geology and Geophysics.

Other Publications

Cherkauer, D.S. and S.A. Ansari, 2005. Estimating ground water recharge from topography, hydrogeology and land cover. Ground Water 43: 102-112.

Cobb, M., D. LePain and K. Bradbury. 2005. Hydrostratigraphic Data Resources for West-Central Wisconsin. Wisconsin Geological and Natural History Survey Open-File Report 2005-04.

Forshay , K.J. and E.H. Stanley . 2005. Rapid nitrate loss and denitrification in a temperate river floodplain. Biogeochemistry 75: 43-64.

Gao, J., Pedersen, J.A. 2005. Adsorption of sulfonamide antimicrobial agents to clay minerals. Environ. Sci. Tech. 39:9509-9516.

Gu, C. and K.G Karthikeyan. 2005. Interaction of tetracycline with aluminum and iron hydrous oxides. Environ. Sci. Technol. 39:2660-2667.

Gu, C. and Karthikeyan, K.G. 2005. Sorption of the antimicrobial ciprofloxacin to aluminum and iron hydrous oxides. Environ. Sci. Technol. 39: 9166-9173

Hunt, R.J., D.T. Feinstein, C.D. Pint and M.P. Anderson. 2006. The importance of diverse data types to calibrate a watershed model of the Trout Lake Basin, Northern Wisconsin, USA. J. Hydrol. 321(2006):28696.

Li, Z., C.R. Reardon, and C.V. Evans. 2005. Desorption of lead and cesium from kaolinite and illite using cationic surfactants, in: Trends in Agriculture and Soil Pollution: New Research, Nova Science Publishers.

Lowry, C.S. and M.P. Anderson. 2006. An Assessment of Aquifer Storage Recovery Using Ground Water Flow Models. Ground Water 4: 661–667.

Lowry, C.S., M.P. Anderson and R.J. Hunt. 2006. Modeling groundwater flow and heat transport within a fen/stream complex. MODFLOW and More 2006: Managing ground water systems, IGWMC, Golden, CO.

Muffels, C., M. Tonkin, H. Zhang, M. Anderson, T. Clemo. 2006. Application of LSQR to Calibration of a MODFLOW Model: A Synthetic Study. In, Managing Ground-Water Systems, International Ground Water Modeling Center, Colorado School of Mines Golden, Colorado Pages 283-287.

Namdar Ghanbari, R. and H.R. Bravo. 2005. Identification of Groundwater Discharge and Recharge Sites through Temperature Time Series. Hydrological Science and Technology 21, 1-4.

Root, T.L., J.M. Bahr, and M.B. Gotkowitz, M.B. 2005. Controls on arsenic in groundwater in southeastern Wisconsin, in: Vlassopoulos, D.; Benning, L.; Meng, X., and O'Day, P., Advances in Arsenic Research, American Chemical Society Symposium Series.

Stoor, R.W., J.P. Hurley, C.L. Babiarz and D.E. Armstrong. 2006. Subsurface Sources of Methylmercury to Lake Superior from a Wetland-Forested Watershed. Sci. Total Environ. 368: 99-110.

For more information, visit http://www.wri.wisc.edu/ or contact Dr. Anders W. Andren, Director, UW-Madison Water Resources Institute, 1975 Willow Drive, Madison, WI 53706; phone (608) 262-0905, fax (608) 263-2063, or email awandren@seagrant.wisc.edu.

UW-Extension's Central Wisconsin Groundwater Center

The Central Wisconsin Groundwater Center provides groundwater education, research 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 2006, the Center assisted over 3,000 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. Thirteen Drinking Water Education Programs helped over 1,000 well users in 12 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 483,144 individual test results for approximately 63,789 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-nine counties are represented by 100 or more samples in the databases and 30 counties are represented by 500 or more samples.

Policy. The Center 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. Center staff serves on the Technical Advisory Group of the Groundwater Advisory Council, the Northeast Wisconsin Karst and Manure Management Task Force, the Drinking Water Quality Partnership.

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, and Extension Nutrient Management Self-Directed Team. The Center continues to work closely with

local governments, Land Conservation Departments, Groundwater Guardian groups, and many local watershed based groups.

Other UW-Extension Water Programs

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).

EYPAW offers four guides and a water curricula database to 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 190 water-related curricula that may be searched by grade level or water topic.

Goals of the GWAH curriculum are to protect and improve local water quality by encouraging youth to investigate local issues, and to plan and complete a service project. Youth then address a problem they identify with the assistance of a local natural resource expert. Program materials 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
- *Evaluating USGS Water Education Resources* – an assessment of USGS materials to assist with USGS education program development decisions
- *Source Water Education* – a gap analyses of youth water curricula for source water education and riparian education resources.
- *Water Action Volunteers (WAV)* – a program for both kids and adults who want to learn about and improve the quality of Wisconsin's waterways through projects and hands-on activities.

Work continues on new water education initiatives including a national youth riparian curriculum, and the National Extension Water Outreach Education project 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.

UWS Farm and Home Environmental Management Program. The UWS Farm and Home Environmental Management Program, originally Farm*A*Syst and Home*A*Syst, enable and motivate urban and rural landowners, managers and residents to assess environmental and health risks and to take voluntary actions to prevent pollution. Projects focus on everything from long-term investments in structural design and siting to daily management practices.

Recently, the program has collaborated with commodity and farm organizations, environmental organizations, government agencies and the private sector to test and evaluate the potential of EMS on Wisconsin dairies. Also, through a grant from the North Central Region Sustainable Agriculture, Research and Education Program (NCR-SARE) is supporting research on six different regulatory and eco-label approaches to managing the environmental impacts of Midwestern dairy farming. Research involves identifying specific environmental goals of different programs and how they might be complemented with an Environmental Management System to strengthen farm sustainability. In addition, the Farm & Home Program recently concluded a two-year study of the use of Integrated Pest Management by professional landscapers in the Lake Monona Watershed. Data from this research was shared with community

collaborators and used to develop a prototype outreach and education strategy to promote the use of IPM. Visit: http://www.uwex.edu/farmandhome/monona.

Additional information is available at http://www.uwex.edu/farmandhome/.

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 more than 150 nutrient management education projects since its inception in 1997. These projects have resulted in awards of over $2 million in educational assistance funds to county-based conservation professionals in Wisconsin who in turn deliver research-based best management practices and expertise into the hands of farmers on an individual basis.

MALWEG partners, such as US Department of Agriculture Cooperative State Research, Education and Extension Service and Natural Resource Conservation Service, UW-Extension, Wisconsin DNR, the Basin Education Program and Discovery Farms, have contributed funding and time to this milestone effort. The counties have also matched a considerable amount of resources to reach more than 1,400 farmers since 1997. More information can be found at http://clean-water.uwex.edu/malweg/.

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 geology, and a variety of other water quality issues. More information can be found at http://basineducation.uwex.edu.

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. 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 hundreds of producers. NPM also coordinates training workshops for Nutrient Management Planners that teach agricultural and conservation professionals how to write nutrient management plans. 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).

For more information on UW Extension programs related to groundwater, 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 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 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 incidents 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, (1) instructional consultations for well owners and well drillers, (2) on-site training of municipal water supply operators, and (3) tours for a variety of international, educational, regulatory, and other governmental groups. Staff members have developed an interactive study guide dealing with safety, sampling, and chemistry for drinking water operators and publications related to drinking water. In FY 07 WSLH updated their well water activity sheet, *Test your well water annually* brochure, and other well water testing promotional materials for National Public Health Week. Staff members attend and present papers at a variety of conferences and symposia and publish research findings in professional journals.

Summary of groundwater-related research in FY 07.

Two research projects funded through the GCC's Groundwater Research and Monitoring Program were completed:

- *Evaluating the occurrence of endocrine disrupting chemicals in high capacity wells under the influence of surface waters and in water supply wells near on-site wastewater treatment systems.* Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene.

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

One research project funded through the GCC's Groundwater Research and Monitoring Program was selected for funding in FY 08:

- *Assessment of the potential of hormones from agricultural waste to contaminate groundwater*. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene.

Other current groundwater-related research projects:

- *Assessing occurrence, persistence and biological effects of hormones released from livestock waste.* Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene. (funded by the Environmental Protection Agency).

- *Toxicological Relevance of Endocrine Disruptors and Pharmaceuticals in Drinking Water*. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene. (funded by the American Water Works Association Research Foundation – AWWARF)

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 53718, phone (608) 224-6200, or email sonzogni@facstaff.wisc.edu.

FEDERAL AGENCY PARTNERS

U.S. Geological Survey: Water Resources Discipline - Wisconsin Water Science Center
The mission of the U.S. Geological Survey-Water Resources Discipline 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, UW System, UW-Extension (WGNHS and CLUE), Southeast Wisconsin Regional Planning Commission (SEWRPC), the Menominee and Stockbridge-Munsee Tribes of Wisconsin, and numerous county and city 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 summary.
3. Investigation of the hydrology of southeastern Wisconsin and development of a Regional Water Supply Plan.
4. Installation of ground-water monitoring wells for instructional purposed for UW-Platteville.
5. Simulation of groundwater/surface-water systems in Pierce, St. Croix, and Polk Counties.
6. Evaluation of drinking water vulnerability.
7. Simulation of the effects of the Shell Lake water diversion, Washburn County, on the shallow ground-water – lake system.

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. Prediction of groundwater susceptibility to contaminants to protect the St. Croix National Scenic Riverway (National Park Service and USGS funded)
5. Spatial and temporal shallow groundwater recharge rates in Wisconsin (USGS funded).

The USGS contributed a number of significant accomplishments to help protect Wisconsin's groundwater in 2007:

Modeling of ground-water flow - Simulation of the Shallow Ground-Water-Flow System near Grindstone Creek and the Community of New Post, Sawyer County, Wisconsin

Grindstone Creek is a 3-mile-long stream near Hayward, Wisconsin that receives much of its flow from four spring complexes. Because the springs are fed by discharge from the ground-water system, hydrologic stresses to the ground-water system could reduce springflow and related streamflow. In order to assess the effects of stresses on the creek, a study was done by the U.S. Geological Survey (USGS), in cooperation with the Lac Courte Oreilles Band of Lake Superior Chippewa (LCO). Initial study objectives were to measure streamflow in Grindstone Creek and, by use of an analytic element ground-water model, simulate the effects of proposed pumping for golf-course irrigation on base flow in Grindstone Creek. In addition, capture zones for existing and possible replacement wells for the community of New Post were delineated, capture zones were simulated to extend from the well locations to an area south of the pumping well locations. Simulated steady-state pumping at a rate of 9,600 gallons per day (gal/d) from one of the possible replacement wells near the Chippewa Flowage induced 70 gal/d of water from the flowage to enter the aquifer. Although no water-quality samples were collected from the Chippewa Flowage or the ground-water system, surface-water leakage into the ground-water system could potentially change the local water quality in the aquifer. Complete information about this study can be found in the USGS Scientific Investigations Report 2007-5014 located at the following site: http://pubs.usgs.gov/sir/2007/5014/pdf/SIR_2007-5014.pdf

Modeling of ground-water flow - Simulation of the Shallow Ground-Water-Flow System near the Hayward Airport, Sawyer County, Wisconsin

The Sawyer County Airport near Hayward, Wisconsin has expansion plans which will necessitate changes to land cover in about 135 surrounding acres. Concerns have been expressed by regulatory agencies regarding potential effects of these changes, along with about 2 acres (distributed) of wetland fill, on the local hydrology. Specifically, it has been expressed that "vegetation removal and hydrologic changes could lead to thermal, flow, and other impacts to a tributary to the Namekagon River, identified as a Class I trout stream". The USGS, in cooperation with Wis DOT and other state and federal agencies, refined an existing regional two-dimensional, steady-state ground-water-flow model to evaluate the shallow ground-water flow system near the Airport (Juckem and Hunt, 2007). Local refinements to the regional model included one additional hydraulic conductivity zone for the local airport area and three additional parameters for streambed resistance for the tributary stream of interest and the Namekagon River. The refined model was calibrated to current conditions and was then used to simulate the capture zone of a small tributary stream north of the airport. The contributing area to the tributary stream was simulated by the calibrated refined model to be about 150 feet wide and extend generally east for about 7000 ft. Agencies are using these results to complete remaining required sections of the Environmental Assessment. A USGS report is in review and is expected to be released late in 2007.

Web Site – Protecting Wisconsin's Ground Water Through Comprehensive Planning

In cooperation with the UW-Extension Center of Land Use Education and the Wisconsin DNR a web site has been developed to make Wisconsin ground-water information and data accessible and usable, thereby encouraging government officials and planners to incorporate ground water into their comprehensive-planning processes. Comprehensive plans that adequately address the range of ground-water issues will play a very important role in protecting the ground-water resources of their communities and the state. This web site provides summaries of, and access to, data and information on geology, general hydrology, and ground-water quantity and quality generated by state, local, federal, and independent sources. The data and information take the form of maps, reports, data bases, and web resources. All data are from publicly accessible

sources. This web site also provides guidance in incorporating ground-water information into comprehensive plans, and presents case studies of municipalities that have worked hard to understand their ground-water resources and develop ground water goals, objectives, and policies. Funding for development of this web site comes from the Wisconsin Department of Natural Resources through the Joint Solicitation for Groundwater Research & Monitoring of Wisconsin's Ground Water Coordinating Council. Additional funds were provided by the US Geological Survey Cooperative Water Program. Project support was provided by the UW-Extension Center for Land Use Education and the USGS Wisconsin Water Science Center. Long term hosting and maintenance of the site is undetermined; the site can be currently accessed at the following location *http://wi.water.usgs.gov/gw_comp/index.html*.

Field Studies - Evaluating the Effects of Nearshore Development on Wisconsin Lakes

The rapid rate of shoreline development in Wisconsin has raised concerns that future development may impair water quality in lakes. Shoreline development can increase runoff volume as well as sediment and pollutant loads. To better assess the effects of development on lakes, the U.S. Geological Survey and the WDNR conducted several studies on how nearshore development affects flows of water and nutrients to lakes. The results of the studies demonstrate that the conversion of undeveloped wooded areas into lawns can significantly affect flow of both water and nutrients to lakes. Large increases in lawn nutrient contributions were due to increased runoff volumes; therefore, reducing runoff to a lake is critical for minimizing adverse effects. Ground water was also affected by the degree of development. Both nearshore areas and distant areas supplied ground water and ground-water-transported nutrients to the lakes. Thus, lake protection should have a watershed focus in addition to a focus on nearshore areas. More information on these studies can be found in a USGS Fact Sheet at the following site: http://pubs.usgs.gov/fs/2006/3033/pdf/fs_2006-3033.pdf

For more information please contact Charles Dunning, (608-821-3827*), cdunning@usgs.gov, *Randy Hunt (608-821-3847), rjhunt@usgs.gov, *Paul Juckem (608-821-3845), USGS, 8505 Research Way, Middleton, Wisconsin, 53562-3581 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 2006 (Oct. 1, 2005 to Sept. 30, 2006), NRCS planned over 520,000 acres of conservation systems and applied over 522,000 acres in Wisconsin 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 1584 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. Last year pest management was implimented on 136 farms on 40,000 acres

- *Animal waste storage*: proper waste storage siting and design is imperative to protect groundwater from contamination by nutrients in animal waste. Last year 52 animal manure storage structures were planned and 64 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 written for 170 farms.
- *Managed grazing:* Pastureland is divided into small paddocks and intensively grazed for 1 or 2 days and then rested for 25-35 days. About 300 prescribed grazing plans were written covering 28,500 acres. Prescribed grazing was applied to 23,000 acres.
- *Wetland Reserve Program*: restores wetlands through permanent or 30-year easements or 10-year contracts. The total acres enrolled in WRP is approximately 45,000.
- *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. In 2006 a total of 1,182 contracts for $17.16 million were signed.
- *Well decommissioning*: proper decommissioning is essential to prevent contaminants from entering groundwater through abandoned wells, which are direct conduits to the groundwater. NRCS planned 101 well decommissionings, and completed 53.
- *Conservation Reserve Program/Conservation Reserve Enhancement Program*: participants establish permanent vegetative cover on agricultural lands in return for guaranteed rental payments.
- *Dam rehabilitation pilot projects*: 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 completed the rehabilitation of 11 deteriorating dams in seven western counties. These accomplishments resulted in obligating of $4.5 million in federal rehabilitation funds. In an average year, these projects reduce flood damages on crops, roads, and communities by an estimated $2 million.
- *Conservation Security Program*: In 2006, the Grant-Little Maquoketa and Lake du Bay watersheds were eligible for CSP, a program to reward good land stewardship and provide incentives to farmers to increase and enhance their conservation practices. Wisconsin has enrolled 195,159 acres and 649 farmers form six watersheds in the three years that CSP has been offered. Last year, the average first year payment was $6,492 for CSP farmers in Wisconsin with total CSP payments of $4.2 million in 2006. 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 was revised in 2005. This revision enhances groundwater protection by promoting better nutrient management and minimizing agricultural nonpoint source pollution of surface and groundwater resources. .

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, *Directions for Future 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 about 20,000 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.

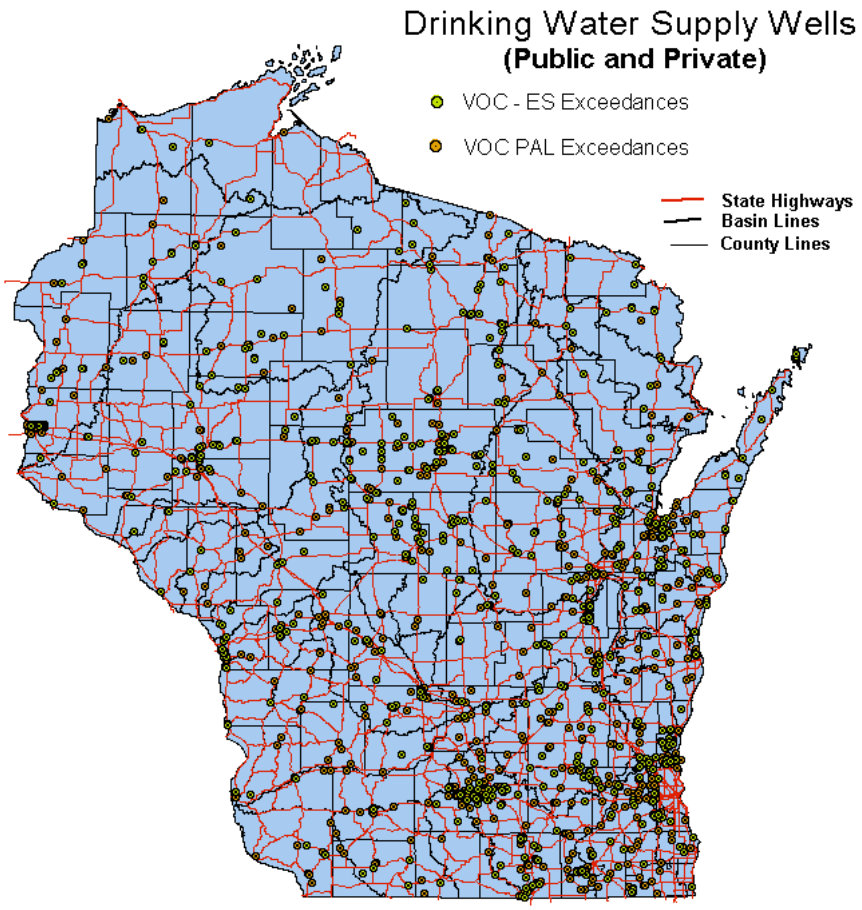

Figure 4.1 Volatile Organic Compounds (VOCs) past enforcement standard (ES) and preventive action limit (PAL) exceedances for public and private drinking water supply wells. Source DNR

Landfills. Two studies conducted over four years revealed that VOCs were significant contributors to groundwater contamination at Wisconsin landfills (DNR 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 (USTs) with a capacity of 60 gallons or greater to be registered with the Department of Commerce. Since 1991, this registration program has identified over 175,000 USTs of which over 80,000 are federally regulated and only about 12,500 tanks are 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. There are approximately 140 sites statewide subject to corrective action authorities, and DNR's Bureau for Remediation and Redevelopment is overseeing investigation or remediation at approximately half of these sites. Generators improperly managing hazardous waste are another source of VOC contamination. The majority of hazardous waste projects are being 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.

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DNR, 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), metolachlor (Dual) and acetochlor (Harness)
- Atrazine and its metabolites
- Metribuzin (Sencor)

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, an herbicide used on corn, is one of the pesticides most often found in private drinking water wells in Wisconsin. There are significant health concerns for humans and wildlife associated with atrazine. Recent studies have found that male frogs develop both male and female sex organs when exposed to concentrations of atrazine at $1/30^{th}$ of the current drinking water standard (Hayes et. al. 2002 and Hayes et. al. 2003)

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

- 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.

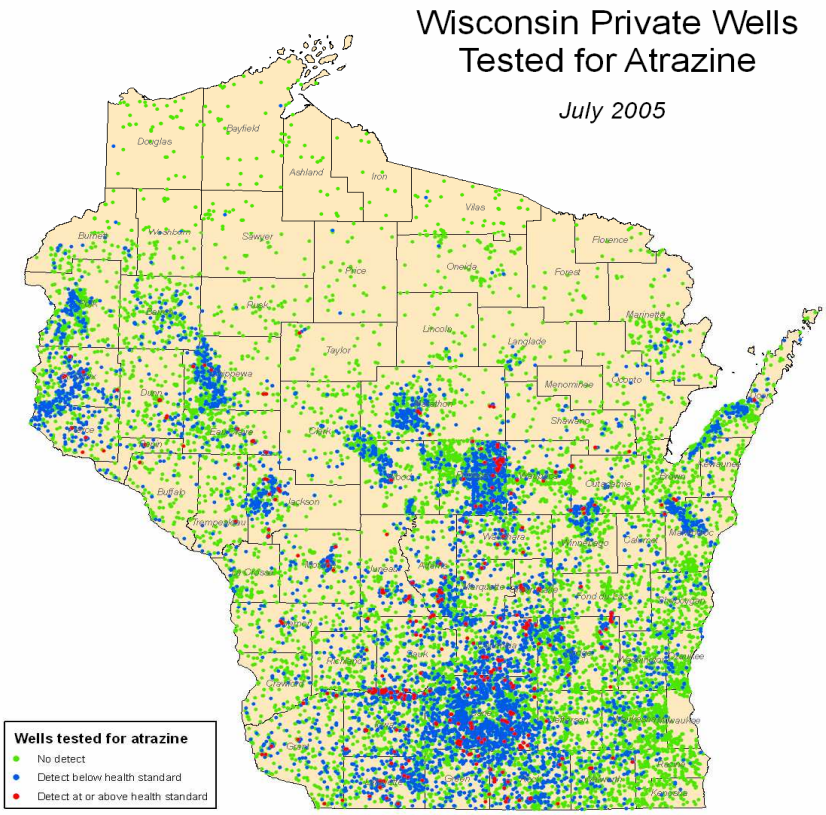

Figure 4.2 Private wells tested for atrazine in Wisconsin as of July 2005. Source: DATCP

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 statistically 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 2005, with samples collected from 150 different wells at least once during this time period. As of 2006, atrazine levels had gone down in over 80% of the wells. Seven 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 2005, this study entered its 20th program year. In 2006 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 through FY 05, DATCP monitored the limited reuse of the herbicide atrazine in selected areas where atrazine use has been prohibited. DATCP gathered the data to see if renewed atrazine use at current restricted use rates will cause groundwater contamination. DATCP monitored groundwater quarterly at 17 fields, 10-40 acres in size, for 5 to 7 years. The data showed that all of the sites that followed study protocols exceeded the ES for atrazine at some point during the study. The nitrate enforcement standard was exceeded at 100% of these sites over the same sampling period. A technical advisory committee reviewed the study results and recommended that the atrazine prohibition areas remain in place, the DATCP Board concurred.

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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 (NO_3-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).

A 2002 random survey of private wells by DATCP showed an estimated statewide exceedance rate of 14%, with the highest exceedance rate in the south central counties of Wisconsin of 21%. 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 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.

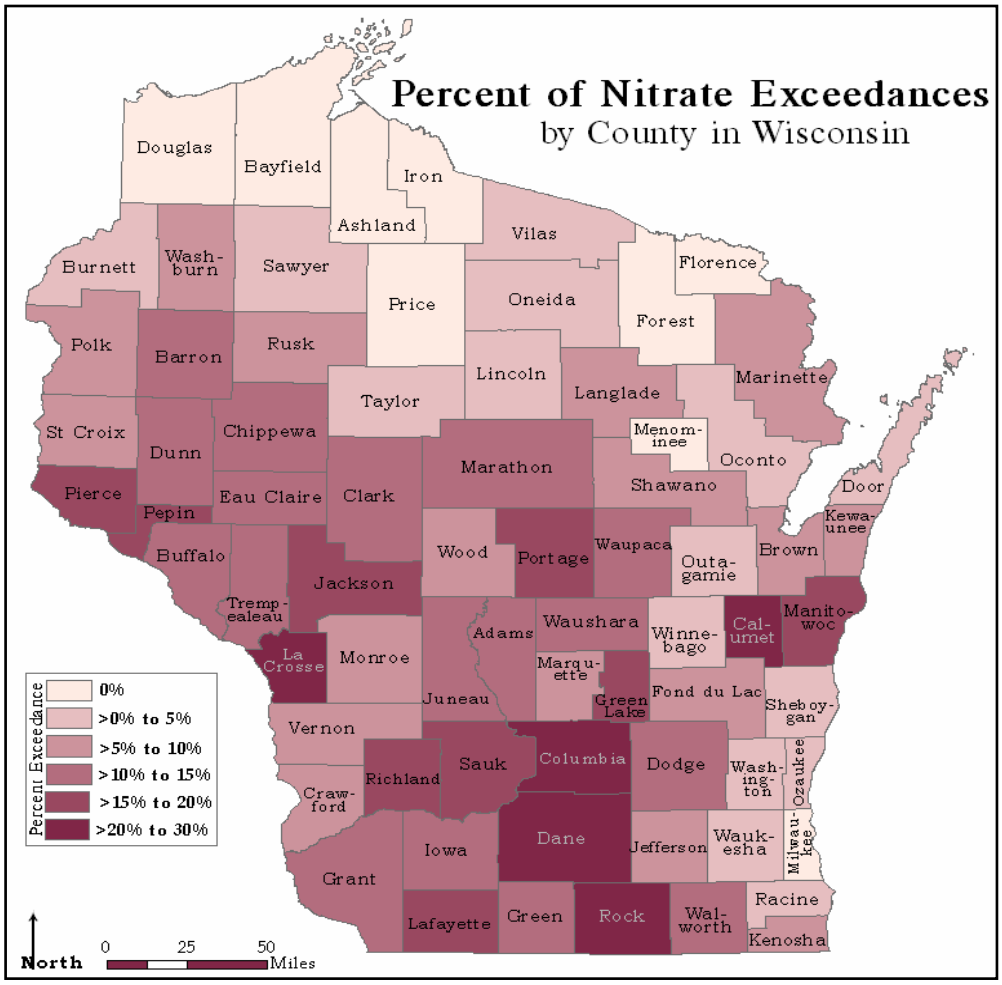

Figure 4.3 - Percentage of nitrate samples from private wells exceeding 10mg/L by county. Date sources: DNR, Center for Watershed Science and Education, and DATCP groundwater databases.

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 municipal water systems have exceeded the nitrate ES and have collectively spent over $24 million on remedies. Excessive nitrate levels have also forced the replacement of hundreds of other smaller public wells.

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, but rarely are. 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. Recent changes to state rules that should decrease groundwater nitrate contamination (at least near existing wells) include:

> NR243 – Should 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. This proposed rule applies to large Concentrated Animal Feeding Operations, 1000 animal units and larger. There are about 150 of these permitted operations currently.
> ATCP51 – With its emphasis on water quality protection, this new livestock siting standard affords protection to areas susceptible to groundwater pollution, requires standards that prevent runoff from entering sinkholes, ensures that existing storage structures do not leak, and requires application of manure according to plan that minimizes risks to groundwater. It imposes standards that reduce water pollution risks including the potential for well contamination. This adopted rule applies to new and

expanding farms, typically over 500 animal units and would apply to about 70 farms annually.
ATCP50 – This rule applies to all farms and requires all farms in Wisconsin implement nutrient management plans by 2008. Similar to NR243 and ATCP51 it requires farms to use UW recommendations for nutrients including nitrogen and phosphorus. As mentioned in the introduction, current over-application of nitrogen sources to farm fields likely accounts for most of the nitrate loading to groundwater in the state. Application according to UW recommendations will reduce nitrate loading and improve groundwater quality.

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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 were also waterborne illness outbreak at Door County restaurants in December 2004 (Wisconsin DNR) and May 2007. Water samples collected from the later restaurant just prior to the outbreak did not contain *coliform* bacteria. However, samples collected in early June, after the illness outbreak, did contain both coliform and *E. Coli.* bacteria.

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 (Borchardt et al. 2004, Hunt et al. 2005), 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.

Data from the Environmental Protection Agency (EPA) shows that the highest percentage of microbial unsafe water is found in small water systems, like transient non-community systems (TN), such as restaurants and convenience stores serving less than 500 people (Peterson 2001). There are approximately 9500 active TN systems in Wisconsin. 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

The DNR became aware of naturally occurring arsenic in groundwater and water supply wells in the early 1990's. Initial investigations found that in NE Wisconsin about 3.5% of wells tested were greater than the then current standard of 50 µg/L. The highest well tested at 15,000 µg/L. The DNR issued an advisory for the area which recommended drilling and casing 80 feet beyond the top of the St Peter sandstone where the main arsenic bearing zone was determined to be. This proved to be over 85% successful in bringing arsenic concentrations to below 50 µg/L. Over the years the department has continued to work with drillers to improve construction techniques to minimize arsenic in potable wells.

Arsenic is released from aquifer materials by several mechanisms. The primary mechanism in NE Wisconsin is oxidative breakdown of sulfide minerals. This is caused both by well construction techniques and by local and regional drawdown caused by increasing water use. When this happens, other metals which are also in the sulfides are also released, often times in concentrations that may pose health risks. These metals include nickel, cobalt, cadmium, chromium, lead and iron. A different release mechanism is predominant in SE Wisconsin and along glacial moraines in Northern Wisconsin. In these areas arsenic is bound to iron oxides in the aquifer material and is released due to reduction reactions. When iron oxide is reduced the arsenic is freed into groundwater.

With a new federal standard on the horizon the department coordinated with DHFS and local health departments to sample private wells in several towns in Outagamie and Winnebago Counties. Over 3900 wells were sampled between 2000 and 2002. Results were delivered to the homeowners at public information meetings. Results indicated that overall about 20% of the wells had concentrations over the new standard of 10 µg/L (the same as the earlier sampling). In some areas, over 40% of the wells exceeded 10 µg/L. One key area was the high density development in the Town of Algoma - just west of Oshkosh. The department made this the first special well casing depth area (SWCDA) in 2002. Three other smaller areas followed soon after.

Between 2002 and 2004 the DNR required more stringent specifications within four small areas where arsenic contamination problems were severe. But it was realized that if SWCDAs were established in this manner, it would result in a 'hodge-podge' of small areas, scattered over a two-county region. So it was decided to seek a more comprehensive regional approach. Based on the success of the SWCDA and the high levels of wells the DNR moved forward with expanding the SWCDAs to cover the entire counties.

The goal was to produce maps delineating low arsenic zones and provide well drillers with guidelines for constructing wells in those aquifers. DNR and WGNHS staff used approximately 14000 wells over a 12 county area to provide a regional context. In the problem area in Outagamie and Winnebago counties over 6000 well constructor reports (WCR) were interpreted to contour problem areas between the top of the St Peter sandstone and top of the Cambrian formations. Maps were then produced giving the maximum depth of a shallow well option or the minimum depth of casing to reach the Cambrian sandstone aquifer. Information on the specifics of the requirements can be found online under special casing areas. (See more under interagency coordination)

The project has been a good example of interagency cooperation. Initial work with DHFS and local health departments and town boards effectively defined the problem and raised awareness. Research supported by the joint solicitation helped define the extent and mechanisms of release. DNR and Commerce worked jointly with water treatment companies on developing treatment systems for arsenic removal. Well drillers assisted in identifying drilling methods that reduce arsenic.

Since the realization of the problem in the early 1990's much research has been focused on the arsenic problems. Sixteen studies through the joint solicitation have explored arsenic related topics from detection to geologic controls to well construction and treatment. (See *Appendix C* and "Arsenic Monitoring and Research in Northeastern Wisconsin" in chapter 5). Arsenic concentrations greater than 10 µg/L have been documented in 52 counties. The studies have helped develop real working solutions in the SWCDA. Much has been learned from these studies, but much remains to be learned.

Current research is focused on release mechanisms, triggers and reaction kinetics that effect well finishing and rehabilitation operations. The other focus is defining the problem in other areas of the state. For example recently 4 wells in Pierce County had arsenic ranging from 5-59 µg/L. Other metals were also elevated. Lead was as high as 927 µg/L, zinc to 21,000 and nickel and manganese were over 1700 µg/L. With the assistance of WGNHS staff who were mapping the area, a new well was drilled, logged with geophysical equipment and tested. The logging will help with understanding the structure and distribution of arsenic bearing minerals in that part of the state. Already what was learned there has helped with the design of a new municipal well for Turtle Lake.

The DNR, DHFS, Commerce and others continue to work on the arsenic problems around the state. Arsenic has been found in groundwater in every county in the state. DHFS has shown health outcome effects in two separate studies. In addition there are 2 known cases of confirmed arsenic poisoning from drinking water. (In both cases neurological damage was moderate to severe.) Current arsenic work includes:

- Refinement of the geology in the Outagamie and Winnebago county area and updating casing requirements,
- DHFS and DNR sampling of transient non community wells

- Commerce and DNR evaluating and pilot testing arsenic treatment systems for public and private systems that do not have an alternative aquifer option.
- DNR and local governments are working with several Blue Cross / Blue Shield grants for a healthier Wisconsin to explore impediments to private wells sampling and promote well sampling programs
- DNR efforts to improve well construction for schools and community wells
- DHFS, DNR and the WGNHS are working together to gather information from drillers and pump installers on areas with high iron and corrosive water, which may be indications of an arsenic problem. Sampling of these areas is being lead by DHFS.
- DHFS and DNR targeting of wells for sampling in the southern and SW potions of the state
- Requiring arsenic sampling for all new and reconstructed wells in Florence County.
- A new study funded through the joint solicitation will begin in July 2006 involving researchers from Wisconsin and West Virginia. WGNHS and the DNR are working to add new data to the geologic model for the SWCDA and refine the mapping project.
- Educational outreach to the well drillers continues.

More information related to arsenic can be found on the DNR Arsenic Web Page.

Naturally-Occurring Radionuclides

Naturally-occurring radionuclides, including uranium, radium, and radon 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) and 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 4.4**). The DNR is enforcing the radionuclide standard adopted into NR 809. The DNR has signed consent orders with 42 community water systems that required them to be in compliance with drinking water standards for radium and gross alpha by December of 2006. While most of these systems are now serving water that meets the radium and gross alpha standards, several systems did not meet the December 2006 deadline. The Department is currently evaluating enforcement options for these facilities.

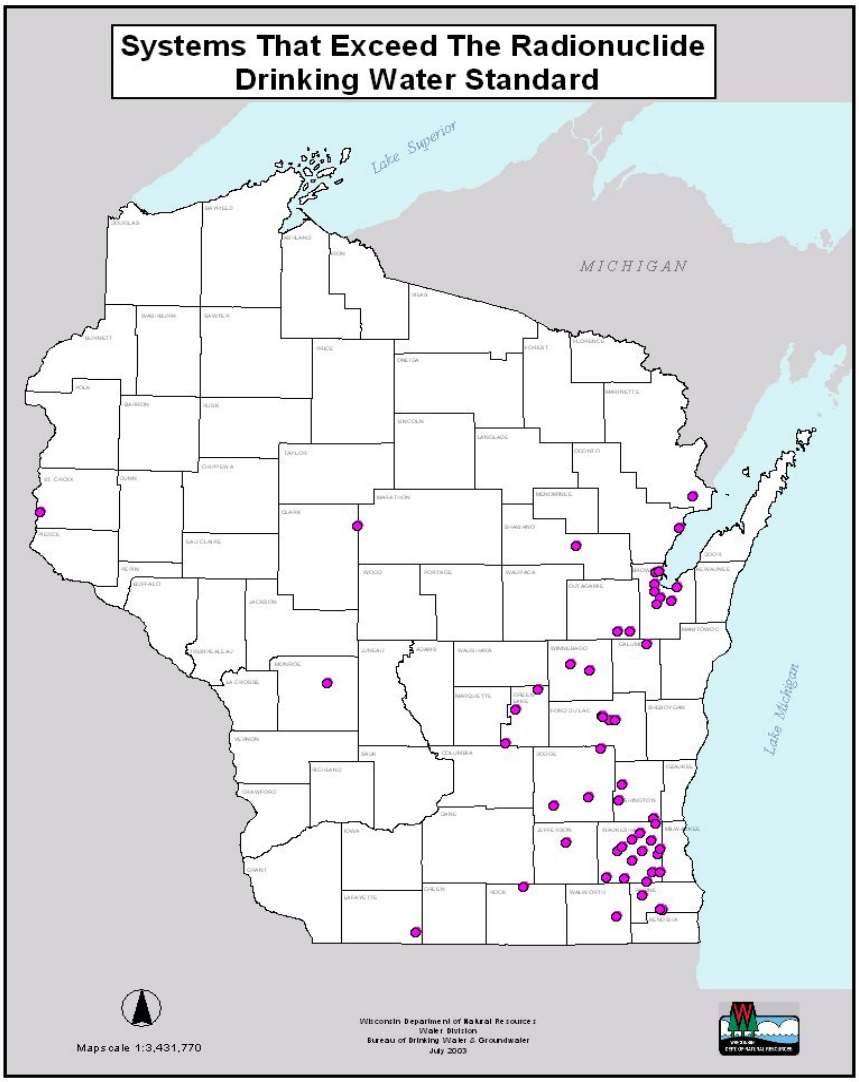
Previous studies have shown that radium concentrations in excess of 5 pCi/L can not be explained solely by the presence of parent isotopes in the aquifer solids. It is possible that high radium concentrations in Cambro-Ordovician water originate from downward flow of recharge water through the Maquoketa 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.

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.

Figure 4.4 Public water systems that exceed 15 pCi/L for gross alpha activity as of July 2003. Source: DNR



Two additional studies were funded 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 radium and its progeny (uranium is a major contributor in relatively few systems, 2 or 3) 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 are an overestimate of the activities of all of the alpha emitters. 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 Affecting 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 2006, EPA has not finalized the drinking water standard for radon. – since Wisconsin has a radon air program, the standard will likely be set at 3,000 pCi/L.

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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. 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 (DNR, 1997). The report also called for funding 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. A sixth report providing the summary of water use in Wisconsin for water year 2005 is expected to be released soon.

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 groundwater use in 2000 is used for public water supplies (330 Mgal/d), which is primarily 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 4.5**). The model simulations on which the Fox River Valley and Dane County drawdown contours are largely based have not been rerun with recent water use data, and may therefore not be entirely representative of the current state of regional drawdown. The best-documented regional water quantity problem is in the Southeast part of the State. A 2004 study by the University of Wisconsin Extension - Wisconsin Geological and Natural History Survey and the USGS shows that in the last 60 years groundwater withdrawals throughout southeastern Wisconsin, Illinois and Michigan were substantial enough to slow and reverse groundwater flow in some areas (Feinstein et.al., 2004). In the region between Milwaukee and Waukesha County, simulations using groundwater models show that pumping water from the deep Sandstone Aquifer 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 regional drawdown can bring about quality concerns is seen in Southeastern Wisconsin where many communities that use deep wells now have a problem with naturally occurring radionuclides present deeper in the Sandstone Aquifer. Wells in the Sandstone Aquifer have drawn water levels down hundreds of feet and in recent years the concentrations of radionuclides and other elements have increased in many of these wells. There appear to be correlations between large 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 remove. Several communities facing a regulatory deadline for reducing the level of a specific radionuclide, radium, in their drinking water have been forced to look for alternative sources. However, the most available alternative of drilling wells into the shallow aquifer is problematic in that it may impact surface waters or other

shallow wells. In addition, shallow wells are more vulnerable than deeper wells 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.

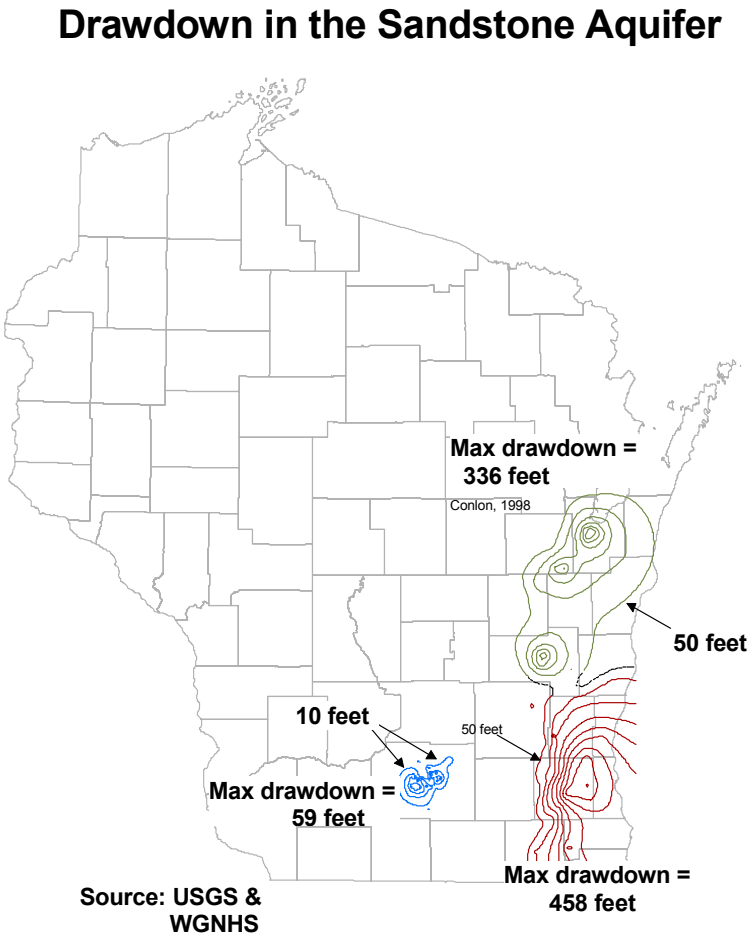

Figure 4.5 Simulated drawdown in the Sandstone Aquifer as of 1998-2000. Contour intervals represent levels of equal hydraulic head and are 50 feet in eastern Wisconsin and 10 feet in Dane County. Sources: USGS and WGNHS

Another example of regional drawdown causing groundwater quality problems is in the Lower Fox River Valley where detections of arsenic in private well water have increased in recent years (also described above in the Groundwater Quality Section of this Chapter). 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 pumping in the Lower Fox River Valley has lowered water levels in the bedrock aquifer to such an extent that the mineralized zone is exposed to the atmosphere and becomes oxidized, releasing arsenic. 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.

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 (ASR) as a method for addressing water shortages. ASR involves injecting treated water into the aquifer during times of less water 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 ASR, as pilot tested, was not feasible. Significant levels of arsenic and other contaminants were mobilized from aquifer bedrock during the Green Bay pilot test ASR storage periods. In addition, the plan to utilize ASR for water storage at Green Bay changed. Communities surrounding the city that initially considered purchasing drinking water from Green Bay decided to purchase their water from Manitowoc instead.

Pilot testing of ASR at Oak Creek has shown that the technology may be viable, although, manganese appears to have been mobilized from aquifer bedrock during the ASR pilot test and levels of this substance in groundwater have increased. Oak Creek has been issued a conditional approval to use ASR, as pilot tested, provided that mobilized substances do not exceed state groundwater quality enforcement standards. Initial sampling results associated with the first Oak Creek ASR system operational cycle after pilot testing shows apparent increased aquifer manganese and iron levels. The levels of both substances in groundwater at the Oak Creek ASR site appear to be significantly above background concentrations, and above state groundwater quality standards. The Department is currently reviewing the submitted Oak Creek ASR site monitoring results.

For some communities tapping Lakes Superior and Michigan is a potential solution to quantity problems. But, for other communities, there are bottlenecks. The Council of Great Lakes Governors which consists of Governors from the eight states and premiers from the two Canadian provinces bordering the Great Lakes has taken the lead in protecting the Great Lakes. The Council signed a Great Lakes Charter in 1985 a voluntary agreement 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. The Council also coordinates the authority granted to the Governors under the U.S. Federal Water Resources Development Act (WRDA) of 1986. This Act requires the Governors' unanimous approval on any proposed out-of-basin diversion or export of water from the Great Lakes Basin. To update the regional water management system and ensure that the Great Lakes are protected, the Governors and Premiers signed the Great Lakes Charter Annex in 2001. The Annex 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.

On December 13, 2005 the Annex Implementing Agreements were signed by the Great Lakes Governors and Premiers. Once enacted, the signed agreements will provide the necessary framework to help the States and Provinces to protect the Great Lakes Basin. The agreements include a ban on new diversions of water outside the Basin with limited exceptions, were approved. This agreement to manage water quantity in the Great Lakes basin is the first multi-jurisdictional agreement of this magnitude in the world. All 10 governments have agreed to collectively manage water usage according to the shared goals expressed in this agreement. Now the agreement must be approved by the eight state Legislatures and Congress before it can become law.

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 DNR issued an approval with conditions to protect the aquifer. The proposal highlighted the issue that prior to Act 310, the DNR had authority to deny a high capacity well application only if it determined that the new well would interfere with a municipal water supply well.

The Little Plover River, a Class I trout stream and Exceptional Resource Water in Portage County, has had reduced flows in the last few years, to the point of drying up, mainly due to the effects of groundwater pumping during drought periods. The river is located in an area with a large density of high capacity wells, and its situation may be indicative of conditions on other headwaters streams located in similar areas. Awareness of extreme low flow conditions grew beginning in 2003, when measurements revealed that flow in the stream was becoming unhealthily low. In the summers of 2005 and 2006 a ~ 1-km stretch went completely dry. The river would have gone dry in 2007 except for an emergency and temporary flow augmentation scheme prevented it. A stakeholders group has been formed to address the problem and has identified short-term solutions. In their 2006 report to the Legislature, the Groundwater Advisory Committee recommended the Little Plover River Watershed be identified as a groundwater attention area. The committee recommended this new designation to enable and encourage coordinated proactive planning and management in areas of emerging groundwater quantity problems. The recent dry-up of Long Lake in Waushara County has drawn attention that lakes in addition to rivers may be at risk.

Solutions

The outcome of several years of work on groundwater pumping policy was 2003 Act 310. The authors of the Act touted it as a "good first step", but recognized that further efforts would be needed to adequately manage groundwater resources in Wisconsin. Specifically, the Act:

- Designated "Groundwater Management Areas" (GMAs) in the northeast and southeast where large drawdowns exist in the deep sandstone aquifer. In the GMAs, plans will be written and implemented to help manage groundwater resources in a sustainable manner.

- Regulates new high capacity wells in Groundwater Protection Areas (GPAs) within 1,200 feet of outstanding or exceptional resource waters, or any class I, II, or III trout stream.

- Regulates new wells that may have a significant environmental impact on springs with a flow of at least one cubic foot per second for at least 80% of the time.

- Creates systems for fees and groundwater pumping data management.

- Created a Groundwater Advisory Committee (GAC) with members appointed by the legislature and governor to provide guidance as to implementing the present law and making recommendations for future legislative efforts.

Gaps exist in Act 310. These include

- No protections from groundwater pumping exist for 99% of lakes, 92% of stream miles, most springs, and all wetlands.

- The 1200 foot buffer provided by GPAs to trout streams and exceptional and outstanding resource waters is not necessarily sufficient to protect these resources from harm.

Act 310 created the concept of GMAs but delegated to the GAC the responsibility for devising the approach to implementation. The GAC completed a report on Groundwater Management Areas in December 2006. The report addresses groundwater management recommendations within GMAs and also addresses other issues related to groundwater quantity and quality management. In summary, the report states that "effective management of groundwater resources in areas that have already experienced substantial regional impacts, such as those within the two groundwater management areas will require an extraordinary level of collaboration between the state, multiple levels of local government, and local stakeholders." The report contains recommendations that would establish a framework for collaboration within the broad structure created by Act 310.

Most of the legislative recommendations put forward by the GAC would basically provide the necessary statutory authority to establish and implement the fundamental elements of an effective groundwater management structure in groundwater management areas. These include the basic framework for groundwater management plans, provisions related to funding, creation of the Groundwater Attention Area concept and continued support for a statewide groundwater monitoring network.

Of the recommended changes to existing statutory provisions, the most substantial relate to providing clear statutory authorization to the DNR to promulgate necessary administrative rules consistent with the GAC's report on GMSs and modification of existing high capacity well approvals for properties within GMAs. The report also recommends changes to existing statutes to specify that after 10 years, the DNR is enabled to modify existing approvals for wells within groundwater management areas so that the operation of high capacity wells are consistent with approved groundwater management plans. Current statutes provide limited opportunity for the DNR to modify existing approvals.

The GAC also made extensive recommendations for key elements that should be included in future administrative rules. But, the GAC cautioned, their recommendations should not be viewed as the final and definitive identification of issues for inclusion in the rules. As additional legislation is developed and the rule-making process proceeds, additional needs will be identified.

The report further states that much additional work remains to be done in terms of refining the planning and implementation processes and emphasizes that proactive management and intervention are critical components of an effective groundwater management policy.

In FY 08 the GAC will continue its deliberation of groundwater quantity issues as directed under Act 310 and will submit a second report to the Legislature before the end of 2007. That report will focus on protection of springs, trout streams, outstanding resource waters (groundwater protection areas, or GPAs) and exceptional resource waters from impacts caused by construction and operation of high capacity wells.

Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded approximately 345 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" non prescription 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 and 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 including the substance's adsorption and biodegradability properties and the amount and type of any soil through which the substance percolates before reaching groundwater. Recent studies in other states have shown that pharmaceuticals and PCPs can be present 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 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. A variety of antibiotics were detected in wastewaters analyzed for the study. Two antibiotics, tetracycline and sulfamethoxazole, were found in all of the wastewater effluents tested. Very small concentrations of these two antibiotics were also found in groundwater monitoring wells located directly adjacent to one of the study land treatment system discharge areas.

A second UW study, conducted by Joel Pedersen and K.G. Karthikeyan, investigated the soil adsorption properties of common antibiotics. This study found that under certain soil conditions, antibiotics such as the sulfonamide antibiotics, have the potential to be 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 Wisconsin State Lab of Hygiene. This study includes 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 includes an assessment of pharmaceuticals and PCPs in both soil water and groundwater impacted by on-site system discharges in an unsewered subdivision.

The Department is using the results of recent pharmaceutical and PCP research studies to evaluate whether current state groundwater protection regulations are adequate to address potential adverse impacts from the discharge of these substances. Studies comparing the levels of pharmaceutical and PCP substances in wastewater influent with those present in treatment system effluents provide information on the removal effectiveness of currently approved wastewater treatment processes. Research into the behavior of pharmaceutical and PCP substances in soil and groundwater is helping the Department develop effective monitoring strategies. Studies evaluating new sampling techniques and analytical methods have helped assure 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 and Materials Management (WMM) 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 WMM 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 WMM program allowed sites to sample for inorganic parameters as part of routine monitoring and not sample VOCs unless inorganics were elevated. The VOC studies provided valuable data that were 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 were 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 WMM 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 meetings 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 WMM 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 WMM 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 revisions of DNR regulations in 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 WMM program about the information collected.

Another study undertaken by the WMM 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 WMM 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 were used to revise groundwater sampling procedures required by the WMM 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 WMM 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 the 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 is 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. WMM staff have incorporated the recommendations of this study into code changes that went into effect in February 2006.

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.

WMM 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.

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 arsenic contamination in groundwater. Homeowners were alerted through direct mailings, public meetings and mass media news releases. Continuing educational efforts and studies were done to alert 72,000 people of their potential exposure to the substance in their drinking water.

In one of the studies 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" (AAA) in the early 1990s. This area included 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, increased the likelihood of installing a well with low arsenic levels. A special well casing depth area (SWCDA) was established for the Town of Algoma in Winnebago County in 2001. In this area, all wells must be drilled with mud/wash rotary methods, 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 some 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 Outagamie and Winnebago Counties.

Several other 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 have helped provide needed information about the occurrence, health risks, and remediation of arsenic in drinking water supplies. A study further investigating reaction kinetics is currently being done. 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.

A follow-up project attempted to verify the results of the Sturgeon Bay wellhead protection project using natural groundwater tracers (Bradbury 2000). This research measured 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. The geochemical and isotopic data are consistent with conceptual and numerical groundwater models near Sturgeon Bay. Both the field study and the numerical model show that the dolomite aquifer responds very rapidly to precipitation events. Advective transport simulations using particle tracking produce concentration breakthrough curves consistent with field results.

The series of projects undertaken in Door County has implications for groundwater investigation, management, and protection in other parts of Wisconsin where fractured carbonate rock occurs near the land surface.

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 (Krohelski et al. 2000), La Crosse County (Hunt et al. 2003), and Southeast Wisconsin (Feinstein et al. 2004) groundwater models. These computer models, which cover entire counties or multiple counties, simulate current and future groundwater conditions and are 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, these models have been used to delineate groundwater capture zones for municipal

wells (e.g. Bradbury 1996, Chapel et al. 2003).

These regional models, which provide a modern hydrogeologic framework for large-scale groundwater movement have stimulated a number of significant research projects by other investigators (Mickelson 1994-95; Bradbury et al., 2000). These investigators have used the model as a starting point for more detailed flow models of specific problems or areas of the county.

The Dane County county or multi-county models have been applied to regional groundwater issues in other parts of Wisconsin including Sauk, Rock, Eau Claire, Fond du Lac, St. Croix, Pierce, Polk, and La Crosse Counties and the Central Sands Region. 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 water-use and land-use decisions.

Chapel, D.M., K.R. Bradbury, and R.J. Hunt. 2003. Delineation of 5-year zones of contribution for municipal wells in La Crosse County, Wisconsin : Wisconsin Geological and Natural History Survey Open-File Report 2003-02, 42 p.

Hunt, R.J., D.A. Saad, and D.M. Chapel. 2003. Numerical Simulation of Ground-Water Flow in La Crosse County, Wisconsin and into Nearby Pools of the Mississippi River . USGS Water-Resources Investigations Report 03-4154. 36 p.

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 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, Borchardt et al. 2004). 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.

Regional studies have identified central Waukesha County as an area where continued deep groundwater pumping might be causing the deep aquifers to become unconfined as water levels fall. A 2004 project installed one deep piezometer near Pewaukee for use as a monitoring point to document water-level declines. In 2006 the WGNHS completed a study to help understand the vertical movement of groundwater through the regional Maquoketa aquitard, with emphasis on the possible effects of cross-connecting wells and fractures.

Other State-supported research has investigated 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 have been 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 has helped guide decision-making about using these systems in Wisconsin.

COMPREHENSIVE PLANNING

The State of Wisconsin has required Wisconsin towns, cities, villages and counties to develop comprehensive plans by 2010 in order to undertake common land use activities such as zoning and land division regulation. Communities that rely on ground water as their sole source of water need to assess the magnitude and limits of their water source as part of their comprehensive development plan, but most have little expertise in quantifying and protecting their water supply. A two-year project funded by the University of Wisconsin Water Resources Institute (WRI) partnered with such a community (Richfield, Wis.) to determine what kinds of groundwater supply information was most relevant and usable for land use planning from a community's perspective. This study determined that the most important information needed by such a community is a good basic understanding of the geology, sources, sinks and water balance of its aquifer system so that residents and community leaders know where their water comes from. Interaction with users at all levels is also crucial to developing the awareness needed to create a long-term land use plan and supporting laws to ensure a sustainable water supply under foreseeable future conditions. The next step is to share this model with other communities to help them plan how best to actively manage and protect the recharge areas that supply their water.

A related WRI project evaluated whether Wisconsin communities are addressing groundwater in their comprehensive plans, and what tools would make them more likely to do so. This project providing multiple presentations to local and state groups involved in groundwater planning; a webpage of study results; articles in a Center for Land Use Education newsletter distributed to more than 160 community planners and educators; a presentation to about 100 people at the 2005 conference of the American Water Resources Association-Wisconsin Section; and publication of an article in a national journal (Comprehensive Planning in Wisconsin: Are Communities Planning to Protect Their Groundwater Water Resources IMPACT 7(6):19-21).

A DNR-funded project provided support for centralizing access to groundwater information for use in comprehensive planning. The project utilized an interagency team of federal, state and local agencies to assist numerous Wisconsin communities in their comprehensive ("Smart Growth") planning by providing groundwater information and data in an accessible and user-friendly manner. Specifically, the interagency team provided personalized assistance for three pilot counties in the form of a 20-30 page report and a locally-tailored presentation for the citizen plan commissioners. The same interagency team prepared a centralized website that provides a suggested process for integrating groundwater information into comprehensive plans and webpages for each of Wisconsin's 72 counties that include local data about groundwater susceptibility, sources of drinking water, groundwater quality, potential sources of contaminants, groundwater quantity, money spent on cleanup and ground-water protection strategies. The website is currently in the final stages of review.

MICROBIOLOGICAL GROUNDWATER MONITORING

Protecting groundwater from microbial contamination is a top public health priority. The United States and Canada experience significant levels of gastrointestinal disease from drinking water, more than 70 percent of which is associated with contaminated well water. A UW Water Resources Institute project examined the strengths and weaknesses of 10 enzyme-based tests approved by the U.S. Environmental Protection Agency for detecting total coliform and E. coli in drinking water. The results suggest these tests differ significantly in their ability to detect/enumerate total coliforms and E. coli and to suppress false positive results from Aeromonas, a non-coliform organism. The most significant of these findings was the inability of some test method/sample matrix combinations to even detect E. coli in high concentrations.

RAIN GARDEN DESIGN & EVALUATION

One product resulting from recently completed Wisconsin WRI research is a user-friendly computer model that can be used in the design and evaluation of rain gardens and bioretention facilities. This model is now recommended by the Wisconsin Department of Resources (DNR) for use in meeting its new stormwater infiltration regulations and is available free of charge on the DNR website. A manual based on related WRI-funded research, Design Guidelines for Stormwater Bioretention Facilities, has been accepted for publication next spring by the University of Wisconsin Aquatic Sciences Center.

METHYLMERCURY FORMED IN GROUNDWATER

A WRI study conducted at the Allequash Creek watershed in northern Wisconsin determined that anoxic zones in shallow groundwater are an important site of methylmercury formation. This information will advance our understanding of mercury transport and methylation in groundwater and watershed response to mitigation of mercury inputs.

ESTROGENIC ENDOCRINE DISRUPTORS IN GROUNDWATER

A WRI-funded analysis of multiple groundwater samples from high capacity wells at five Wisconsin municipalities showed no estrogenic endocrine disruptor activity, leading the investigators to conclude that no infiltration of these contaminants from surface water into nearby groundwater is occurring. Also, analysis of multiple samples of septic influent, effluents, monitoring wells and soil water indicate septic systems using the biomicrobic aerobic and sand filtration system provided cleaner effluent than mound systems.

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.

RESEARCH & MONITORING PRIORITIES

- **Protect funding for groundwater monitoring and research**: For several years state budget cuts have limited the number of groundwater research and monitoring projects that were funded (see Table 3 in Chapter 2). DNR's state funding for projects has been cut since FY 02 and it has been forced to use more Federal dollars with high overhead costs. Although relatively new Wellhead Protection and Groundwater Quantity funding has offset some of these DNR cuts, the new funding is earmarked towards a limited scope of work. The UWS budget was cut by 10% in FY 04 and FY 05. DATCP and Commerce have been unable to fund any 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. Research and monitoring are necessary to identify cost-effective prevention strategies. These strategies are needed to prevent groundwater problems that are much more time-, labor-, and cost-intensive to remediate than to prevent in the first place. Without adequate funding for research and monitoring we don't know what the best prevention strategies are. 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.

- **Acute and chronic impacts to groundwater from manure management:** Groundwater contamination from manure has been an increasing problem in recent years for private well owners. A statewide assessment is needed to understand the scope and magnitude of the problem. Mechanisms, pathways, and timing of movement into groundwater, the influence of landscape settings and climatic factors, the applicability of new analytical tools and methods of vulnerability assessment and best management practices (BMPs) and the threat of associated contaminants (bacteria, nitrates, pharmaceuticals, viruses, other pathogens, etc) all need to be understood better to address the problem. Several manure management research and monitoring projects are starting in FY 08. The GCC and its subcommittees need to help evaluate the findings and guide follow-up projects on this topic to assure an effective response to this problem.

- **Investigate adverse impacts from groundwater withdrawals:** Recent headlines about lakes and streams drying up, long term availability of water supplies in the Fox River Valley, and severe groundwater level 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 between 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 (TDS), and radium have been found in some new deep municipal wells in the Lower Fox River Valley, making the wells difficult to use. In some other existing deep wells as far south as Milwaukee, the TDS 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.

POLICY & PLANNING PRIORITIES

- **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. Since passage of the new law the DNR has begun implementing the new law and the Groundwater Advisory Committee has addressed specific policy issues related to groundwater management planning. There is a clear need for proactive regional groundwater planning in areas of concern, where development/population growth pressures intersect limited groundwater resources. 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. The GCC has helped to guide a DNR-funded project that has developed a website to provide groundwater information to communities involved in comprehensive planning. Through the Local Government and Planning Subcommittee, the GCC will seek ways to further 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.

- **Develop methods to assess and protect against health hazards posed by exposure to 'orphan' contaminants as well as multiple contaminants in a water supply.** Data collected by DNR and DATCP indicate that many groundwater aquifers are contaminated with 'orphan' chemicals, such as pesticide degradates, chlorinated organics and petroleum derivatives, for which toxicity information is inadequate to support risk assessment. Solutions are needed to effectively address scenarios where multiple contaminants are present in a well. Frequently wells are found to have one or more pesticide degradates present, perhaps in tandem with a parent compound or totally unrelated compounds. The GCC will support the agencies in their attempt to develop uniform methods that can be used to establish contaminant-specific advisories for owners of impacted water supplies.

COORDINATION PRIORITIES

- **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 and refine a Statewide Groundwater Monitoring Strategy to guide agency monitoring efforts for the next eight to ten years. The strategy has been incorporated into the DNR Water Monitoring Strategy. In FY 07 a multiagency groundwater monitoring workgroup developed a process and priorities for taking the first step: enhancing the Wisconsin Observation Well Network. The GCC encourages agencies, the university, and federal and local partners to implement this and other 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. The GCC will continue to use the Groundwater Information Network and other means to promote water stewardship and awareness of water quantity issues, find innovative ways to encourage testing of private water supplies, and provide materials for local communities to support

comprehensive planning activities.

- **Promote consistency between the agencies on data management issues:** Through the DNR's Groundwater Retrieval Network (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. In 2002 the GCC's Monitoring and Data Management Subcommittee produced *Recommended Minimum Data Elements for Groundwater Databases* to guide groundwater database architects towards multi-user-friendly data element choices. 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 130 summaries of groundwater-related monitoring and research projects funded through the Wisconsin Groundwater Research and Monitoring Program are now available online. 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 29th, 2006
Held at the Wisconsin Department of Agriculture, Trade, and Consumer Protection
2811 Agriculture Drive, Madison

Members Present: Todd Ambs (DNR), Ken Bradbury for James Robertson(WGNHS), Anders Andren (UWS), Eric Scott for Berni Mattsson (Commerce), Henry Anderson (DHFS), Kathy Pielsticker (DATCP), and George Kraft (Gov. Rep).

Others Present: Mike Lemcke, Gordon Stevenson, Mark Putra, Tom Riewe & Jeff Helmuth (DNR); Lori Bowman, Jeff Postle, Sara Walling & Jim Vanden Brook (DATCP); Barb Lensch (NRCS); Chuck Dunning (USGS); Jim Hurley (UW-WRI); Ed Morse (WRWA); and Lynn Markham (UW-SP).

The meeting began at 10:00 AM.

1. **General business** – Introductions were made. Todd Ambs reported that a certificate had been sent to Fran Garb to thank her for her 9 years on the GCC. Todd welcomed Anders Andren as the new UWS representative on the GCC. Minutes were approved from the April 28, 2006 GCC meeting.

2. **Approval of 2006 GCC Report to the Legislature –** Jeff Helmuth described comments received and changes made to the report since the second draft and asked for the council's approval of the document as revised. The report and revisions were approved as amended. There was discussion of how to communicate the groundwater efforts of the agencies to the Legislature in a more concise way. Todd Ambs illustrated the need to communicate key points by the example of his upcoming meeting with the Legislative Study Committee on the Great Lakes Compact that is forming a state implementing legislation on this issue. The committee's groundwater needs are met by a small portion of the report that could easily be overlooked within the full report. Anders Andren indicated that press releases and editorials can be highly effective in clarifying issues and raising general groundwater awareness. Anders added that the 20th anniversary of the first funded research and monitoring projects, which had just passed, might make a good occasion to commemorate with articles, press releases and/or an event. Kathy Pielsticker added that stakeholder input would be valuable in determining how to convey the message. The issue was forwarded to the Education Subcommittee to make recommendations back to the council.

3. **Research Subcommittee report: Evaluation of research and monitoring related to manure management** – Ken Bradbury summarized the subcommittee's July 19th meeting held to discuss research and monitoring related to manure impacts on groundwater and make recommendations to the GCC on related research priorities, data sharing and interpretation. The subcommittee concluded that manure management should be elevated to a priority issue in the FY 08 Joint Solicitation. Specific research issues targeted by the subcommittee include the following:
   - Impacts of liquid manure, manure digestion, and other new agricultural practices
   - Impacts of specific climatic conditions such as drought, floods, or climate change
   - Application timing

- Flow and transport mechanisms, and in particular rapid flow paths through fractures or macropores
- New analytical tools such as isotopic methods or microbial source tracking
- Social science aspects; barriers to implementing best management practices
- New contaminants such as pharmaceuticals, microbial pathogens, and viruses
- (Note: These issues were included in the FY 08 joint solicitation under a priority DNR monitoring and research priority. The solicitation package was distributed in early October).

The Research and Monitoring & Data Management Subcommittees will continue to address data sharing and interpretation issues.

4. **Impacts of manure management on private well water quality** – Tom Riewe gave a presentation on the February 2006 Village of Wayside (Town of Morrison, Brown County) private well contamination incidents and follow up efforts. The contamination was potentially caused by broken pipes at a concentrated animal feeding operation (CAFO) followed by snowmelt and rain. Groundwater contamination susceptibility is very high in this area of shallow karstified bedrock. In March the well compensation program was revised by Senate Bill 646 to allow eligibility for wells contaminated with bacteria if contamination can be tied to an animal waste-related incident. The new law requires that DNR establish a special "area of well compensation eligibility" and require at least 250' of cement-grouted casing and other well construction specifications. At the public assistance meetings in the Town of Morrison, DNR staff helped well owners submit 23 well compensation claims. As of late-August, 16 wells were completed with safe water at an average cost of $13,000. The well compensation limit is $9,000. About half of awardees have also received NR 738 funds for the portion of costs not covered by well compensation.

   There was some discussion of determining the source of the contamination. Tom said from a hydrogeologic standpoint it was pretty clear that the Town of Morrison incidents were from manure though this could not be said with certainty. There was a manure spill near an intermittent stream that heads directly toward a fracture trace in the bedrock aquifer and there is land application of manure in the area. There are analytical limitations that make it difficult to differentiate manure and septic sources. Furthermore, the purpose of the well compensation program is not to assign blame but to provide safe drinking water. It was also pointed out that the State Lab of Hygiene had recently hired a contamination source tracking expert.

5. **Acute and chronic groundwater impacts of manure management in Wisconsin** –Gordon Stevenson reviewed the activities of the Manure Management Task Force convened by DNR and DATCP to address water quality problems from manure-related runoff events. He gave an overview of the 52 geographically widespread manure runoff incidents that occurred in Wisconsin from July 2004 to June 2005. 80% were related to dairy operations, 74% were related to land-spreading of manure, 84% of the land spreading problems were on frozen soil, and 60% of the land spreading problems were associated with liquid manure. Fish-kills, well contaminations, and discharges to water bodies occurred. Gordon attributed the problems to changes in the dairy industry, like bigger farms and liquid manure systems. Large CAFOs now house about 10% of all livestock. The task force recommended a number of actions which the agencies have agreed to initiate.

   Jim Vanden Brook added that one of the Task Forces' recommendations was to support more research on manure management's impacts on groundwater and the chronic health impacts of

nitrogen. That recommendation is being implemented by the DNR adding the manure management priority developed by the Research Subcommittee. Data sharing and interpretation can also be accomplished by GCC coordination of research on manure management issues related to groundwater impacts. Kathy Pielsticker noted that DATCP may also have funds to support manure/nutrient management research in FY 09.

6. **Groundwater information database for comprehensive planning** – Lynn Markham and Chuck Dunning's reported on their project which has identified: barriers for including groundwater information in comprehensive plans, preferred methods for receiving on-line groundwater information, and groundwater data included in existing plans. The primary reason groundwater data was not included in plans was because plan writers were not aware of the data. A lot of progress has been made on compiling data sources and links and organizing the information for planners. There will be links to many other agencies from the site.

   Anders Andren suggested presenting the findings to the Groundwater Research Advisory Committee. Ken Bradbury added that a presentation or poster exhibit could be made on the topic at the Wisconsin Groundwater Association meeting next March.

   There was some discussion of where the site should be hosted. Mike Lemcke cautioned that the DNR websites are undergoing migration to a new server at DOA and that there might be other obstacles to hosting the site at DNR or other state agencies. It was generally agreed that it was not critically important where it was hosted. Chuck said he would investigate some potential sites and report back at a future meeting.

7. **Monitoring & Data Management Subcommittee Report** – Jeff Helmuth reported on the July 27 subcommittee meeting. The subcommittee learned about the monitoring done and the decision process DATCP used to consider the repeal of atrazine prohibition areas (PAs). Other items of interest were the WGNHS Water Use Study which is taking a fresh look at DNR's high-capacity well data in Waukesha and Sauk Counties and has conducted a survey of water users in the two counties. The subcommittee also heard updates on: four springs projects supported by the Wisconsin Wildlife Federation, DNR and UWS; Little Plover River data collection; DNR well abandonment form scanning; and a DATCP statewide random survey of pesticides and nitrate planned for 2007. Subcommittee members also contributed to the FY 08 joint solicitation package.

8. **Education Subcommittee Report** – Jeff Helmuth reported on the July 19 subcommittee meeting. There was continued discussion on the arsenic website that Lori Severtson (affiliated with the UW Department of Nursing) will present to the GCC in November. There are questions on how the arsenic problem was geographically portrayed and where the site will be hosted. The subcommittee, led by Kevin Masarik, is finishing up a revision of the *Improving Well Water Quality,* a UWEX publication for private well owners dealing with ways to improve well water quality and is starting an update of the *Wisconsin Groundwater Directory*. The subcommittee heard updates on the 4th annual Groundwater Festival held in held in Manitowoc County and attended by over 600 5th and 6th grade students. The festivals have been a huge success but are also a tremendous amount of work. Because of workload there are no plans for a festival next year. The subcommittee is tracking the activities and recommendations of the Karst Advisory group in Northeastern Wisconsin and will be involved in coming up with a consistent message regarding karst issues, particularly what to do if someone discovers a karst feature. The subcommittee discussed goals and ideas for future groundwater education efforts and decided to create a series of press releases related to

groundwater issues. Lastly the subcommittee will make recommendations on what water tests should be recommended when the new well inspection rules are written by DNR and will review the DNR Private Water Systems Section's webpage to assist private well owners with water quality problems diagnosis and provide recommendations for testing.

9. **Agency Updates**
   - DATCP – Lori Bowman reported that as a result of the Atrazine Prohibition Area Repeal/Reuse Study DATCP decided that no further atrazine prohibition areas should be repealed at this time. Also, ATCP 32 (Fertilizer Bulk Storage) and ATCP 33 (Pesticide Bulk Storage) are in Legislative committees and should be soon published as one combined code. DATCP staff have also been involved in the Alachlor ESA issue.
   - UW - Anders Andren reported that the Water Resources Center's authorization had expired and that he had been working with Congress to get it reauthorized. The Senate has already passed it but the House had not. Andren is confident that it will pass. Andren also noted that Steve Ventura at UW would be funded to do a remote sensing project to locate recharge areas. Jim Hurley reported that he was looking for someone to replace Galen Kenoyer on the Groundwater Research Advisory Committee and that there would be an $8,000/year tuition reimbursement fee added to UW research projects.
   - WGNHS – Ken Bradbury noted that the WGNHS Mapping Advisory Committee would take place the next day. Other work going on includes geologic mapping in Iowa County, groundwater susceptibility mapping in Calumet County, groundwater and karst investigation in Pierce and St. Croix County, groundwater flow modeling in southeast Wisconsin, potential model updating in Dane County. WGNHS has also received a grant from the Wisconsin Coastal management program to delineate contributing areas for springs that provide habitat for the Hines emerald dragonfly. These sites are in Door County. The Nature Conservancy and US Fish and Wildlife agency are partners in this one-year project.
   - Commerce – Eric Scott noted that Commerce's reimbursement rule would be going into effect soon but the storage tank rules were not moving forward because the users group was not satisfied with the rule yet.

10. **Adjourn –** The meeting adjourned at 1:00 pm. The next meeting will be hosted by the Department of Transportation. Their facility is located at 4802 Sheboygan Avenue in Madison.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist - Program Coordinator
Groundwater Section
Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Meeting Minutes – November 10th, 2006
Held at the Wisconsin Department of Transportation
Waukesha Conference Room, 4802 Sheboygan Ave, Madison

Members Present: Mike Lemcke for Todd Ambs (DNR), Dan Scudder (DOT); James Robertson (WGNHS); Kathy Pielsticker (DATCP); Jim Hurley for Anders Andren (UWS); Eric Scott for Berni Mattsson (Commerce); Chuck Warzecha for Henry Anderson (DHFS); and George Kraft (Gov. Rep).

Others Present: Ken Bradbury (WGNHS); Lori Bowman (DATCP); Lori Severtson (UW Department of Nursing); Ed Morse (WRWA); Nancy Quirk (Waukesha Water Utility); Daniel Feinstein (USGS); and Jeff Helmuth (DNR).

The meeting began at 10:00 AM.

1) General business – Jamie Robertson agreed to chair the meeting for Todd Ambs who had sent his regrets. Introductions were made. Minutes from the August 29, 2006 meeting were approved with one change; removal of a metaphor used in the Manure Management discussion.

2) Arsenic Well Test Website demonstration and discussion –Lori Severtson (affiliated with the UW Department of Nursing) presented screen shots and other information from the test website and asked the GCC for comments and feedback. GCC comments emphasized the need for a better web presence for all groundwater issues and noted that traditional information pamphlets were not keeping up with people's information needs. Links to WGNHS geologic maps and the GIS Registry were suggested. Members also suggested emphasizing that one sample result can be misleading and multiple samples should be taken.

Lori also summarized a Blue Cross/Blue Shield planning grant project that aims to develop recommendations for comprehensively addressing elevated arsenic levels in residential drinking water. A part of this project is a mailed survey (to about 1500 in Wisconsin and an additional 1200 in MN and MI via a regional extension grant) to understand social indicators of well water testing. One question will ask participants to indicate whether (and at what level of spatial resolution) they would share well test results with the DNR. The program benefits of data sharing were discussed with WGNHS, DHFS and DNR all interested in arsenic data. There was acknowledgement that advocating data sharing could impede the main message. A BC/BS implementation grant may be pursued.

Lori thanked the GCC for their input and asked members to watch for appropriate funding opportunities for continued work to develop the website as a user-centered public information resource on well water testing and groundwater.

3) Education Subcommittee report and discussion of GCC outreach options – Jeff Helmuth reported on the subcommittee's discussion of options on how: 1) to make the public and decision-makers aware of the need for groundwater research and monitoring as well as the important coordinating role that the GCC performs; and 2) to commemorate 20 years of experience in supporting science-based policy decision-making addressing groundwater issues.
The subcommittee came up with a list of activities that they hoped the GCC could help to prioritize and determine available resources for:

1. Update and expand "Benefits of Research" in 2007 report to the Legislature.

2. Press releases in conjunction with special events (i.e. Groundwater Awareness Week March 11-17, Drinking Water Awareness Week May 7-13, Earth Day April 22).
3. Guest columns in newspapers by GCC members focusing on current or emerging issues with a side bar or accompanying news article about the role of the GCC in coordinating groundwater research, monitoring, educational efforts and other activities (assistance available from Steve Wittman).
4. More web-based information (e.g. for private well owners).
5. Letters to the editor of major papers from GCC members
6. A Governor's proclamation.
7. One- or two-page fact sheets on key groundwater issues (i.e. arsenic, nitrate, groundwater quantity, pesticides, etc.). Steve Wittman can provide a template. Would work well in conjunction with the DNR's Condition of the Resource series which will consist of longer reports on each issue.
8. A booth at an event at the Capitol when the Legislature is in session to commemorate the accomplishments of the GCC and highlight current groundwater issues. This could be done during one of the special events listed above.

Discussion supported all of the above with extra emphasis on showing value of research and monitoring projects locally. Jim Hurley indicated that he had a proposal which would be discussed under item #8 and so further discussion was deferred until then.

4) Monitoring & Data Management Subcommittee report – Jeff Helmuth reported that the subcommittee met on October 17th at which time members reported on the following projects: 1) Dave Mechenich and George Kraft's modeling of groundwater flow in the Little Plover River Basin; 2) Madeline Gotkowitz's Waukesha and Sauk County Water Use Study; and 3) Jeff Helmuth's Spring Inventory Form. Other monitoring and data management topics were discussed as well. A highlight was an Arc application developed by DATCP's Cody Cook. The application allows use of a mapping application to search for and select scanned images of well construction reports made available by WGNHS and DNR. Jamie Robertson asked that Cody be invited to present his application at the February meeting.

5) DATCP Lead Arsenate Task Force update - Lori Bowman gave an overview of the purpose, and activities of the task force. In brief the task force is to provide recommendations to the DATCP Secretary in developing strategies to address soil contamination from the historic use of lead arsenate pesticides in orchards. This includes limiting human exposure to contamination, identifying and eliminating challenges to implementing the proposed strategy, and identifying an outreach and educational approach useful in explaining the exposure risks. The primary concern is residential direct contact. There are over 50,000 acres of affected land in Wisconsin but most lead arsenate contamination affects soil and not groundwater. Mixing and loading sites have more of a potential groundwater threat. The task force is expected to report their findings and recommendations in March 2007 [Note: The March deadline will be postponed]. More information on the task force is available at: http://leadarsenate.wi.gov

6) Proposed changes to the triazine screen for the State Lab of Health and Water and Environmental Analysis Lab – Mike Lemcke gave the history of the current triazine screen and the new screen developed that shows the missed breakdown product. The new screen has a better correlation with gas chromatograph analysis but adds to the cost by about $25. Mike's workgroup is recommending that the tests be offered together despite the likelihood that it will reduce the number of test results received each year.

7) Joint Solicitation Update – Jim Hurley described the fully automated online submittal process which is based on a new system this year. The systems appeared to be working well. Jim now has over 1200 names in the reviewer database. The GRAC and GCC meetings will be in February. The goal is to have funding decisions made before the March 1st graduate student signing date.

8) Water Resource Institute Education and Outreach proposal - Jim Hurley and Steve Wittman introduced a project idea for furthering the education and outreach goals of the GCC. The project is designed to draw political, media and public attention to the benefits of the state's unique Groundwater Research and Monitoring Program. The project would include producing an overview pamphlet and a series of fact sheets on important groundwater resource issues. The goal would be to draw public and media attention to the importance of groundwater quality and quantity issues to the state and the crucial role the GCC plays in coordinating the joint solicitation process to address those issues. A secondary goal would be to secure political support for the Groundwater Research and Monitoring Program and thereby benefit the citizens of Wisconsin and perhaps other states as well through improvements to and expansion of groundwater research and monitoring programs. The project would be funded by UWS funds in FY 07 and 08.

9) Request for Pre-approval of UW System Continuing Projects - Jim Hurley proposed that the GCC consider approving a Water Resources Institute strategy which would allow UWS to optimize USGS 104b funding dollars. To optimize the total dollars for the FY 2008 funding year there would need to be a motion for the WRI to fund the second year of two projects in FY 08. The first project, is titled "Enhanced Reductive Dechlorination of Chlorinated Aliphaitic Hydrocarbons: Molecular and Biochemical Analysis", by William Hickey. The second project would be the Water Resources Institute Education and Outreach project discussed above. Jim moved that the GCC endorse the University of Wisconsin Water Resources Institute's inclusion of these two projects in their USGS 104(B) base institute funding submission for FY2007. Based on sufficient progress, the second year of the two-year project will be selected for inclusion in the 104(B) submission." The motion was passed unanimously.

10) Update on Senator Kedzie's Great Lakes study committee work – Jeff Helmuth (for Todd Ambs) reported that the report from the study committee will likely be done by January. Senator Kedzie's office is working to get the report out on time. When completed, the report will be given to the Senate.

11) Update on Southeastern Wisconsin Groundwater Flow Modeling: Where does Waukesha's water come from? – Daniel Feinstein and Ken Bradbury reported on the WGNHS/USGS/SEWRPC groundwater project. Their flow model for southeastern Wisconsin shows the effect of pumping through time on both the shallow aquifer and deep sandstone aquifer. At the November 2005 meeting Daniel and Ken reported on findings in the shallow aquifer system. This update focused on the deep aquifer system. Deep aquifer concerns are both quantity- and quality-related. High TDS and/or radium issues have plagued several utilities in the area. These problems have raised the question about who has the right to use Lake Michigan water.

Before pumping from the deep sandstone aquifer began in the mid 1800's, water that moved from the land surface to the deep sandstone aquifer flowed toward Lake Michigan from the "deep ground-water divide" located in western Waukesha County. Model results indicate that the total amount of groundwater flow moving toward Lake Michigan through the deep sandstone aquifer amounted to about 3 million gallons per day (MGD). Beginning in the 1860's, gradually-increasing pumping from deep wells has significantly altered the natural ground-water flow

system in the deep sandstone aquifer. Daniel showed the development of the cone of depression over time to its present level, now centered at Elm Grove. Well withdrawals from the deep aquifer now amounts to about 33 MGD resulting in much higher flow through the lower aquifer. The direction of flow has also changed. Deep ground water no longer moves toward Lake Michigan but now moves toward pumping centers. Groundwater converges on these pumping centers from all directions; from the west in Jefferson County and from the east under Lake Michigan. All of the 33 MGD of pumped water originates from west of the pumping centers. Some ground water that once flowed toward streams in the Mississippi River Basin is now flowing downward toward the deep wells. This source accounts for about 70% of the replenishment of the water currently withdrawn from deep wells. The remaining 30% originates from inside the Lake Michigan Basin.

A question answered by the modeling is: are communities like the City of Waukesha pumping water that was flowing toward Lake Michigan? The water coming out of the deep wells was flowing toward Lake Michigan before pumping started. That water had been flowing to the east at a relatively slow pace for hundreds or thousands of years; now much of it is changing direction and flowing westward toward the pumping centers. It is also important to recognize the effect of pumping on more recently recharged water. Deep pumping has caused water that is currently entering the ground-water system to move downward toward the deep part of the flow system instead of following its natural course to streams at the land surface. Most of this water is being diverted from streams in the Mississippi River Basin and will not arrive at the pumping wells for hundreds or thousands of years.

None of the water currently withdrawn from deep wells in southeastern Wisconsin is water pulled directly from Lake Michigan. Thousands of years of pumping would be necessary before water released by Lake Michigan would travel all the way to the deep wells at inland pumping centers. However, the model indicates that a small part (4%) of the water entering the ground-water system in response to deep well withdrawals is flowing out of the Lake.

More information on this topic can be found at: http://wi.water.usgs.gov/glpf/

Daniel added that a new project on water availability and water use in the Lake Michigan Basin has begun.

12) Agency Updates
Commerce – Eric Scott noted that there had been some interest in participating in this year's joint solicitation from Commerce's Bureau of Tanks program. There is concern over the corrosive effects of ethanol fuels on tanks, piping and dispensers. Unfortunately, for FY 08, there is no funding available.
DATCP – Kathy Peilsticker reported that ATCP 30 (Pesticide Product Registrations) revisions are near the completion stage. Kathy also added that DATCP was planning a private well survey.
DHFS - Chuck Warzecha reported that the DHFS Environmental Health Tracking Program was looking at environmental health exposures and evaluating program effectiveness. Chuck is looking for other program data on this topic.
DNR – Mike Lemcke reported that the DNR had consolidated and was scanning well abandonment reports. Subsequent reports will be data-entered. DNR is also doing a comprehensive inventory of high-capacity wells that should result in a major improvement to the hi-cap database. Two LTEs are working on this effort.

13) Set 2007 Meeting Dates – Jeff Helmuth said he would send an email proposing meeting dates for the February meeting and asking for hosts for all 2007 meetings. Anders Andren

offered that the February meeting be held at the Water Resources Institute in late-February.

14) Adjourn – The meeting adjourned at 1:00 pm. The next meeting will be held 10:00 – 12:30 on February 26th at the Water Resources Institute on the 2nd Floor of Goodnight Hall, 1975 Willow Drive, on the UW campus in Madison.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist - Program Coordinator
Groundwater Section
Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Meeting Minutes – February 26th, 2007
UW Water Resources Institute Conference Room
2nd Floor, Goodnight Hall, 1975 Willow Drive, UW - Madison.

Members Present: Todd Ambs (DNR), James Robertson (WGNHS); Lori Bowman for Kathy Pielsticker (DATCP); Jim Hurley for Anders Andren (UWS); Eric Scott for Berni Mattsson (Commerce); and George Kraft (Gov. Rep).

Others Present: Cody Cook (DATCP); Steve Wittman (WRI); Randy Hunt (USGS); Ed Morse (WRWA); Jeff Helmuth (DNR).

The meeting began at 10:00 AM.

General business –Introductions were made. Minutes from the November 10, 2006 meeting were approved.

Joint Solicitation Update – Jim Hurley reported that the fully automated online submittal process worked well. The IPROPOSE interface was used for both submission and reviews and feeds the IPRO project management software. Each of the 22 proposals had 3-5 reviews by January 15. The GRAC meeting (that afternoon) would provide a prioritized list. The goal is to have funding decisions made before the March 1st graduate student signing date. Jim asked how the GCC should approve the UW Groundwater Research Plan. There was consensus that email would suffice unless discussion was warranted. [Note: email polling of GCC resulted in unanimous agreement on the funding prioritization identified by GRAC.]

Water Resource Institute Education and Outreach project - Steve Wittman reported that the WRI would likely have only half of the funding needed to fund a grad student. The project scope would still include producing an overview pamphlet and a series of fact sheets on important groundwater resource issues. The job announcement was posted with a due date of February 26. Several GCC members reiterated their support of the project goals of highlighting the importance of groundwater quality and quantity issues and the crucial role the GCC plays in coordinating the joint solicitation process to address those issues. The project will be funded by UWS funds in fiscal years 2007 and 2008.

Tribal Water Quality Standards Program Authorization process – Todd Ambs described the history and current status of tribes applying for "treatment as a state" status by USEPA in regard to Clean Water Act regulatory authority. Three tribes (Mole Lake, Lac du Flambeau, Bad River) have applied for this status and, in some cases the applications have been controversial. There is concern over patchwork regulation and precedents. DNR both solicits public comments and submits comments itself.

Groundwater Quantity issues update – Todd Ambs reported that there was a lot of activity on this topic. The Great Lakes Compact had already passed in Quebec and Minnesota [Note: Compact legislation has now also passed in Ontario and Illinois and is moving in New York, Pennsylvania and Michigan.] However the legislation has met substantial challenges in the Wisconsin Legislature. The City of New Berlin has an application in to DNR to meet radium standards. Progress should come after that has been dealt with.

Wisconsin Act 310 is being implemented by DNR and the Groundwater Advisory Council is

addressing various components of the new law. One of the fundamental challenges is how water conservation will be addressed. The Governor's "Conserve Wisconsin" package of legislation and executive orders also emphasizes conservation and offers potential solutions to these issues. A potential issue for the GCC to address is evaluating how well Act 310 is working. It can be addressed in the Report to the Legislature.

Todd is also interested in the connection between water conservation and energy savings and will be starting a dialogue on that topic soon and invited GCC members to participate in that discussion. Use of the economic benefits of conservation could avoid the legal and other problems common in other parts of the country. Todd will follow up with a meeting on this topic with a smaller group.

DATCP Well Construction Report image search tool – Cody Cook discussed the ArcIMS application he had developed. The application allows use of a mapping application to search for and select scanned images of the approximately 350,000 well construction reports made available by WGNHS on CD. The scanned images were first converted from .tif format to .pdf format. Cody showed on-screen searches and results. DATCP needs to do some testing and address security and privacy concerns before allowing wider use of the application.

Using Iron Foundry Slag to Remove Arsenic in Groundwater - Stacy Metz (UW -Madison) talked about her recent project (under Dr. Craig Benson, Civil & Environmental Engineering) testing the effectiveness of using inexpensive foundry slag in permeable reactive barriers to treat arsenic-contaminated groundwater. Stacy discussed the preliminary batch tests, the importance of arsenic speciation, year-long column studies, and the analysis of slag composition. Four different slags were tested. Long-term removal was found to be dependent on slag iron content. In column studies arsenic breakthrough occurs quickly for slags with low iron content. The presence of phosphate results in competition for absorption sites, reducing the percentage of arsenic removed, thus showing the importance of using natural waters in testing. They are looking for an explanation for why arsenic removal occurs largely in the first 5 cm of the columns. One hypothesis is that the oxidizing conditions at the influent end of the columns are necessary for arsenic removal.

Agency Updates

Commerce – Eric Scott noted that sweeping changes proposed for the PECFA program include: 1)authorizing Commerce to use the PECFA funds to pay for the removal of certain underground petroleum storage tanks; 2) authorizing Commerce to contract with a certified tank removal contractor for the costs of associated with removal of a tank that has not been properly closed if the responsible party can't be identified or is unable or unwilling to pay for the activities; 3) authorizing Commerce to allow a tank owner or operator to submit a claim for consultants and contractors to be paid directly by the Department; 4) Transferring a large portion of the petroleum inspection fund to the general fund and decreasing the PECFA awards appropriation substantially. [Note: On May 22nd the Joint Committee on Finance failed to advance the Abandoned Tank Removal and Direct Pay provisions, approved the transfer of PECFA monies to the General Fund and approved a PECFA sunset provision proposed by the Legislative Fiscal Bureau.]

WGNHS - Jamie Robertson noted that the Wisconsin Public Utility Institute (WPUI) approached WGNHS about the potential for geologic carbon sequestration in the upper, sedimentary portion of the Midcontinent Rift in northwestern Wisconsin. Geologic carbon sequestration involves capturing carbon dioxide from coal-burning power plants and injecting the CO2 into rock

formations at least 2500-3000 ft below ground surface. The carbon is kept in place by various stratigraphic and/or structural "seals" along with hydrostatic pressure. We have very little detailed information about the sedimentary rocks or the deep hydrologic systems currently operating in our part of the Midcontinent Rift, and the WGNHS estimates the cost of constructing wells, installing monitoring devices, and performing appropriate analysis just to begin to understand the setting may well exceed $10-20 million. Jamie is working with Ken Bradbury on this, and they will give an invited presentation at an upcoming Power Lunch Series session sponsored by WPUI.

UWS – Jim Hurley reported that the Water Resources Center budget was again zeroed out. Anders was busy working with members of Congress to rectify the situation.

DNR – Todd Ambs reported that DNR was looking at more budget cuts in the new biennium. Substantial cuts would affect information technology consolidation efforts. Also, Water Division work-planning efforts are focusing on increasing contract spending efficiencies.

DATCP **-** Lori Bowman reported that private well survey was being undertaken. She also shared a map of drinking water wells with nitrate detections over10 ppm from the DATPC database. A quick summary of the data is as follows

Nitrate concentration	# of wells
10-20 ppm	3155
20-30 ppm	715
30-40 ppm	202
40-50 ppm	57
>50 ppm	61

DATCP is also dealing with manure issues stemming from livestock expansion, and budget issues.

Governor's Representative - George Kraft invited the council to Stevens Point for a meeting. The group decided to discuss it at the next meeting.

Wisconsin Rural Water Association – Ed Morse added that his position (EPA-funded) was likely to be cut for the next fiscal year. Ed is primarily involved in wellhead protection.

Adjourn – The meeting adjourned at 1:00 pm. The next meeting will be held 10:00 – 1:00 on May 25th at the Wisconsin Geological and Natural History Survey, Conference Room, 3817 Mineral Point Road, Madison.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist - Program Coordinator
Groundwater Section
Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Meeting Minutes – May 25th, 2007
Wisconsin Geological and Natural History Survey Conference Room
3817 Mineral Point Road, Madison.

Members Present: James Robertson (WGNHS); George Kraft (Gov. Rep), Henry Anderson (DHFS), Lori Bowman for Kathy Pielsticker (DATCP); Jim Hurley for Anders Andren (UWS), Bob Pearson for Dan Scudder (DOT).

Others Present: Ken Bradbury, Madeline Gotkowitz and Dave Hart (WGNHS); Steve Wittman and Peter Boger (WRI); Ed Morse (WRWA); Mike Lemcke and Jeff Helmuth (DNR).

The meeting began at 10:00 AM.

General business –Introductions were made. Minutes from the February 26th meeting were approved.

Joint Solicitation Update – Jim Hurley handed out a table showing new projects to be funded in FY 08 and reported that the joint solicitation had gone smoothly. James Robertson noted that there was a relatively equal geographic representation in the projects to be funded.

Mike Lemcke reported that, despite a long history of success in getting projects completed successfully, this year there were two projects with problems. DNR and UWS will be working with the principal investigators to resolve the problems.

Water Resource Institute Education and Outreach project - Steve Wittman introduced Peter Boger and reported that they had met twice with the Education Subcommittee on the GCC overview pamphlet to highlight the importance of groundwater quality and quantity issues and the crucial role the GCC plays in coordinating the joint solicitation process to address those issues. Jamie Robertson indicated that he hoped the brochure would be helpful in providing information to other states interested in improving their coordination on groundwater issues. Jamie also suggested contacting people who were around when the 1983 groundwater legislation was developed to be able to tell the story of how it came about. Several people offered names to follow up with if needed.

There was discussion of the timetable for completion of the pamphlet with the GCC indicating they would review it whenever it was ready after the current Education Subcommittee review. The UWS-funded project will be continued into fiscal year 2008 and produce fact sheets on the specific issues.

Education Subcommittee report – Dave Hart reported that the subcommittee was delighted to have the WRI professionals working on the GCC pamphlet and were happy to provide input. The subcommittee has also been active in reviewing agency materials on Private Well Water Quality and Arsenic. Mike Lemcke emphasized the importance of the Education Subcommittee in providing a consistent review of publications.

Water Use Project – Madeline Gotkowitz summarized the USGS/National Institutes for Water Resources-funded project contrasting groundwater pumping in urban (Waukesha Co.) and rural (Sauk Co.) areas of the state. Motivation for the project included and illustration of the sensitivity of the SEWRPC flow model to pumping and the escalating rate of water use in the region.

Project objectives include evaluating: 1) uncertainty in estimates of historical, current and future groundwater pumping; 2) the impact of uncertainty on calibration and predictions of regional models; and 3) implications for water conservation in Wisconsin.

Waukesha and Sauk Counties were contrasted with key differences being population density (650 vs. 66 people/sq.mi.), and rates of growth in population and developed acreage (Waukesha>>Sauk). Municipal water use per capita shows Waukesha leveling off and substantial increases in Sauk due to increasing commercial and industrial use. Per capita municipal residential use shows Waukesha usage above that of Sauk but Waukesha is declining, possibly due to conservation programs, and Sauk is increasing.

Municipal water use is the only type that is reported in Wisconsin so there is great uncertainty in water use estimates for self-supplied use. About 75% of water use is self-supplied in Sauk (as compared to 40% in Waukesha). The study looked at Wisconsin Agricultural Statistics Service (WASS) data for irrigation estimates and good success with it. Madeline recommends this data over the DNR high-capacity well database for the USGS 5-year water use report.

For 2003, Waukesha's water use is estimated at about 47.2 mg/d (primarily residential, commercial and industrial) as compared to 29.6 mg/d (primarily irrigation, commercial and industrial) for Sauk. Per capita consumption was 126 gal/d in Waukesha vs. 523 gal/d in Sauk. Population is a good predictor of municipal pumping. The rate of growth of per capita municipal use is higher in Sauk. Population is less useful in predicting future self-supplied water use.

Three water use histories were compared in calibrating the SE Wisconsin flow model with the conclusion being that records of historical pumping are sufficient for calibrating the SEWRPC model of the confined system which is relatively insensitive to uncertainty in pumping. A key finding is that the modeled 150-foot drawdown contour doesn't change much with pumping changes but is determined by the confined/unconfined boundary. The 400-foot contour, however, is much more sensitive because the entire sandstone aquifer is confined in that area.

Madeline also concluded that the regional model is not a good tool to predict the effect of conservation or drawdown because it is not capable of enough resolution to simulate local effects.

Discussion focused on the insensitivity of the SEWRPC model's 150-foot contour to pumping changes. This indicates that the SEWRPC area will likely not be able to reduce drawdown to less than 150 feet, the trigger level for being in a Groundwater Management Area as determined be Act 310. The Council thanked Madeline for her work and noted that it was the first time such work had been completed in Wisconsin.

Agency Updates

DATCP **-** Lori Bowman reported that budget discussions included increasing funds for Clean Sweep and pharmaceutical collection. Emergency rules would be required. No new atrazine prohibition areas were proposed. Data for a new private well survey was being collected by the Wisconsin Agricultural Statistics Survey. Nitrate continues to be a discussion point

UWS – Jim Hurley reported that the Congressional continuing resolution hurt the Water Resources Institute funding. The 10% FY06 budget cut of Geological Survey funds was sustained in FY07 and another 5% cut is expected. Many iterations of the Water Resources Institute budget included funds completely eliminated, then restored, then the national competition was cut.

DNR – Mike Lemcke reported that legislative language was being drafted to propose use of well compensation funds for well abandonment. The goal of the proposal is to get more focus on proper filling and sealing of old unused wells that are providing potential pathways of contaminants to our aquifers. On a parallel initiative identification of unused wells at the time of property transfer is being highlighted by the future requirement that licensed well drillers or pump installers will be required to do private water well inspections at the time of property transfer. The DG program is also conducting a high-capacity well inventory to meet the requirements of the recent groundwater quantity law. About 60% of the high-capacity wells, owners, and locations have been identified at this time. In the future water pumpage data will be collected. Mike anticipates that the data collection will be quite difficult. Suggestions included contacting county sanitarians and Irene Lippelt, the well data manager at WGNHS. Mike further reported that the DG program would have a statewide training session in October.

DHFS – Dr. Anderson reported that portions of DHFS were being reorganized but that major functions related to groundwater should not be affected. Children's social services were being pulled out. Chuck Warzecha, the new Director for the Bureau of Environmental & Occupational Health was giving that program new focus and direction. DHFS used the WASS in their environmental health tracking survey. The nitrate issue is of continued interest. Henry also noted that the DHFS arsenic project would continue to share materials with the Education Subcommittee.

WGNHS – Ken Bradbury noted that WGNHS was involved in siting Madison well # 3. Jamie Robertson added that the survey was still looking at the potential for geologic carbon sequestration in the upper, sedimentary portion of the Midcontinent Rift in northwestern Wisconsin. A huge investment would be required to implement the technology there. WGNHS is also providing geologic and hydrologic context for ethanol plant sitings.

Sources of Antibiotic Resistance in the Environment – Trina McMahon and Erin Seyfried reported on several projects related to the presence of antibiotic resistant bacteria in surface waters and groundwater. The presence of resistant bacteria is indicated by detection of resistance genes using molecular techniques. A WRI-funded project looked for significant sources of tetracycline resistance genes which are numerous and diverse (at least 40 types of genes). Aquaculture sites were monitored because of the common use of tetracycline antibiotics to treat fish diseases in these facilities. Antibiotics and resistant genes were expected to be present in the water and the sediment. Fish rearing facilities in Brule, Bayfield, St. Croix Falls and Superior were monitored seasonally over two years. Resistance genes were more frequently deteted in water samples but less frequently in sediments. Sedimentation ponds had a higher frequency of detection whether the facility was treating or not. Contrary to expectations, the resistance genes were found in sediments more often in the control facilities than in treating facilities. Based on these findings aquaculture is probably not a significant source of antibiotics.

Wastewater treatment plants (Oshkosh and Nine Springs) were also looked at because of the high concentrations of bacteria present and antibiotic presence in influents. Nearly all of the resistance genes the team searched for (10 total) were found in effluents. Fewer were detected in Lakes Mendota and Wingra (not impacted by the Nine Springs plant). Influents had very high concentrations of resistance genes, the activated sludge had less, biosolids about the same and the effluent had less than the influent. Trina concluded that wastewater treatment plants are a source but there is a 99.95% reduction from the influent concentrations. Membrane bioreactors could potentially reduce these concentrations even more. An interesting aside was that resistance genes can be passed from one bacteria to another.

Samples were also obtained from a related project monitoring groundwater downgradient of the Savannah Valley subdivision near Sun Prairie. Wisconsin mound septic systems are in use at the new subdivision on formerly agricultural land. Different genes were found in monitoring well samples as in private drinking water well samples. More genes were found in the water wells which are typically deeper. This indicates a variation over the age of the groundwater and a potentially larger impact from the previous land use (agriculture) than from the mound systems.

Trina concluded that many types of antibiotic resistance genes are found in the environment, but source fingerprints are difficult to characterize. One confounding factor is that the various resistance genes have different ecologies. The human health significance remains to be determined.

Set next meeting location and adjourn – The next meeting will be held 10:00 – 1:00 on August 24th at the Department of Agriculture and Consumer Protection, Board Room (first floor), Agriculture Drive, Madison. The meeting adjourned at 1:00 pm.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist - Program Coordinator
Groundwater Section
Department of Natural Resources

Appendix C : Groundwater Research & Monitoring Projects 1985-2007

Project title	Investigators	Contract Period	Funding Agency	Project Number
Volatile Organic Compound Contamination of Private Water Supplies Adjacent to Abandoned Landfills in Marathon County	Thomas Witthopf, Environmental Health Division-Marathon County	1985	DNR	DNR-41
Environmental Investigation of the City of Two Rivers Landfills, Manitowoc County, Wisconsin	Thomas Van Biersel, Michael Noel, Hydro-Search Inc.	01/30/1986-06/30/1987	DNR	DNR-24
West Bend Area Road Salt Study	Marianna Sucht, DNR	1986-1991	DNR	DNR-8
Filtration Preservation Study of Groundwater Samples	David Sauer, John Schwalbe, DNR	1985	DNR	DNR-21a
Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin	Jack G. Saltes, Ed Kruel, DNR	1985	DNR	DNR-29
Graphical and Statistical Methods to Assess the Effect of Landfills on Groundwater Quality	Kenneth W. Potter, Iris Goodman, UW-Madison	08/30/1985-06/30/1987	DNR	DNR-14a
Grounwater Monitoring Project for Pesticides	Jeffrey K. Postle, Kevin Brey, DATCP.	08/13/1985-06/30/1990	DNR	DNR-2
Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading	Thomas L. Portle, Carolyn Hunger, DNR	1985	DNR	DNR-19
Monitoring of Volatile Organic Compounds in Tomah, Wisconsin	Charles J. Krohn	1985	DNR	DNR-31a
Fate of Aldicarb Residues in a Groundwater Basin Near Plover, Wisconsin	George J. Kraft, WGNHS.	12/05/1985-06/30/1988	DNR	DNR-3
Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality	Phil Kammerer, USGS	1986	DNR	DNR-15
The Occurrence of Volatile Organic Compounds in Wastewater, Sludges and Groundwater at Selected Wastewater Treatment Plants in Wisconsin	Carolyn Hunger, John Melby, DNR	1985	DNR	DNR-18
Evaluation Techniques for Groundwater Transport Models	John A. Hoopes, Howard Trussell, UW-Madison	09/25/1985-06/30/1986	DNR	DNR-7
The Use of Groundwater Models to Predict Groundwater Mounding Beneath Proposed Groundwater Gradient Control Systems for Sanitary Landfill Designs	John A. Hoopes, Kathleen O. Slane, UW-Madison	09/30/1985-06/30/1986	DNR	DNR-6
A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone Into Groundwater	John A. Hoopes, John A. Brasino, UW-Madison.	07/30/1985-06/01/1986	DNR	DNR-1
Field Investigation of Groundwater Impacts from Absorption Pond Systems Used for Wastewater Disposal	John A. Hoopes, Laurie Parsons, UW-Madison	01/21/1985-06/30/1986	DNR	DNR-17a
Barron County Nitrate Study	Dave Hanson, William McKinley, DNR	1985	DNR	DNR-37
Volatile Organic Compounds in Groudwater and Leachate at Wisconsin Landfills	Marci A. Friedman, DNR	1985-1987	DNR	DNR-4a
Project title	**Investigators**	**Contract Period**	**Funding Agency**	**Project Number**

The Effect of Construction, Installation and Development Techniques on the performance of Monitoring Wells in Fine-Grained Glacial Tills	Douglas S. Cherkauer, Carl D. Palmer, Duane G. Paul, UW-Milwaukee	10/01/1985-06/30/1986	DNR	DNR-16
The Prediction of Nitrate Contamination Potential Using Known Hydrogeologic Properties	Douglas S. Cherkauer, Cynthia L.W. Cruciani, Univeristy of Wisconsin-Milwaukee	11/25/1985-06/30/1987	DNR	DNR-10
Hydrogeology of the Wisconsin River Valley in Marathon County, Wisconsin	Kenneth R. Bradbury, WGNHS. Eloise Kendy, UW-Madison	05/01/1986-06/30/1986	DNR	DNR-22
Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifier in Door County, Wisconsin	Kennth R. Bradbury, Maureen A. Muldoon, WGNHS. Margaret C. Blanchard, UW-Madison.	03/06/1986-06/30/1990	DNR	DNR-12
Volatile Organic Compounds in Small Community Wastewater Disposal Systems Using Soil Absorption	William C. Boyle, William C. Sonzogni, James C. Converse, John A. Hoopes, James O. Peterson, E. Jerry Tyler, Bruce A. Greer: UW-Madison.	10/25/1985-06/30/1986	DNR	DNR-5
A Case Study of Nitrogen Transformation at a Rapid Infiltration System Used for the Disposal of Food Processing Wastewater	William C. Boyle, John A. Hoopes, John Niewoehner, UW-Madison	11/15/1985-06/30/1986	DNR	DNR-17b
Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations	William Boyle, Frederic J. Doran, UW-Madison	1985	DNR	DNR-23
Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin	Jim Anklam, William J. Evans, DNR	1985	DNR	DNR-31b
Lead Migration from Contaminated Sites - Door County, Wisconsin	James J. Wiersma, Ronald D. Stieglitz, UW-Green Bay	08/07/1986-09/30/1988	DNR	DNR-13
Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision	John R. Tinker, UW-Eau Claire	1987-1990	DNR	DNR-11
Hydrogeologic Investigation and Groundwater Quality Assessment (Havenswood Landfill)	Pratap N. Singh, Miller Consulting Associates, Anthony R. Pawloski, Miller Consulting Engineers	1986	DNR	DNR-28
Investigation of Large Scale Subsurface Soil Absorption Systems	Daniel Peerenboom, DNR	11/13/1986-06/30/1987	DNR	DNR-42
Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System	Chris Norenberg, Jon Standridge, Wisconsin State Laboratory of Hygiene	1986	DNR	DNR-21b
Project title	**Investigators**	**Contract Period**	**Funding Agency**	**Project Number**

Flambeau Paper Sulfite Lagoon Site Contamination Study	William Lantz, Dan Detroit, DNR	07/08/1986-08/15/1986	DNR	DNR-30
1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin	David Holman, Environmental Health Division, Rock County	1986	DNR	DNR-40
Downward Movement of Water Below Barnyard Grass Filter Strips - Case Studies	Gary D. Bubenzer, James C. Converse, John W. Patoch, UW-Madison	08/26/1986-09/30/1988	DNR	DNR-39
Research and Data Analysis of Groundwater Contamination from Municipal Rapid Infiltration Land Disposal Systems	William C. Boyle, John A. Hoopes, Kenneth W. Potter, John Schwalbe, UW-Madison	1986	DNR	DNR-56
Characterization of Groundwater Impacts at an Above Ground Petroleum Storage Terminal	Gregory T. Becker, Robert K. Ham, UW-Madison	08/13/1986-06/30/1987	DNR	DNR-43
Plover Area Nitrate Study	Fred Bailey, DNR	1986	DNR	DNR-48
Lead Contamination Study of Door County	Rick Stoll, DNR	1987	DNR	DNR-44
Analytical Determination of Atrazine Alachlor and Their Selected Degradation Products in Contaminated Groundwater: Implication for Wisconsin Groundwater	William Sonzogni, Wisconsin State Laboratory of Hygiene. Deborah B. DeLuca, UW-Madison.	09/1987-08/1989	DNR	DNR-47
Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities	Kenneth W. Potter, Sarah R. Fisher, UW-Madison	08/05/1987-12/31/2988	DNR	DNR-14b
Evaluation of the Effect of Stormwater Disposal on Groundwater	Byron Shaw, Gerald Nienke, James Berndt, UW-Stevens Point	07/16/1987-06/30/1989	DNR	DNR-53
Mineralogical and Geophysical Monitoring Naturally Occurring Radioactive Elements in Selected Wisconsin Aquifers	Robert W. Taylor, Gregory Mursky, UW-Milwaukee	07/15/1987-12/30/1988	DNR	DNR-51
Mutagenic Effects of Selected Toxicants Found in Wisconsin's Groundwater	Lorraine F. Meisner, UW-Madison. David A. Belluck, DHSS. Boyd Roloff, UW-State Laboratory of Hygiene	08/01/1987-12/31/1989	DNR	DNR-38
Sealing Characteristics of Sodium Bentonite Slurries for Water Wells	Tuncer Edil, Michael M.K. Chang, Ahmad S.H. Mahanna, L.T. Lan, UW-Madison	07/27/1987-06/30/2988	DNR	DNR-34
Radionuclides in Drinking Water of North central Wisconsin	Chuck Fitzgerald, Bill Dobbins, DNR	1987	DNR	DNR-54
Degradation of Atrazine, Alachlor, Metolachlor in Soils and Aquifer Materials	Gordon Chesters, Geronimo Simsiman, Riyadh Fathulla, Bashar Alhajjar, Robin Harris, John Harkin, Jonathan Levy, UW-Madison	07/10/1987-09/30/1989	DNR	DNR-52

Project title	Investigators	Contract Period	Funding Agency	Project Number
Digital Simulation of Solute Transport to Green Bay and Lake Michigan by Groundwater from Door County, Wisconsin	Douglas S. Cherkauer, Peter McKereghan, Linda Schalch, UW-Milwaukee	07/1987-09/1990	DNR	DNR-57
Assessment of Geologic Controls on Groundwater Flow and Distribution in Precambrian Bedrock, Central Wisconsin, Using Remote Sensing and Geophysical Analysis	Donald M. Davidson Jr., Northern Illinios University. Bruce A. Brown,WGNHS	07/13/1987-06/30/1989	DNR	DNR-49
VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications	Janet R. Battista, DNR	1988-1989	DNR	DNR-4b
A Ground Penetrating Radar Study of Water Table Elevation in a Portion of Wisconsin's Central Sand Plain	Mary P. Anderson, Charles R. Bentley, Geoffrey C. Bohling, UW-Madison	07/22/1987-06/30/1988	DNR	DNR-50
Effect of Soil Type on Atrazine and Alachlor Movement Through Unsaturated Zone	Tommy Daniel, Rick Wietersen, Kevin Fermanich, UW-Madison	10/05/1988-06/20/1989	DNR-DATCP	DNR-DATCP-62
Effects of Volatile Organic Compounds on clay landfill liner performance	Edil, Berthouex, Park, Sandstrom		DNR	DNR-61
Grade A Dairy Farm Water Well Quality Survey	Gary LeMasters, DATCP. Douglas J. Doyle, WASS.	09/02/1988-06/30/1989	DNR	DNR-58
Groundwater Quality Investigation of Selected Townships in Jefferson County, Wisconsin	Fred Madison, UW. Andrea Kenter, Wisconsin Geological & Natural History Survey	12/27/1988-07/01/1989	DNR	DNR-60
Designs for wellhead protection in Central Wisconsin	Osborne, Sorenson, Knaak, Mechenich		DNR	DNR-63
Pesticide Migration Study	Byron Shaw, UW - Stevens Point, and Mike Heitman, UW - Stevens Point	07/01/1989 – 06/30/1991	DNR	DNR-55
Optimum Manure Application Rate - Corn Shaw Fertility Management and NitrateLeaching to Groundwater in Sandy Soils	Byron Shaw, Paul Trapp, UW - Stevens Point	07/01/1989 - 06/30/1991	DNR	DNR-71
Subdivision impacts on groundwater quality	Shaw, Ameson, VanRyswyk	07/01/1989 – 6/30/1991	DNR	DNR-67
Demo of low input strategies for potato/vegetable production in irrigated sands	Shaw, Curwen, Kraft, Osborne	07/01/1989 – 6/30/1991	DNR	DNR-59
A Field Evaluation of Drainage Ditches as Barriers to Contaminant Migration	Jean Bahr, Lucy W. Chambers, UW-Madison	11/16/1989-09/30/1991	DNR	DNR-75
Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN)	Bohn	07/01/1989 – 06/30/1990	DNR	DNR-68
Atrazine Contamination of Groundwater in Dane County, Wisconsin	Bradbury, McGrath	07/01/1989 – 06/30/1991	DNR	DNR-64
Sources and Extent of Atrazine Contamination of Groundwater at a Grade A Dairy Farm in Dane County, Wisconsin	Chesters, UW-Madison, and Levy, Miami University	07/01/1989 – 06/30/1991	DATCP, UWS, DNR	GCC-UWS-14

Project title	Investigators	Contract Period	Funding Agency	Project Number
Follow Up to the Grade A Dairy Farm Well Water Quality Survey	Cowell, LeMasters	07/01/1989 – 06/30/1990	DNR	DNR-70
Report on Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells	Keith Hutchinson, Bruce Urben, and Sue Beaumier, DNR	07/01/1989 – 06/30/1991	DNR	DNR-72
DNR and DATCP Rural Well Survey	LeMasters	01/1990 - 03/1991	DNR	DNR-69
Variation in Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology		01/1990 - 03/1992	DNR	DNR-74
Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells	Sonzogni, Eldan,, Lawrence, WSLH, UW-Madison	01/1990 - 03/1991	DNR	DNR-77
Nitrogen Isotope Monitoring at Unsewered Subdivisions		01/1990 - 03/1991	DNR	DNR-76
Volatile Organic Compound Attenuation in Unsaturated Soil Above and Below an On-site Wastewater Infiltration System	Tyler, Peterson, Sauer	07/01/1989 – 06/30/1991	DNR	DNR-73
Integrated decision support for wellhead protection	Adams, Benson	07/01/1990 – 06/30/1991	UWS	UWS
Role of mobile colloids in the transport of chemical contaminants in groundwater	Armstrong, Shafer		UWS	UWS
On-site nitrogen removal systems research demonstration project: Phase 1	Ayers and Associates	07/01/1990 – 06/30/1991	UWS	UWS
Evaluation of Potential Phytotoxicity and Crop Residues when Using Sprayer Rinsate as a Portion of the Diluent in Pesticide Spray Mixtures	Binning	07/01/1990 – 06/30/1991	UWS	UWS
To Expand Groundwater Sampling in the Lower Wisconsin River Valley	Cates, Madison, Postle	07/01/1990 – 06/30/1991	DNR	DNR-78
Renovation of Pesticide Contaminated Rinse Water	Gordon Chesters, John Harkin	07/01/1990 – 06/30/1991	UWS	UWS
In-situ Removal of Fe, Mn, and Ra from groundwater	Christensen, Cherkauer	07/01/1990 – 06/30/1991	UWS	UWS
Reactions of Chlorohydrocarbons on Clay Surfaces	Fripiat	07/01/1990 – 06/30/1991	UWS	UWS
The Biological Impact of Landfill Leachate on Nearby Surface Waters	William Sonzogni, Jonathon Standridge, and Steven Geis, UW - State Laboratory of Hygiene	07/01/1990 – 06/30/1991	DNR	DNR-83
Chemical transport across a sediment-water interface	Green	07/01/1990 – 06/30/1992	UWS	UWS
Adsorptive Behavior of Atrazine and Alachlor in OrganicPoor Sediments	Grundl, Small	07/01/1990 – 06/30/1991	UWS	UWS 91-PTC-1
The Effects of Complex Mixtures of Chemicals in Leachates on the Transport of Pollutants in Groundwater	Grundl, Cherkauer	07/01/1990 – 06/30/1992	UWS	GCC-UWS-04
Bioremediation of Herbicide-Contaminated Soil and Water	Robin F. Harris, UW-Madison	07/01/1990 – 06/30/1992	UWS	GCC-UWS-19
Near-source transport of contaminants in heterogeneous media	John Hoopes	07/01/1990 – 06/30/1991	UWS	UWS

Project title	Investigators	Contract Period	Funding Agency	Project Number
Design of a small scale transportable mixing/loading system	Kammel	07/01/1990 – 06/30/1992	DATCP	DATCP
Munipcal wastewater project	Kopecky	07/01/1990 – 06/30/1991	DNR	DNR-85
Dependence of aldicarb residue degradation rates on groundwater chemistry in the Wisconsin Central Sands	George Kraft, Phil Helmke	07/01/1990 – 06/30/1991	DNR	DNR-84
Using ground pnetrating radar to predict preferential solute movement and improve contaminant monitoring in sandy soils	Kiung, Madison	07/01/1990 – 06/30/1992	UWS	UWS
Nitrate Movement through the Unsaturated Zone of a Sandy Soil in the Lower Wisconsin River Valley	Lowery, Fermanich, Grant, McSweeney, Kussow	07/01/1990 – 06/30/1991	UWS	GCC-UWS-03
Effect of Soil Type, Selected Best Management Practices, and Tillage on Atrazine and Alachlor Movement through the Unsaturated Zone	Lowery, McSweeney, Fermanich, Hart, Wang, Seybold	8/18/89-12/31/91	DNR	DNR-66
A Study of the Response of Nitrate and Atrazine Concentrations in Groundwater from Agricultural use on a Sandy, Irrigated Corn Field in the Lower Wisconsin River Valley	Kim Cates, Fred Madison	07/01/1990 – 06/30/1993	DNR	DNR-81
Facility plan amedment for wastewater collection for Green Lake Sanitary District, Green Lake, WI		07/01/1990 – 06/30/1991	DIHLR	DIHLR
Contamination Attenuation Indices for Sandy Soils: Tools for Information Transfer.	Kevin McSweeney, UW-Madison, Fred Madison, Geological and Natural History Survey	07/01/1990 – 06/30/1991	UWS	GCC-UWS-09
Tracking contaminant pathways in groundwater using a geologically based computer code for outwash	David Mickelson, Mary Anderson	07/01/1990 – 06/30/1992	UWS	UWS
A tracer technique for measuring regional groundwater velocities from a single borehole	Monkmeyer	07/01/1990 – 06/30/1991	UWS	UWS
The economic effects of groundwater contamination on real estate	Page	07/01/1990 – 06/30/1991	UWS	UWS
Prediction of organic chemical leachate concentrations from soil samples	Jae Park	07/01/1990 – 06/30/1991	UWS	UWS
Crop Rotations Effects on Leaching Potential and Groundwater Quality	J. L. Posner, G. D. Bubenzer, F. Madison, UW-Madison	06/01/1990 - 12/31/1992	DNR	DNR-80
Barnyard Management Practices: Effect on Movement of Nitrogen Through Soils and Impact on Groundwater Quality	Byron Shaw, Michael J. Travis, Bryan D. Bowen, UW-Stevens Point. Bob Wilson, Soil Conservation Service. Tim Victor, PCLCC. Dave Jelinski, DATCP.	08/25/1988-09/30/1990	DNR	DNR-9
A Comparative Study of Nitrate Loading to Groundwater from Mound, In-Ground Pressure and At-Grade Septic Systems	Byron Shaw, Nancy Turyk	7/01/1991-6/30/1992	DNR	DNR-82

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Waupaca County groundwater project: Towns of St. Lawrence and Little Wolf	Wilson, Blonde	7/01/1990-6/30/1992	DNR	DNR-79a
Waupaca County: Towns of Lebanon and Scandinavia	Wilson, Blonde	07/01/1991 – 06/30/1992	DNR	DNR-79b
Arsenic as a naturally elevated parameter in water supply wells in eastern Winnebago and Outagamie Counties	Rick Stoll	07/01/1991 – 06/30/1992	DNR	DNR-87
Evaluation of denitrification systems for improving groundwater from on-site waste disposal systems	Byron Shaw	07/01/1991 – 06/30/1993	DNR	DNR-95a
Assessment of Wisconsin's Groundwater Monitoring Plan (GWM) Program for Active Non-Approved Landfills (1985-1990)	Laura Pugh, DNR, Barbara Gear, DNR	07/01/1991 – 06/30/1992	DNR	DNR-92
Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits	Laura Pugh, DNR, Barbara Gear, DNR	07/01/1991 – 06/30/1993	DNR	DNR-98a
Estimating the spatial distribution of groundwater recharge rates using hydrologic, hydrogeologic, and geochemical methods	Ken Potter and Carl Bowser	07/01/1991 – 06/30/1993	UWS/DATCP	UWS/DATCP
New approaches to measuring bioloic effects of groundwater contaminants	Warren Porter	07/01/1991 – 06/30/1992	UWS	UWS
Nitrogen removal from domestic wastewater in unsewered area	Otis, Converse	07/01/1991 – 06/30/1993	DIHLR	DIHLR
Spatial attributes of the soil-landscape-groundwater system of the lower Wisconsin River Valley	McSweeney, Madison, Attig, Bohn, Falk	07/01/1991 – 06/30/1993	DNR	DNR-88
Herbicide and nitrate movement in a sandy soil aquaifer in the Lower Wisconsin River Valley	Lowery, McSweeney	07/01/1991 – 06/30/1993	UWS	UWS/DATCP
Remediation of Soils Contaminated by Leaking Underground Storage Tanks by Vapor Extraction and in situ Bioremediation	Hickey, Jacobsen, Bubenzer	07/01/1991 – 06/30/1993	DNR	DNR-96
Living mulch systems for nitrate trapping in vegetable production	Harrison	07/01/1991 – 06/30/1993	UWS	UWS
Municipal wastewater absorption pond renovation for enhanced nitrogen removal	Gilbert	07/01/1991 – 06/30/1993	DNR	DNR-97
Use of tire chips to attenuate VOC's	Tuncer Edil, Jae Park	07/01/1991 – 06/30/1993	UWS	UWS
Dane County atrazine/lead management project	Conners, Bohn, Madison, Muldoon, Richardson	07/01/1991 – 06/30/1992	DNR	DNR-99
Distribution, Sources and Fate of Atrazine in a Sandy-Till Aquifer	Gordon Chesters, Jonathan Levy	07/01/1991 – 06/30/1993	UWS & DATCP	UWS/DATCP
GIS Mapping of Groundwater Contaminant Sources Quality and Contamination Susceptibility for Door County	Richard Stoll, Mike Hronek	07/01/1991 – 06/30/1993	DNR	DNR-93
Preliminary comparison of a discrete fracture model with a continuum model for groundwater movement in fractured dolomite	Bradbury, Muldoon	07/01/1991 – 06/30/1992	DNR	DNR-89

Project title	Investigators	Contract Period	Funding Agency	Project Number
Evaluation of NURE hydrogeochemical groundwater data for use in Wisconsin groundwater studies	Bradbury, Mudrey, Shrawder	07/01/1991 – 06/30/1992	DNR	DNR-90
Distribution of radionuclides in Wisconsin groundwater	Bradbury, Mudrey	07/01/1991 – 06/30/1992	DNR	DNR-91
GIS for subsurface characterization	Bosscher, Adams	07/01/1991 – 06/30/1993	UWS	UWS
Effects of transient cross-stratification flow on contaminant dispersion	Jean Bahr	07/01/1991 – 06/30/1993	UWS	UWS
The Impact of Atrazine Management Areas Designation on Weed Control Strategies in Wisconsin Corn Production	Nowak, Wolf, McCallister, Hartley, UW - Madison	07/01/1992 – 06/30/1994	DATCP and Ciba Geigy	DATCP-92-01
Variability of hydraulic conductivity in supraglacial sediments	David Mickelson	07/01/1992 – 06/30/1994	UWS	UWS
Field evaluation of near source transport of contaminants in heterogeneous media	John Hoopes	07/01/1992 – 06/30/1994	UWS	UWS
Long-term Transformation and Fate of Nitrogen in Mound-type Soil Absorption Systems for Septic Tank Effluent	John Harkin, Chen Peng Chen	07/01/1992 – 06/30/1994	DNR	DNR-103
Ultrasonic verification technique for evaluating well seals	Tuncer Edil	07/01/1992 – 06/30/1994	UWS	UWS
A further study of organics at municpal solid waste landfills	Jack Connelly	07/01/1992 – 06/30/1994	DNR	DNR-104
Impact of tunnel dewatering on surface water bodies in Milwaukee County	Doug Cherkauer	07/01/1992 – 06/30/1994	UWS	UWS
Management of sweet corn processing to protect groundwater quality	Larry Bundy	07/01/1992 – 06/30/1994	UWS	UWS
Evaluation of Groundwater Susceptibility Assessment Systems in Dane County, Wisconsin	Bohn, Muldoon, Madison, Bradbury, Zaporozec	07/01/1992 – 06/30/1994	DNR	DNR-100
Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite	Maureen A. Muldoon, Kenneth R. Bradbury	07/01/1992 – 06/30/1994	DNR	DNR-101
Trace metal transport affected by groundwater stream interactions	Jean Bahr	07/01/1992 – 06/30/1994	UWS	UWS
Urban stormwater infiltration: Assessment and enhancement of pollutant removal	David Armstrong	07/01/1992 – 06/30/1994	DNR	DNR-102
The use of peat as an absorbtive medium	Jim Wiersma, Ron Stieglitz	07/01/1993 – 06/30/1994	DATCP	DATCP
Groundwater Survey for Alachlor and ESA its Polar Metabolite in Southern Wisconsin	James Vanden Brook, DATCP	01/6/1994 – 05/30/1994	DATCP, DNR, Monsanto Company	DNR-112
The further incidence of native arsenic in eastern Wisconsin water supply wells: Marinette, Oconto, Shawano and Brown Counties	Rick Stoll	07/01/1993 – 06/30/1994	DNR	DNR-110
Integrated computerized mapping of point source contaminants and phytsical environmental characterisitics to protect and manage groundwater quality	Rick Stoll	07/01/1993 – 06/30/1994	DNR	DNR-105
Factors affecting the determination of radon in groundwater	William Sonzogni	07/01/1993 – 06/30/1994	DNR	DNR-111
Optimization of two recirculating sans filters for nitrogen and organic chemical removal from domestic wastewater	Byron Shaw	07/01/1993 – 06/30/1994	DNR	DNR-95b

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Investigation of potential groundwater impacts at yard waste sites	Pugh, Connelly	07/01/1993 – 06/30/1994	DNR	DNR-98b
Groundwater hydrogeology of an agricultural watershed	Ken Potter	07/01/1993 – 06/30/1995	DNR/DATCP	DNR-109
Cover Crops to Limit Herbicide Use on Sweet Corn	Astrid Newenhouse	07/01/1993 - 08/30/1995	DATCP	DATCP-93-04
Cover crops to limit herbicide use on sweet corn	Newenhouse	07/01/1993 – 06/30/1994	DATCP	DATCP
Leaching potential of Imazethapyr and nicosulfron in Sparta sand	Birl Lowery	07/01/1993 – 06/30/1994	DATCP	DATCP
Comparative evaluation of biostimulation approaches for enhancing in situ TCE degradation in contaminated aquaifers	William Hickey	07/01/1993 – 06/30/1995	UWS	94REM6B2
Using "PREDICT" to reduce herbicide usage and improve groundwater quality	Harvey	07/01/1993 – 06/30/1995	UWS	94PES6B2
Stratigraphy, sedimentaology and porosity distribution of the Silurian rocks of Door County, Wisconsin	Mark Harris	07/01/1993 – 06/30/1995	UWS	94HGE2B2
Mineral Phase Sorption of Selected Agrichemicals to Wisconsin Soils	Timothy J. Grundl and Greg Small, UW-Milwaukee	1994 – 1995	UWS	GCC-UWS-13
Mineral phase sorption of selected agrichemicals to Wisconsin soils	Tim Grundl	07/01/1993 – 06/30/1995	UWS	94PES1B2
An investigation of field-filtering and low-field pumping when sampling for metals	Jack Connelly	07/01/1993 – 06/30/1994	DNR	DNR-106
Herbicide contamination of soil and groundwater at a mixing and loading site	Gordon Chesters	07/01/1993 – 06/30/1995	UWS & DATCP	94PES2B2
Improved design of pump and treat systems for heterogeneous aquaifers	Jean Bahr	07/01/1993 – 06/30/1995	UWS	94REM3B2
Photocatalytic degradation of volatile organic carbon	Marc Anderson	07/01/1993 – 06/30/1995	UWS	94REM2B2
Collection of hydraulic and geologic data to improve the quality of the Wiscosnin Groundwater Monitoring Network	Zaporozec	07/01/1994 – 06/30/1996	DNR	DNR-118
An evaluation of long-term trends and a mineralogical interpretation of naturally occurring metals contamination and acidification	Weissbach	07/01/1994 – 06/30/1996	DNR	DNR-115
Evaluation of enzyme-linked immunosorbent assay for herbicide analysis of Wisconsin soil in comparison to gas chromatogeraphy	William Sonzogni	07/01/1994 – 06/30/1995	UWS	UWS
Characterization of E. coli and total coliform organisms isolated from Wisconsin groundwater and reassessment of their public health significance	William Sonzogni	07/01/1994 – 06/30/1995	DNR	DNR-117
Geologic constraints on arsenic in groundwater with applications to groundwater modeling	Tony Simo	07/01/1994 – 06/30/1995	UWS	UWS
Development and demonstration of an accurate manure spreading system to protect water quality, improve waste management and farm profitability	Shinners	07/01/1994 – 06/30/1996	UWS	UWS
Synergistic effects of endocrine dirupters in drinking water	Warren Porter	07/01/1994 – 06/30/1996	UWS	UWS

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Vertical and horizontal variability of hyrogeologic properties of glaciated landscapes	David Mickelson	07/01/1994 – 06/30/1995	DNR	DNR-119
Agrichemical impacts to groundwater under irrigated vegetables in the Central Sand Plains	George Kraft, Bryant Browne	07/01/1994 – 06/30/1996	DNR	DNR-116
Use of heavy nitrogen to study nitrate flux from septic systems	John Harkin	07/01/1994 – 06/30/1996	UWS & Commerce	UWS/Comm
A low-input crop management plan for Wisconsin fresh-market vegetable growers	Delahunt	07/01/1994 – 06/30/1995	DATCP	DATCP
A comparison of low flow pumping and bailing for VOC sampling	Jack Connelly	07/01/1994 – 06/30/1995	DNR	DNR-114
Integration of hydraulics and geology into a hydrostratigraphic model for the Paleozoic Aquifer of eastern Dane County, Wisconsin	Doug Cherkauer	07/01/1994 – 06/30/1995	UWS	UWS
Direct and residual effects of land-applied sweet corn processing wastes on nitrate loss to groundwater	Larry Bundy	07/01/1994 – 06/30/1996	DNR	DNR-120
Application of a discrete fracture flow model for wellhead protection at Sturgeon Bay, Wisconsin	Ken Bradbury, Maureen Muldoon	07/01/1994 – 06/30/1996	DNR	DNR-113
Tracer study for characterization of groundwater movement and contaminant transport in fractured dolomite	Ken Bradbury	07/01/1994 – 06/30/1996	UWS	UWS
Evaluating the efectiveness of landfill liners	Craig Benson	07/01/1994 – 06/30/1996	UWS	UWS
An integrated approach to the management of insects in sweet corn grown for fresh market	Wedberg	07/01/1995 – 06/30/1997	UWS	
The use of azimuthal resistivity and self potential measurements to delineate groundwater flow direction in fractured media	Taylor	07/01/1995 – 06/30/1996	UWS	
GIS as a tool to prioritize environmental releases, integrate their managaement and alleviate their public threat	Stoll	07/01/1995 – 06/30/1997	DNR	DNR-126
Evaluation of shallow-soil adsorption fields associated with on-site disposal systems	Ron Stieglitz	07/01/1995 – 06/30/1997	UWS & DNR & DATCP	
Stratigraphic controls on the mobilization and transport of naturally-occurringarsenic in groundwater: Implication for wellhead protection	Tony Simo	07/01/1995 – 06/30/1996	UWS	
Land Use Effects on Groundwater and Streamwater Quality in the Little Plover River Watershed	Byron Shaw and Phillip Albertson, UW-Stevens Point	07/01/1995 – 06/30/1997	DATCP	DATCP
Groundwater recharge and contamination in Wisconsin's Driftless Area	Ken Potter	07/01/1995 – 06/30/1997	DATCP	DATCP
Characterization of the role of evapotranspiration on groundwater movement and solute chemistry in groundwater-fed wetlands	Ken Potter	07/01/1995 – 06/30/1997	UWS	
Variability of nitrate loading and determination of monitoring frequency for a shallow sandy aquifer, Arena, Wisconsin	Fred Madison	07/01/1995 – 06/30/1996	DNR	DNR-123

Project title	Investigators	Contract Period	Funding Agency	Project Number
Optimum management of groundwater resources in the Lower Fox River Valley	Jim Krohelski	07/01/1995 – 06/30/1997	DNR	DNR-122
Biostmulation of trichloroethylene degradation in contaminated aquifers	William Hickey	07/01/1995 – 06/30/1997	UWS	
Iron-based abiotic destruction of chlorinated pesticides in groundwater	Gerry Eykholt	07/01/1995 – 06/30/1996	UWS	
Evaluation of well seals using an ultrasonic probe	Tuncer Edil	07/01/1995 – 06/30/1996	UWS	
Responses of biological toxicity tests to mixtures of pesticides and metabolites	Gordon Chesters	07/01/1995 – 06/30/1997	UWS	
Deliniation of capture zones for municipal wells in Dane County, Wisconsin	Ken Bradbury	07/01/1995 – 06/30/1997	DNR	DNR-121
Bioremediation of Hydrocarbons influenced by air sparging: A multi-model approach to assess contaminant mass removal	Jean Bahr	07/01/1995 – 06/30/1997	UWS	
A study of well construction guidance for arsenic contamination in northeast Wisconsin	Weissbach	07/01/1996 – 06/30/1998	DNR	DNR-127
Determining compatibility between herbicide release and habitat for Karner Blue butterfly in red pine plantations	Sucoff	07/01/1996 – 06/30/1997	DATCP	DATCP
Improved detection limits for groundwater monitoring	William Sonzogni	07/01/1996 – 06/30/1997	UWS & DNR	DNR-128
Stratigraphic controls on distribution of hydraulic conductivity in carbonate aquifers	Tony Simo	07/01/1996 – 06/30/1998	DNR	DNR-129
Evaluation of the use of DUMPSTAT to detect the impact of landfills on groundwater quality	Ken Potter	07/01/1996 – 06/30/1997	DNR	
Treatment of groundwater contaminated with chlorinated aliphatics using silicone tubing supported methanotrophic biofilm reactor	Jae Park	07/01/1996 – 06/30/1998	UWS	DNR-130
Fate of nicosulfron in Sparta sand	Birl Lowery	07/01/1996 – 06/30/1997	DATCP	
Nitrate-contaminated drinking water followback study	Marty Kanarek	07/01/1996 – 06/30/1997	DNR	DNR-131
Molecular techniques for detection and identification of sewage-borne human pathogens in soils	William Hickey	07/01/1996 – 06/30/1998	Commerce	
Stratigraphy, seidmentology and porosity distribution of the Silurian Aquifer of Ozaukee County, Wisconsin	Mark Harris	07/01/1996 – 06/30/1997	UWS	
Experiemtnal verification of models used to evaluate landfill liner effectiveness	Tuncer Edil	07/01/1996 – 06/30/1997	UWS	
Groundwater bioremediation: Monitoring with MMO probes	MLP Collins	07/01/1996 – 06/30/1998	UWS	
Development of a variable rate nitrogen application approach for corn	Larry Bundy	07/01/1996 – 06/30/1998	UWS	
Holding tank effluent and fecal-contaminated groundwater: soureces of infectious diarrhea in central Wisconsin	Mark Borchardt	07/01/1996 – 06/30/1998	Commerce	Commerce
Project title	**Investigators**	**Contract Period**	**Funding Agency**	**Project Number**

Project title	Investigators	Contract Period	Funding Agency	Project Number
Groundwater protection by application of modern portfolio theory to microbiotesting strategies	George Blondin	07/01/1996 – 06/30/1997	UWS	
In situ air sparging: Air plume characterization and removal effectiveness	Craig Benson	07/01/1996 – 06/30/1998	UWS	
Hydrogeochemical and microbiological studies for enhanced groundwater bioremediation	Jean Bahr	07/01/1996 – 06/30/1998	UWS	
Improved estimation of groundwater recharge rates	Mary Anderson	07/01/1996 – 06/30/1997	UWS	
Evaluation of geology and hydraulic performance of Wisconsin groundwater monitoring wells	Alex Zaporozec	07/01/1997 – 06/30/1998	DNR	DNR-135
Effects of Fosamine, Glyphosate, Picloram, Triclopyr, and Sodium Tetraborate on Reducing Aspen in Prairie Bush Clover Habitat	Paul C. West	07/01/1997 – 06/30/1998	DATCP	DATCP
Northeast region public water supply location utilizing GIS and GPS	Stoll	07/01/1997 – 06/30/1998	DNR	DNR-133
Impact of Ginseng Production on Groundwater Quality	William DeVita and Byron Shaw	07/01/1997 – 06/30/1998	DATCP	DATCP
Relationships between water quality in stream base flow and private wells and land use in the Tomorrow/Waupaca watershed	Byron Shaw	07/01/1997 – 06/30/1999	DNR	DNR-132
The direct effect of agricultural chemicals on Wisconsin's declining and endangered amphibians	William Karasov	07/01/1997 – 06/30/1999	UWS & DATCP	
Investigation of air sparging: Numerical modeling, laboratory verification and design guidelines	Hoopes	07/01/1997 – 06/30/1999	UWS	
Fate of metolachlor, alachlor and nitrate in granular iron/soil/ water systems	Eykholt, Davenport, Wonsettler	07/01/1997 – 06/30/1998	DATCP	DATCP
Evaluation of exploration borehole seals using Time Domain Reflectomtery	Tuncer Edil	07/01/1997 – 06/30/1999	UWS	
Further evaluation of well seals using ultrasonic probes	Tuncer Edil	07/01/1997 – 06/30/1998	DNR	DNR-136
Characterization of the hydrostratigraphy of the deep sandstone aquifer in southeatern Wisconsin	Timothy Eaton	07/01/1997 – 06/30/1999	DNR	DNR-134
Determining Ground-Water Recharge Rates in Southern Wisconsin County	Douglas S. Cherkauer, UW-Milwaukee, and Craig J. LaCosse, UW-Milwaukee	07/01/1999 – 06/30/2001	UWS	R/UW-HDG-005
Watershed-scale nitrate contamination and chlorofluorocarbon ages in the Little Plover Basin: A study at the groundwater/surface water interface	Bryant Browne	07/01/1997 – 06/30/1999	UWS	
Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin	Timothy T. Eaton, Kenneth R. Bradbury	07/01/1997 – 06/30/1998	DNR	DNR-138
Groundwater-surface water interactions in the Nine Springs watershed	Jean Bahr	07/01/1997 – 06/30/1999	DNR	DNR-137
Assessment of impacts on groundwater/lake and wetland systems	Mary Anderson	07/01/1997 – 06/30/1998	UWS	

Hydraulic Conductivity and Specific Storage of the Maquoketa Shale	Eaton, Hart, Bradbury, Wang. WGNHS and UW-Madison	07/01/1998 – 06/30/2000		
Fate of herbicides atrazine, cyanazine and alachlor and selected metabolites	Stoltenberg	07/01/1998 – 06/30/1999		
Natural Attenuation of fuel and related groundwater contaminants - A measurement method	William Sonzogni	07/01/1998 – 06/30/1999	UWS	
Water and land use: interpretation of existing data to foster constructive public dialog and policy formulation	Harry Read	07/01/1998 – 06/30/1999	UWS	
Using GIS and soil landscape models to predict critical sites for nonpoint source pollution	Birl Lowery	07/01/1998 – 06/30/2000	DATCP	
Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems	K-J Samuel Kung, Joshua Posner, Gary Bubenzer, and John Hall, UW - Madison	07/01/1998 – 06/30/2000	DATCP	DATCP 98-03
Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers	Hickey, Bahr, Schreiber, Zwolinski,, and Taglia, UW-Madison	07/01/1998 – 06/30/2000	DNR	DNR-143
Sedimentology, stratigraphy, and porosity-conductivitiy relations of the Silurian aquaifer in Ozaukee County, Wisconsin	Harris	07/01/1998 – 06/30/2000	UWS	
Maquoketa Shale as Radium Source for the Cambro-Ordovician Aquifer in Eastern Wisconsin	Tim Grundl	07/01/1998 – 06/30/2000	DNR	DNR-141
Acute and chronic toxicity of nitrate to brook trout Salvelinus fontinalis	Ronald Crunkilton, UW-Stevens Point, and Todd Johnson, UW-Stevens Point	07/01/1998 – 06/30/2000	DNR	DNR-140
Mechanical controls on fracture development in carbonate aquifers: implications for groundwater flow systems	Cooke	07/01/1998 – 06/30/2000		DNR-142
Monitoring: Evaluation of the Abundance, Diversity, and Activity of Methanotroph Populations in Groundwater	Mary Lynne Perille Collins and Charles C. Remsen, UW-Milwaukee	07/01/1998 – 06/30/2000	UWS	R/UW-99-SAM-01
Groundwater Flow and Heat Transport in Wetlands: Transient Simulations and Frequency-Domain Analysis	Hector Bravo, UW-Milwaukee	07/01/1998 – 06/30/2000	UWS	R/UW-99-WLA-01
Viral contamination of household wells near disposal sites for human excretia	M. Borchardt, W. Sonzogni	07/01/1998 – 06/30/2000	DNR	
A rational design for permeable reactive walls	Craig Benson			
On-line SFE/GC for Improved Detection of Trace Organic Pollutants in Ground Water Monitoring	David E. Armstrong, Robert J. Noll, UW - Madison	07/01/1998 – 06/30/1999	UWS/DATCP	DATCP 98-02
Field Monitoring of Drainage and Nitrate Leaching from Managed and Unmanaged Ecosystems	John Norman, UW-Madison	7/1/1999 - 06/30-2001	UWS & USGS-B	00-BMP-2
Agrochemical Leaching From Sub-Optimal, Optimal, and Excessive Manure-N Fertilization of Corn Agroecosystems	John M. Norman, UW - Madison	07/01/2001 – 06/30/2003	DATCP	DATCP-01-01
Compatibility of Containment Systems with Mine Waste Liquids.	Tuncer B. Edil , Craig H. Benson, S. Basak Gulec, UW-Madison	07/1999 - 06/2001	UWS	R/UW-CTP-001S
Macropore Flow: A Means for Enhancing Groundwater Recharge or a Potential Source of Groundwater Contamination	Kenneth Potter, Peter Bosscher, UW-Madison	7/1/1999 - 06/30-2001	UWS	00-HDG-5

Project title	Investigators	Contract Period	Funding Agency	Project Number
Development of Neural Network Models for Predicting Nitrate Concentration in Well Water in the Tomorrow-Waupaca Watershed	Hangshen Lin	7/1/1999 - 06/30-2001	UWS	00-HDG-6
Causes of Historical Changes in Groundwater Recharge Rates in Southeastern Wisconsin	Douglas Cherkauer	7/1/1999 - 06/30-2001	UWS	00-HDG-1
Remediating Groundwater Using Reactive Walls Containing Waste Foundry Sands	Benson, Eykholt UW-Madison	7/1/1999 - 06/30-2001	UWS & DNR	00-REM-3
Admicelle-Catalyzed Reductive Dechlorination of Perchloroethylene (PCE) by Zero Valent Iron	Dr. Zhaohui Li, UW – Parkside	07/01/1999 – 06/30/2001	UWS	R/UW-REM-002
A groundwater model for the Central Sands of Wisconsin: Assessing the environmental and economic impacts of irrigated agriculture	Anderson, Bland, Kraft	7/1/1999 - 06/30-2000		
Improvement of Wisconsin groundwater monitorng network	Zaporozec	7/1/1999 - 06/30-2000	DNR	
Time Domain Electromagnetic Induction Survey Of Eastern Waukesha County And Selected Locations	John Jansen, Aquifer Science and Technology; Robert Taylor, UW-Milwaukee	7/1/1999 - 06/30-2000	UWS	00-HDG-8
Evaluating options for changing groundwater and leachate monitoring requirements for landfills to reduce mercury used by laboratories	Connelly, Stephens, Shaw	7/1/1999 - 06/30-2001	DNR	
Refinement of two methods for estimation of groundwater recharge rates	Bradbury, Anderson, Potter	7/1/1999 - 06/30-2000	DNR	
Field Verification of Captures Zones for Municipal Wells at Sturgeon Bay, Wisconsin	Bradbury, Rayne, Muldoon	7/1/1999 - 06/30-2000	DNR/DATCP	HDG
Importance of Groundwater in Productions and Transport of Methyl Mercury in Lake Superior Tributaries	David Armstrong	7/1/2000 - 6/30/2002	UWS & USGS-B	01-GSI-1
A Basin-Scale Denitrification Budget for a Nitrate Contaminated Wisconsin Aquifer: A Study at the Groundwater/Surface Water Interface	Bryant Browne, George Kraft	7/1/2000 - 6/30/2002	UWS & USGS-B	01-GSI-3
Removal of As(III) and As(V) in Contaminated Groundwater with Thin-Film Microporous Oxide Adsorbents	Marc Anderson	7/1/2000 - 6/30/2002	UWS	01-REM-2
Remediation of Soil and Groundwater Using Effectively and Ineffectively Nodulated Alfalfa	Nancy Turyk, Byron Shaw	7/1/2000 - 6/30/2002	UWS & DNR	01-REM-4
Effect of Clean and Polluted Groundwater on *Daphnia* Reproduction and Development	Stanley Dodson	7/1/2000 - 6/30/2001	UWS	01-SAM-1
The Spatial and Temporal Variability of Groundwater Recharge	Mary Anderson, Kenneth Potter	7/1/2000 - 6/30/2001	UWS	01-HDG-3
An analysis of arsenic replacement wells to determine validity of current DNR well construction guidance	O'Connor	7/1/2000 - 6/30/2002	DNR	DNR-156
Pesticide and nitrate leaching in soils receiving manure	Lowery, Arriaga, Stoltenberg	7/1/2000 - 6/30/2001	DATCP	

Project title	Investigators	Contract Period	Funding Agency	Project Number
Public health impacts of arsenic contaminated drinking water	Knobeloch	7/1/2000 - 6/30/2002	DNR	DNR-158
Screening of agricultural and lawn care pesticides for developmental toxicity using the mouse embryo assay	Greenlee	7/1/2000 - 6/30/2001	DATCP	
Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin	Gotkowitz	7/1/2000 - 6/30/2002	DNR	DNR-152
Groundwater Modeling: Semi-Analytical Approaches for Heterogeneity and Reaction Networks	Lin Li, Gerald R. Eykholt, Craig H. Benson; UW-Madison	7/1/2000 - 6/30/2001	UWS	R/UW-CTP-002
Verification and characterization of a fracture network within the Maquoketa shale confining unit, SE Wisconsin	Eaton	7/1/2000 - 6/30/2001	DNR	DNR-157
Effectiveness of phytoremediation and hydrogeologic response at an agricultural chemical facility in Bancroft, WI	DeVita, Dawson	7/1/2000 - 6/30/2002	DATCP	
Evaluation of pathogen and nitrogen movement beneath on-site systems receiving domestic effluent from single pass sand filters	Converse	7/1/2000 - 6/30/2001	Comm	
VOC trend analysis of WI solid waste landfill monitoring data: A preliminary analysis of the natural attenuation process	Connelly	7/1/2000 - 6/30/2002	DNR	153
New approaches to the assessment of microbes in groundwater: application to monitoring bioremediation and detection of pathogens	Collins	7/1/2000 - 6/30/2002	DNR	155
A study of microbiological testing of well water quality in Door County and incidence of illness in humans	Braatz	7/1/2000 - 6/30/2001	DNR	159
Development of analytical methods for comprehensive chemical and physical speciation of arsenicals in groundwater	Aldstadt	7/1/2000 - 6/30/2002	DNR	154
Field Evaluation of Rain Gardens as a Method for Enhancing Groundwater Recharge	Kenneth Potter	7/1/2001 - 6/30/2002	UWS	02-BMP-1
Investigation of Changing Hydrologic Conditions of the Coon Creek Watershed in the Driftless Area of Wisconsin	Randy Hunt	7/1/2001 - 6/30/2002	UWS	02-GSI-2
Groundwater-Lake Interaction: Response to Climate Change in Vilas County, Wisconsin	Mary Anderson	7/1/2001 - 6/30/2002	UWS	02-GSI-1
Impacts of Land Use and Groundwater Flow on the Temperature of Wisconsin Trout Streams	Stephen Gaffield	7/1/2001 - 6/30/2003	UWS	02-GSI-3
Impacts of Privately Sewered Subdivisions on Groundwater Quality in Dane County, Wisconsin	Kenneth Bradbury	7/1/2001 - 6/30/2003	UWS	02-OSW-1
Removal of Heavy Metals and Radionuclides from Soils Using Cationic Surfactant Flushing	Christine Evans, Zhaohui Li	7/1/2001 - 6/30/2003	UWS & USGS-B	02-REM-3
Removal of Arsenic in Groundwater Using Novel Mesoporous Sorbent	Jae Park	7/1/2001 - 6/30/2003	UWS	02-REM-5

Project title	Investigators	Contract Period	Funding Agency	Project Number
Co-occurrence and Removal of Arsenic and Iron in Groundwater	Paul McGinley	7/1/2001 - 6/30/2003	UWS	02-REM-2
Monitoring and Scaling of Water Quality in the Tomorrow-Waupaca Watershed	Bryant Browne (Henry Lin was also a PI, but he left USTP)	7/1/2001 - 6/30/2003	UWS	02-SAM-1
Chloroacetanilide and atrazine residue penetration and accumulation in two Wisconsin groundwater basins	DeVita, McGinley, Kraft	7/1/2001 - 6/30/2003	DATCP	DATCP
Time domain electromagnetic induction survey of the sandstone aquifer in the Lake Winnebago area	Taylor, Jansen	7/1/2001 - 6/30/2002	DNR	DNR-173
Development of a culture method for detection of Helicobacter pylori in groundwater	Sonzogni, Standridge, Degnan	7/1/2001 - 6/30/2002	DNR	DNR-167
Preservation and survival of E. coli in well water samples submitted for routine analyses	Sonzogni, Standridge, Bussen	7/1/2001 - 6/30/2002	DNR	DNR-173*
Importance of disinfection on arsenic release from wells	Sonzogni, Bowman Standridge, Clary	7/1/2001 - 6/30/2003	DNR	DNR-172
Agrochemical leaching from sub-optimal, optimal, and excessive manure-N fertilization of corn agroecosystems	Norman, Brye	7/1/2001 - 6/30/2003	DATCP	DATCP
Nitrate loading history, fate, and origin for two WI groundwater basins	Kraft	7/1/2001 - 6/30/2003	DNR	DNR-171
Occurrence of antibiotics in wastewater effluents and their mobility in soils. A case study for Wisconsin	Karthikeyan, Bleam	7/1/2001 - 6/30/2003	DATCP/DNR	DNR-169
Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions	Hunt, Borchardt	7/1/2001 - 6/30/2002	DNR	DNR-165
Delineation of High Salinity Conditions in the Cambro-Ordovician Aquifer of Eastern Wisconsin	Tim Grundl, and Lori Schmidt, UW – Milwaukee	7/1/2001 - 6/30/2002	DNR	DNR-170
Monitoring contaminant flux from a stormwater infiltration facility to groundwater	Dunning, Bannerman	7/1/2001 - 6/30/2003	DNR	DNR-168
Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility	William DeVita	7/1/2002 - 6/30/2004	UWS & USGS-B	03-REM-06
Role of the Hyporheic Zone in Methylmercury Production and Transport to Lake Superior	David Armstrong	7/1/2002 - 6/30/2004	UWS & USGS-B	03-CTP-02
Arsenic Contamination in Southeast Wisconsin: Sources of Arsenic and Mechanisms of Arsenic Release	Jean Bahr, Madeline Gotkowitz	7/1/2002 - 6/30/2004	UWS & DNR	03-HDG-01
F Test for Natural Attenuation in Groundwater: Application on Benzene	Fe Evangelista	7/1/2002 - 6/30/2003	UWS	03-REM-08
Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters	Marc Anderson	7/1/2002 - 6/30/2003	UWS	03-WSP-02
Determination of Aquitard and Crystalline Bedrock Depth Using Time Domain Electromagnetics	David Hart, David Alumbaugh	7/1/2002 - 6/30/2003	UWS & USGS-B	03-HDG-03

Project title	Investigators	Contract Period	Funding Agency	Project Number
Evaluation of Enzyme Linked Immunosorbent Assay for Analysis of Di Amino Atrazine in Wisconsin Groundwater in Comparison to Chromatography	John Strauss, William Sonzogni	7/1/2002 - 6/30/2003	DNR	DNR-175
An Experimental and Mathematical Study of the Alpha-Particle Activity of Wisconsin Ground Waters with High Gross Alpha	Sonzogni, Arndt, West	7/1/2002 - 6/30/2003	DNR	DNR-176
Design and Evaluation of Rain Gardens for Enhancement of Groundwater Recharge	Kenneth Potter	7/1/2003 - 6/30/2005	UWS	04-BMP-01
A Combined Hydrogeologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI	Timothy Grundl, Kenneth Bradbury, Daniel Feinstein and David J. Hart	7/1/2003 - 6/30/2005	UWS	04-WSP-02
Coupled Modeling of Gravity and Aeromagnetic Data For Analysis of the Waukesha Fault, Southeastern Wisconsin	John Skalbeck	7/1/2003 - 6/30/2004	UWS	04-HDG-03
What happens when the confined Cambrian-Ordovician aquifer in SE Wisconsin is "dewatered"?	Timothy Eaton	7/1/2003 - 6/30/2004	UWS	04-HDG-02
An Assessment of Aquifer Storage Recovery for Selected Generic Hydrogeologic Settings in Wisconsin	Mary Anderson	7/1/2003 - 6/30/2004	UWS	04-HDG-01
Evaluation of Contamination of Groundwater around Landfills	Tuncer Edil, Craig Benson and Jack Connelly	7/1/2003 - 6/30/2005	UWS	04-CTP-04
Providing Communities with the Groundwater Information Needed for Comprehensive Planning.	Douglas Cherkauer	7/1/2003 - 6/30/2005	UWS & USGS-B	04-WSP-01
Fate Of Representative Fluoroquinolone, Macrolide, Sulfonamide And Tetracycline Antibiotics In Subsurface Environments	K.G. Karthikeyan and Joel Pedersen	7/1/2003 - 6/30/2005	UWS	04-CTP-02
Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation	Zhaohui Li	7/1/2003 - 6/30/2005	UWS	04-REM-04
Groundwater Pollutant Transfer and Export in Northern Mississippi Loess Hills Watersheds	Kraft, Browne	7/1/2003 - 6/30/2005	DNR	DNR-181
Monitoring and predictive modeling of subdivision impacts on groundwater in Wisconsin	Bradbury, Bahr	7/1/2003 - 6/30/2005	DNR	DNR-178
Development of a groundwater flow model for the Mukwonago River watershed, southeastern Wisconsin	Bahr	7/1/2003 - 6/30/2005	DNR	DNR-180
Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters	Anderson (Marc)	7/1/2003 - 6/30/2004	DNR	DNR-179
Mercury Speciation along a Groundwater Flowpath	David Armstrong and Christopher L. Babiarz	7/1/2004 - 6/30/2006	UWS	05-CTP-01
Delineation of Flow Paths, Capture Zones and Source Areas, Allequash Basin, Vilas County, Wisconsin	Mary Anderson	7/1/2004 - 6/30/2005	UWS	05-HDG-01
A Comparison of USEPA-Approved Enzyme-Based Total Coliform/E. coli Tests for Microbiological Groundwater Monitoring and Laboratory Consultation	James Schauer, Jeremy Olstadt, Jon Standridge and Sharon Kluender	7/1/2004 - 6/30/2005	UWS	05-SAM-01

Project title	Investigators	Contract Period	Funding Agency	Project Number
Occurrence of Estrogenic Endocrine Disruptors in Groundwater	William Sonzogni, Jocelyn Hemming, Miel Barman and Steven Geis	7/1/2004 - 6/30/2006	UWS	05-BEP-01
Development of Tools to Address Groundwater in Comprehensive Planning	Lynn Markham, Charles Dunning and Chin-Chun Tang	7/1/2004 - 6/30/2005	UWS	05-BMP-01
Hydrostratigraphy of West-Central Wisconsin: A New Approach to Groundwater Management	David L. LePain and Kenneth R. Bradbury	7/1/2004 - 6/30/2005	UWS	05-HDG-02
Monitoring Environmental Effects at an Established Phytoremediation Site	William M. DeVita and Mark Dawson	7/1/2004 - 6/30/2006	UWS	05-REM-01
Foundry Slag for Treating Arsenic in Groundwater and Drinking Water	Craig H. Benson and David W. Blowes	7/1/2004 - 6/30/2006	UWS	05-REM-02
Arsenic Species (III,V) Distribution in Wisconsin Groundwaters: Field Measurements and Prediction Using Multivariate Analysis of Geochemical Data Prediction Using Multivariate Analysis of Geochemical Data	Martin Shafer, Kristie Ellickson, James Schauer	7/1/2005 - 6/30/2007	UWS & USGS-B	06-CTP-03
Measuring and Modeling Macroporous Soil Water and Solute Flux Below the Root Zone of a Plano Silt-Loam Soil	Birl Lowery, John Norman, Brian Lepore	7/1/2005 - 6/30/2007	UWS	06-CTP-05
Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer	George Kraft, Bryant Browne	7/1/2005 - 6/30/2007	UWS & USGS-B	06-CTP-07
Assessing the Ecological Status and Vulnerability of Springs in Wisconsin	Susan Swanson, Kenneth Bradbury, David Hart	7/1/2005 - 6/30/2007	UWS	06-GSI-09
Climate Signals in Groundwater and Surface Water System: Spectral Analysis of Hydrologic Processes	Hector Bravo	7/1/2005 - 6/30/2007	UWS	06-GSI-10
Evaluation of On-Site Wastewater Treatment as a Source of Antibiotic Resistance Genes in Groundwater	Katherine McMahon	7/1/2005 - 6/30/2006	UWS	06-SAM-02
Transient Functioning of a Groundwater Wetland Complex, Allequash basin, Wisconsin	Mary Anderson	7/1/2005 - 6/30/2007	UWS	06-WLA-01
Validation of Transport of VOCs from Composite Liners	Tuncer Edil, Craig Benson,	7/1/2005 - 6/30/2007	UWS	06-CTP-06
Disinfection of Enteric Viruses in Wisconsin Municipal Groundwater Systems	Harrington, Borchardt, Xagoraraki	7/1/2006 - 6/30/2008	DNR	DNR-188
Evaluating drinking-well vulnerability to viruses	Hunt, Borchardt	7/1/2006 - 6/30/2008	DNR	DNR-187
Identification and characterization of springs in west-central Wisconsin	Grote	7/1/2006 - 6/30/2007	DNR	DNR-184
Mapping and Characterization of Springs in Brown and Calumet Counties	Fermanich, Stieglitz, Zorn	7/1/2006 - 6/30/2007	DNR	DNR-183
Groundwater Mounding and Contaminant Transport Beneath Stormwater Infiltration Basins	Thompson	7/1/2006 - 6/30/2008	DNR	DNR-189
A Survey of Baseflow for Groundwater Protection Areas Western Fox-Wolf Watershed	Kraft	7/1/2006 - 6/30/2008	DNR	DNR-186

Project title	Investigators	Contract Period	Funding Agency	Project Number
Centralizing Access to Groundwater Information for Use in Comprehensive Planning	Markham, Tang, Dunning	7/1/2006 - 6/30/2008	DNR	DNR-190
Mechanisms of Groundwater Flow across Aquitards	Hart, Bradbury, Feinstein and Yikoff	7/1/2006 - 6/30/2007	DNR	DNR-191
Multi-Parameter, Remote Groundwater Monitoring with Referencing Using Crossed Optical Fiber Fluorescent Sensor Arrays	Peter Geissinger	7/1/2006 - 6/30/2008	UWS	07-SAM-02
Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses	William Hickey	7/1/2006 - 6/30/2008	UWS & USGS-B	07-REM-02
Application of LSQR to Calibration of a Regional MODFLOW Model: Trout Lake Basin, Wisconsin	Mary Anderson, Haijiang Zhang	7/1/2006 - 6/30/2007	UWS	07-HDG-05
Mineral transformation and release of arsenic to solution under the oxidizing conditions of well disinfection	Gotkowitz WGNHS	7/1/2006 - 6/30/2007	DNR	DNR-192
Groundwater recharge through a thick sequence of fine-grained sediment in the Fox River Valley, east-central Wisconsin	Hooyer UWEX	7/1/2006 - 6/30/2007	DNR	DNR-194
Use of Human and Bovine Adenovirus for Fecal Source Tracking	Pedersen UW- Mad	7/1/2006 - 6/30/2008	DNR	DNR-195
Knowledge Development for Groundwater Withdrawal Management around the Little Plover River	Clancy UW-SP	7/1/2006 - 6/30/2008	DNR	DNR-196
Precambrian Basement Surface Estimation using Coupled 3D Modeling of Gravity and Aeromagnetic Data in Fond du Lac County and Southeastern, Wisconsin	Skalbeck UW- Park	7/1/2006 - 6/30/2008	DNR	DNR-193

State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

Jim Doyle, Governor

101 South Webster Street
Box 7921
Madison, Wisconsin 53707
FAX 608-267-7650
TDD 608-267-6897

Joint Solicitation for Groundwater Research & Monitoring Proposals

For FY 2008
(July 1, 2007 – June 30, 2008)

Facilitated by
Wisconsin Groundwater Coordinating Council
University of Wisconsin Water Resources Institute

Participating Agencies
University of Wisconsin System
Wisconsin Department of Natural Resources
Wisconsin Department of Agriculture, Trade & Consumer Protection
Wisconsin Department of Commerce

Proposal Submission Deadline: November 13, 2006

Please contact Jim Hurley, UW-WRI (hurley@aqua.wisc.edu) or Jeff Helmuth, WDNR (jeffrey.helmuth@dnr.state.wi.us) if you have questions or wish to be removed from the mailing list for this annual solicitation.

State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

Jim Doyle, Governor

101 South Webster Street
Box 7921
Madison, Wisconsin 53707
FAX 608-267-7650
TDD 608-267-6897

Todd Ambs
Council Chair
DNR

James Robertson
WGNHS

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DHFS

Anders Andren
UWS

Berni Mattsson
COMMERCE

Dan Scudder
DOT

Kathy Pielsticker
DATCP

George Kraft
GOVERNOR'S REP.

To: Interested Researchers
From: Todd Ambs, Groundwater Coordinating Council
Date: October 12, 2006
Subject: Joint Solicitation for Groundwater Research and Monitoring

Enclosed is information on the State of Wisconsin Groundwater Research and Monitoring Program's joint solicitation for project proposals related to groundwater, pesticides and/or on-site wastewater treatment for funding in the fiscal year (FY 08) beginning July 1, 2007.

The solicitation is a coordinated effort of the University of Wisconsin System (UWS) and the Wisconsin departments of Natural Resources (DNR); Agriculture, Trade & Consumer Protection (DATCP), and Commerce. This cooperative solicitation allows interested individuals to prepare project proposals that can be submitted to several different funding sources simultaneously and eliminates the need to submit similar proposals several times for different solicitation efforts. Up to $460,000 will be available for new monitoring and/or research to meet specific agency needs and objectives in FY 08.

The UWS and the state agencies have prepared guidelines on the specific priorities for monitoring and/or research and other pertinent information relative to their request for proposals. You are invited to review the enclosed materials and decide if you wish to submit proposals. **The deadline for submittals is Monday, November 13, 2006.** Please note that specific instructions for submission of proposals will posted on the UW Water Resources Institute website at *http://wri.wisc.edu* after October 18, 2006.

It is our intent that this joint solicitation will make it easier for interested researchers to prepare proposals, promote coordination among state agencies and researchers, and enhance the ability of state agencies to meet their objectives.

FY 08 Joint Solicitation for Groundwater Research and Monitoring Proposals

October 2006

The University of Wisconsin System (UWS) and the Wisconsin departments of Natural Resources (DNR); Agriculture, Trade & Consumer Protection (DATCP), and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or on-site wastewater treatment systems. Up to $460,000 will be available for groundwater-related monitoring and research in fiscal year 2008 (FY 08) for new projects. The four programs, 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 06, the UWS has invested $4.7 million on 137 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP, and 13 were co-funded through the National Institutes for Water Resources program (U.S. Geological Survey). The UWS will have $270,000 to fund new and continuing projects in FY 08.

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 $5.8 million on 181 monitoring projects. Several of these projects have been co-funded with DATCP, Commerce and/or UWS. The DNR may have up to $190,000 to support new groundwater research and monitoring studies in FY 08, depending upon the 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 08. DATCP will, however, take part in the proposal review process.

4. Department of Commerce Private On-Site 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 October 2006, Commerce has indicated that no funds will be available for research projects in FY 08.

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. 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 (PIs)

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. Generally, faculty salaries plus fringe benefits should not exceed 10% of an individual grant.

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*
Jeff Helmuth, Dept. of Natural Resources: (608) 266-5234; *jeffrey.helmuth@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 UWS or by academic staff who have achieved nomination to PI status.
DNR & Commerce:	Funds are restricted to use by UWS 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 PI with unfinished WGRMP-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 GCC may consider extenuating circumstances on a case-by-case basis.

Submission of Proposals

Complete instructions for online submission will be available on the UW Water Resources Institute website after October 18, 2006.

Proposals for the WGRMP will be submitted via the University of Wisconsin Water Resources Institute (WRI) website at *http://wri.wisc.edu*. The WRI website will post all directions for submission of proposals on October 18, 2006. **The deadline for submittal of proposals is 5:00 p.m. Monday, November 13, 2006.**

Investigators will be required to provide the following for submission of proposals:

1. An abstract, list of investigators, location of the research, targeted agencies, three to five suggested reviewers and their areas of expertise (two of the reviewers suggested must be from outside of Wisconsin), the name of the department and the administrator(s) responsible for financial management of the project if funded.
2. A proposal narrative in Adobe Portable Document File (PDF) format. (A Word or WordPerfect template for proposal narrative will be available for download from WRI website).
3. An Excel file detailing budget information. (The Excel template for budget detail will be available for download from WRI website).
4. Transmittal form with signatures of individuals authorized to sign off on proposal submissions. (Details will be provided on WRI website).

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 five 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 each start on a new page, have double-spaced lines (except for Figure and Table legends), and use no smaller than 11-point type. 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).

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 8 to assist proposal authors.

All proposals must be submitted via the instructions that will be available on the WRI website after October 18, 2006. No facsimiles of proposals and no handwritten 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 WGRMP joint solicitation process receive reviews from the following four groups:

1. External peer review: The UW WRI solicits a minimum of four external peer reviews of all proposals.
2. The Research and the Monitoring & Data Management Subcommittees of the GCC
3. The Groundwater Research Advisory Council
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 2007. 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 are required to submit a two-page Project Summary upon completion of the project and to make a copy of the final report available to the WRI Library. For more information on these requirements, please contact Jeff Helmuth or James Hurley.

Dissemination of Project Findings

Final reports are required for each project funded through WGRMP. Reports from UWS-funded projects are kept in the WRI 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 of the two-page Project Summaries submitted by project investigators upon completion of the project final report are made available on the WRI website *(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 website 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 website (*http://wri.wisc.edu*) for complete submission details after October 18, 2006)

The exact specifics for submission of proposals are under development. Specific details will be available on the WRI website (*http://wri.wisc.edu*) after October 18, 2006. Regardless of the specific mechanism, investigators are required to submit proposals via an electronic process by **5:00 p.m. (Central Standard Time) on November 13, 2006**. Instructions below indicate the information that will be required:

I. Information about proposal:

A. Title.

B. Investigator(s) name(s) and affiliation.

C. Abstract (condensed version of project summary – 300 words maximum).

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.)

F. Names, addresses (including email) and specialties of three to five qualified reviewers (two of the reviewers must be from outside Wisconsin).

G. Name of department and administrator(s) responsible for financial administration of the project if it is funded.

II. Full proposal in Adobe Acrobat PDF file format (please use Word or WordPerfect template provided on WRI website to develop this section, then convert to PDF):

A. Project Summary (begin on same page, **not to exceed two 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. Potential users of project findings.

B. 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 that 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.

C. Curriculum vitae of PIs (begin on new page, **not to exceed 4 pages total**) – include curriculum vitae (including recent publications) of each investigator and the amount of time each will spend on the project.

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

III. Budget Information (Excel spreadsheet – use downloadable template from WRI website):

A. Salaries and wages.

B. Fringe benefits.

C. Tuition remission charges (if applicable).

D. Supplies and publication costs: list office, lab, 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.

IV. Transmittal form documenting administrative approval of the proposal (specific instructions will be posted on the WRI website after October 18, 2006).

All proposal submissions require appropriate administrative approvals before they can be considered. Please refer to the website for specific instructions. Review the accuracy of the information provided and submit final proposal package. **Proposals must be submitted by 5:00 p.m. on Monday, November 13, 2006.**

PROPOSAL GUIDELINE CHECKLIST

ITEM	GUIDELINE	THIS PROPOSAL
GENERAL PRESENTATION		
Typesize	Minimum of 11 points	
Margins	Minimum of 0.75 inches	
PAGE LIMITATIONS		
Project Summary	Maximum of 2 pages	
Narrative and supplements	Maximum of 10 pages	
Curriculum Vitae	Maximum of 4 pages total; 2 pages if one PI	
Current and Pending Support	Maximum of 2 pages	
Entire Proposal	Maximum of 18 pages	
Budget/Suggested Reviewers	Excel spreadsheet attachment	
PAGINATION		
Project Summary	Pages 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 PROJECTS FUNDED THROUGH THE GROUNDWATER RESEARCH ADVISORY COUNCIL

The University of Wisconsin System (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. For the purposes of this solicitation, "groundwater research" is defined as research that advances the understanding, protection or management of the groundwater resource. Projects that are primarily focused on wastewater or drinking water treatment technologies, surface water protection or soil science must make a clear link to current groundwater science. Projects funded in the current cycle are listed on the WRI website at *http://wri.wisc.edu*. The UWS has approximately $230,000 to $270,000 available in FY 08 to fund new projects. The remainder of the UWS groundwater research funds has been committed to ongoing projects.

Applicant Requirements: Most often the PI will be a faculty member on any campus in the UWS. However, academic staff who have achieved nomination to PI 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 the name of a PI or co-PI 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. Generally, faculty salaries and fringe benefits to be paid from any project should not exceed 10 percent of the total individual grant. Overhead costs are not allowed. Supplies should not exceed 20 percent of the total individual grant.

Review of Proposals: Two types of peer reviews will be conducted for proposals submitted for UWS consideration. First, WRI participates in the external peer review process for the Joint Solicitation. Reviews are solicited from national and international experts in the field, with a focus on the technical merits of the proposal. Second, a research subcommittee of the GCC assembles a panel of state experts to evaluate each proposal's mission relevancy and consistency with UWS priorities.

Final Decision Making: The GRAC, which consists of university, state agency, and public representatives, meets as a body to discuss the results of the review process. The GRAC pays close attention to UWS priorities and direct relevance to groundwater issues in their deliberations. The GRAC recommends 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

(in no particular order of importance)

- Identification and characterization of chemical and biological pollutants in groundwater systems and their threats to ecosystems and human health, including the type, toxicity and persistence of degradation products.

- Transport of pollutants in groundwater, including elucidation of factors controlling movement and development or validation of predictive models.

- Impact of agricultural (including agricultural feeding operations), industrial or municipal waste and 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 groundwater.

- Investigations on the development, understanding, improvement, cost-effectiveness or utility of innovative biological, chemical or physicochemical technologies for remediation of contaminated groundwater.

- Field validation of new technologies for on-site wastewater and groundwater treatment.

- Investigations into the best methods for optimizing groundwater use in Wisconsin, and strategies for long-term management of groundwater.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

FY 08 GROUNDWATER MONITORING AND RESEARCH PROGRAM

The Wisconsin Department of Natural Resources (DNR) supports monitoring and research on drinking water and groundwater-related topics. Funding for these projects comes from a variety of state and federal sources and supports a wide variety of topics (see DNR's Groundwater Research and Monitoring Web page. Currently, DNR monitoring and research is funded from the following four sources:

1. Management Practice Monitoring is state-supported groundwater monitoring or support activities, such as laboratory technique development or geologic resource characterization, for establishing or improving management practices necessary to meet the state groundwater quality standards of NR 140, Wisconsin Administrative Code.
2. 2003 Wisconsin Act 310 created funding for groundwater quantity monitoring and research related to (a) interaction of groundwater and surface water, (b) characterization of the groundwater resource, and (c) strategies for managing water.
3. Federal support for groundwater monitoring and research is available through Section 106 Clean Water Act Funding. Goals include maintaining groundwater quality standards, identifying impaired groundwater and its causes and sources, and implementing groundwater management programs.
4. Federal funds for groundwater monitoring and research related to protecting public well water are available through the Wellhead Protection provisions of the Safe Drinking Water Act.

The DNR anticipates having approximately $190,000 to fund new monitoring and research projects in FY 08 (July 1, 2007, through June 30, 2008). Specific research and monitoring needs are prioritized and listed after the application requirements.

Applicant Requirements

Eligibility: Funds are restricted to UWS and state agency contractors. Others may submit proposals if they include a state-affiliated co-PI. The DNR encourages applicants to include a UWS-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. Project cost will be a factor in selection. Budget items should include personnel costs, supplies, equipment and necessary travel. State funds cannot support indirect costs nor the purchase of capital equipment. Indirect costs for use of federal funds should be included.

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.

Reporting: The PI 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 two-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 members of the Groundwater Coordinating Council's Research and Monitoring & Data Management subcommittees. Three important criteria in evaluating each proposal are: (1) whether the proposal addresses a priority issue as listed below; (2) whether the proposal addresses an ongoing need as listed below, and (3) whether the project fits one of the four funding 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 the practical application of results in mind.

In making final funding decisions, the Bureau of Drinking Water and Groundwater 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 Research and Monitoring Priorities for FY 08

The DNR has identified the following priorities for groundwater monitoring and research for FY 08. 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. **Evaluation of Livestock Waste Management Practices for Protection of Groundwater and Drinking Water Wells.** Drinking water wells can be contaminated by livestock waste. Research is needed to determine effective management practices and site characteristics for livestock waste handling that are protective of drinking water wells and groundwater. Projects should address acute and/or chronic impacts to groundwater from livestock waste management and may focus on one or more of the following:
   - Problem assessment
   - Mechanisms, pathways and timing of movement into groundwater
   - Influence of landscape settings
   - Influence of climatic effects (droughts, floods, climate change)
   - New analytical tools (microbial source tracking, isotopic methods, etc.)
   - Methods of vulnerability assessment and BMPs
   - Associated contaminants (bacteria, nitrate, pharmaceuticals, viruses, other pathogens, etc.)

2. **Information to support implementation of 2003 Wisconsin Act 310.** In May 2004, state statutes were modified, setting new standards and conditions for approval of high-capacity wells and other requirements for the use of groundwater (see summary at *http://www.legis.state.wi.us/lc/act_memo/2003/act310-ab926.pdf*). To help implement the new law, the DNR needs additional data and information on the following topics:
   - *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. More

information is needed for evaluating proposed wells, including impacts on water quality, flow rates, habitat need, and existing public water supply wells.

- *Predicting cumulative pumping impacts* – The legislation directs the department to establish Groundwater Management Areas around Brown and Waukesha counties, where significant drawdown is creating water quality and quantity concerns. The DNR is interested in evaluating and predicting cumulative impacts of pumping on water resources.
- *Impacts of groundwater withdrawals* – A better understanding of the implications of groundwater use on groundwater quality, groundwater quantity and surface water resources is needed. For example, estimates of current and projected water use rates, basin-scale groundwater budgets, and quantification of environmental, social and economic impacts of groundwater withdrawals.
- *Identification and mapping of springs* – DNR is required to review proposed wells that may impact a spring, which is statutorily defined as "an area of concentrated groundwater discharge occurring at the surface of the land that results in a flow of at least one cubic foot per second at least 80 percent of the time." Existing information about location and flow rates of springs is limited. Spring inventories are needed in many parts of the state, along with maps and characterization of these springs. In addition, better information about spring hydrology is needed to assess the impacts of high capacity wells on spring flow rates.

Other groundwater quantity goals needing support from monitoring and research include:

- Reduced water demand through conservation, reuse and irrigation efficiencies
- Efficient and accurate water use reporting
- Enhancement of natural recharge
- Identification of multi-aquifer wells
- Assessing how well construction requirements affect groundwater quantity concerns
- Improved hard surface infiltration technologies

3. **Implementation of Statewide Groundwater Monitoring Strategy.** In 2004, the GCC facilitated the creation of a statewide groundwater monitoring strategy, which was subsequently refined and incorporated into the DNR Water Division's Monitoring Strategy. The purpose of the strategy is to provide a common state and federal agency framework to coordinate groundwater monitoring programs. One component of the strategy that needs to be addressed is taking a comprehensive look at existing data for parameters of concern. Existing databases
(Groundwater Retrieval Network, DATCP, Wisconsin Groundwater Center and others) can be mined for public, private and monitoring well data on nitrate, chloride, other major anions and cations, arsenic, radon, VOCs, pesticides, etc.

4. **Research and Monitoring to Support Wellhead Protection.** In 2004, the DNR finished delineating source water areas, mapping potential sources of contamination and assessing the susceptibility to contamination for all public water wells in Wisconsin. Additional research is needed to assist communities in:

- *Hydrogeologic studies to support characterization of the 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 into comprehensive planning efforts* – Current law mandates that all local governments make land use decisions based on a comprehensive plan by January 1, 2010. Studies are needed to identify and evaluate practices of incorporating water management planning into land use planning.
- *Land use impacts on the groundwater resource* – A better understanding is needed of the effect of various land uses (e.g., urbanization and agriculture) and management practices on groundwater quality and quantity. Simple tools should be developed for communities evaluating how land use decisions impact groundwater.
- *Identifying wells for abandonment in wellhead protection areas* (e.g., an area-wide pilot project).

Ongoing Needs

The following topics represent ongoing needs as determined by the Research and Monitoring & Data Management subcommittees of the Wisconsin GCC, state agency staff and university researchers. While the department will give precedence to proposals that meet its priorities above, the following needs will be considered.

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 our groundwater resource and to human health.

Occurrence of Groundwater Contaminants – The department needs more information about the extent and causes of elevated nitrate, arsenic, sulfate, total dissolved solids (TDS), radium, low pH and other water quality problems in order to give advice to homeowners, municipalities and well drilling contractors.

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 a specific aquifer or area of the state (e.g., contaminant transport in karst areas).

Contact Jeff Helmuth at (608) 266-5234 for more information if you have questions about the DNR's Groundwater Monitoring and Research Program.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

PESTICIDE RESEARCH PROGRAM

RESEARCH GRANT PROGRAM FOR FY 08

SOLICITATION OF APPLICATIONS

The Wisconsin Department of Agriculture, Trade and Consumer Protection (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 08. DATCP will, however, take part in the proposal review process and recommend funding for projects that meet their research objectives. Contact Jeff Postle at (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 08

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. **Evaluation of Factors Influencing the Patterns of Groundwater Contamination by Pesticides and Pesticide Metabolites in Wisconsin.**

   This topic involves examining factors that influence pesticide leaching to determine areas of the state that are susceptible to groundwater contamination by specific pesticides.

4. **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.

5. **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.

6. **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

ON-SITE WASTEWATER TREATMENT RESEARCH OBJECTIVES

The Wisconsin Department of Commerce supports research focused on the performance of on-site sewage system designs, products and management practices that can be incorporated into the administrative rules regulating on-site sewage systems. These designs, products or management practices must be:

- Directed toward protecting public health, groundwater and surface water quality;
- Result in on-site sewage treatment that is consistent with the provisions of the Groundwater Protection Law;
- Be affordable by the average owner of an on-site 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 on-site sewage system methods and technologies. The purpose of the performance monitoring is to provide additional information on the long-term performance of the various on-site 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 October 2006, the department has indicated that it will not have funds available to fund projects in FY 08. 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 08

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.