Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August, 2008

GROUNDWATER COORDINATING COUNCIL MEMBERS

Department of Natural Resources - **Todd Ambs (Chair)**
Department of Agriculture, Trade, and Consumer Protection – **Kathy F. Pielsticker**
Department of Commerce - **Berni Mattsson**
Department of Health Services - **Henry Anderson, MD**
Department of Transportation - **Dan Scudder**
Geological and Natural History Survey (State Geologist) - **James Robertson**
Governor's Representative – **George Kraft**
University of Wisconsin System – **Anders Andren**

SUBCOMMITTEE MEMBERS

Research

Geological and Natural History Survey - **Ken Bradbury** (Chair)
Department of Agriculture, Trade and Consumer Protection - **Jeff Postle**
Department of Commerce – **Harold Stanlick**
Department of Health Services - **Henry Anderson and Robert Thiboldeaux**
Department of Natural Resources – **Bill Phelps**
University of Wisconsin System - **David Armstrong, Paul McGinley and Maureen Muldoon**
U. S. Geological Survey - **Randy Hunt and Chuck Dunning**

Monitoring & Data Management

Monitoring Work Group
Department of Natural Resources – **Jeff Helmuth** (Chair) **and Mike Lemcke**
Department of Agriculture, Trade and Consumer Protection – **Bruce Rheineck* and Rick Graham**
Department of Commerce - **Jon Heberer**
Department of Health Services - **Mark Werner* and Bruce Rheineck**
Geological and Natural History Survey – **Madeline Gotkowitz**
Center for Watershed Science and Education - **George Kraft**
U. S. Geological Survey – **Jason Smith**
Data Management Work Group
Department of Natural Resources – **Jeff Helmuth** (Chair), **and Randell Clark**
Geological and Natural History Survey - **Bill Bristoll**
Center for Watershed Science and Education – **Dave Mechenich**
Department of Agriculture, Trade and Consumer Protection – **Cody Cook**
Department of Health - **Chuck Warzecha* and Bruce Rheineck**
U. S. Geological Survey – **Jason Smith**

Education

Center for Watershed Science and Education - **Kevin Masarik** (Acting Chair)
Department of Agriculture, Trade and Consumer Protection – **Jeff Ackerman***
Department of Commerce - **Thomas Braun**
Department of Health Services - **Elizabeth Truslow-Evans* and Jessica Maloney**
Department of Natural Resources – **Dorie Turpin and Dave Lindorff***
Geological and Natural History Survey - **Dave Hart**
Natural Resources Conservation Service - **Jim Kaap**
State Laboratory of Hygiene – **Amy Mager and Jeremy Olstad**
University of Wisconsin System – **Suzanne Wade and Ken Genskow**

Local Government and Planning

Department of Natural Resources - **Dave Lindorff*** (Chair)
Association of Wisconsin Regional Planning Commissions – **Eric Fowle**
Center for Watershed Science and Education –**Lynn Markham**
Department of Agriculture, Trade and Consumer Protection – **Duane Klein**
Department of Commerce - **Roman Kaminski**
Department of Health Services - **Chuck Warzecha* and Bruce Rheineck**
Geological and Natural History Survey - **Fred Madison**
Wisconsin Alliance of Cities –**Mayor John David**
Wisconsin County Code Administrators - **Ray Schmidt and Bruce Haukom**
Dane County Conservation and Planning – **Mike Kakuska**
Wisconsin Rural Water Association - **Ed Morse**
Wisconsin Water Association - **Nancy Quirk**
Department of Transportation - **Bob Pearson**
University of Wisconsin System **- Steve Born**
U. S. Geological Survey **– Chuck Dunning**

***** No longer a subcommittee or workgroup member

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, 2008

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
Deputy Secretary Aaron D. Olver - Department of Commerce
Secretary Rod Nilsestuen- Department of Agriculture, Trade & Consumer Protection
Secretary Karen Timberlake - Department of Health Services
Secretary Matthew J. Frank - 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 2008 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 24 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 08 (July 1, 2007 to June 30, 2008) 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:

- 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 a DATCP publication on Agricultural Chemicals in Groundwater, groundwater teacher workshops, several WRI publications highlighting the Groundwater Research and Monitoring Program and a USGS website making groundwater information available for those working on comprehensive plans.

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). The report is required by s. 15.347, Wisconsin Statutes and describes the condition and management of the groundwater resource and summarizes the GCC's activities for fiscal year 2008 (FY 08). 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 Services (DHS); 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 Chapters 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 08. Examples include:

The UW Water Resources Institute (WRI) funded and worked closely with the GCC Education Subcommittee on a comprehensive groundwater education/outreach project that resulted in: 1) a pamphlet entitled *Protecting Wisconsin's Buried Treasure*, that documents the accomplishments, impacts and benefits of the Groundwater Research & Monitoring Program. 2) fact sheets on nitrate and arsenic groundwater resource issues; and 3) activities for Groundwater Awareness Week (March 9-15), The later included groundwater-related press releases prepared by UW-SP and WRI, and a public radio talk show with DHS and DNR representatives discussing groundwater issues.

The GCC's Education and Local Government & Planning Subcommittees helped guide development of a DNR - and US Geological Survey-funded website that provides groundwater information to help communities with comprehensive planning. Legislation enacted in 1999 requires local units of government to develop a Comprehensive Plan by 2010 in order to undertake land-use
activities. Comprehensive plans must address natural and agricultural resources, housing, utilities, and land use. The planning process presents a unique opportunity to implement groundwater protection at the local level. Since its official launch in March of 2008, the website is averaging nearly 800 information requests per day. Over 950 different individuals have visited the site.

Three groundwater workshops for teachers were held in January of 2008 in Green Bay, Stevens Point, and Jefferson. Staff from the DNR, WGNHS and CWSE at UW Stevens Point instructed teachers on using a groundwater sand tank model and provided other groundwater teaching aids. Fifty – three teachers from 24 different schools and nature centers attended the workshops and received a free model for their school or center.

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 09 solicitation for groundwater research and monitoring proposals was released in October 2007 (see *Appendix D*). A total of 15 project proposals were received. A comprehensive review process resulted in the selection of 7 new projects for funding for FY 09, four by UWS and three by the DNR. The GCC approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 09 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 08.

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 08. Two highlights are below.

Groundwater Protection Act Implementation – Under the Groundwater Protection Act (2003 Act 310) changes to the application process increased DNR's authority to consider the environmental impacts of high capacity wells on critical surface water resources. In FY 08 a new rule, NR 820 (effective September 1, 2007), created a mechanism for evaluating proposed high capacity wells to determine if there will be 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. Chapter NR 820 also requires owners of high capacity wells to report the volume of water pumped from their wells on a monthly basis. DNR staff has made substantial progress updating the inventory and collecting and verifying basic information for the roughly 10,000 existing high capacity wells in the state. Using this updated information, over 7,600 annual pumpage reporting forms were mailed to owners of high capacity wells in late 2007 and early 2008. These pumpage reports will help to establish baseline information regarding water use in the state.

The Groundwater Advisory Council completed its assignment in December 2007 with submission of a second report to the Legislature assessing the effectiveness of Act 310. The GAC concluded that Act 310 is working as intended, as a first step in integrated water management. The Council recognized that the law has provided an added level of environmental protection for trout streams, outstanding resources waters, exceptional resource waters and springs by ensuring that potential impacts to these resources will be evaluated and reduced as part of the high capacity well approval process. The GAC acknowledged that more work remains to build upon the initial improvements in groundwater management provided under Act 310. The 2007 report contains extensive recommendations and alternatives for enhancing the effectiveness of Act 310.

DATCP's April 2008 report, "Agricultural Chemicals in Wisconsin Groundwater" (http://www.datcp.state.wi.us/arm/agriculture/land-water/environ_quality/pdf/ARMPub180.pdf), summarizes results of private well survey conducted in 2007. The purpose of the survey was to obtain a current picture of agricultural chemicals in groundwater and to evaluate changes in water

quality over time. Samples collected from private wells, drawing water from different aquifers, were analyzed for 32 compounds including herbicides, herbicide metabolites, one insecticide, and nitrate-nitrogen. The results of a time trend analysis did not show any statistically significant changes for parent atrazine, total atrazine, nitrate-nitrogen, alachlor ESA and metolachlor ESA between 2001 and 2007. The estimate of the proportion of wells that exceeded the 10 mg/l enforcement standard for nitrate-nitrogen was 9.0%.

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 and at least 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), and atrazine and its metabolites. 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 2001 DATCP survey of private drinking water supplies showed that 38% of wells contain a detectable level of an herbicide or herbicide metabolite. A 2007 DATCP private well survey estimated that the proportion of wells in Wisconsin that contained a pesticide or pesticide metabolite was 33.5%. Areas of the state with a higher intensity of agriculture generally had higher frequencies of detections of pesticides. The two most commonly-detected pesticide compounds were the herbicide metabolites metolachlor ESA and alachlor ESA which each had a proportion estimate of 21.6%.

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, 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. A 2007 DATCP survey estimated the proportion of private wells that exceeded the 10 mg/l enforcement standard for nitrate-nitrogen at 9.0%.

Microbial agents: Microbiological contamination often occurs in areas where the depth to groundwater is shallow, in areas where soils are thin, 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 young children, the elderly and those with chronic illnesses. In one assessment (Warzecha et.al., 1994), 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 in groundwater are increasingly becoming a concern as new analytical techniques have

detected viral material in private wells and public water supplies. Research conducted at the Marshfield Clinic indicates that 4-12% of private wells contain detectible viruses. (Borchardt 1997, 1999). Another study, conducted in conjunction with the USGS, found that 50% of water samples collected from four La Crosse municipal wells were positive for enteric viruses (Hunt and Borchardt, 2002, Borchardt et al. 2004). More recent and on-going studies have shown a link between virues found in the municipal wells and wastewater system in Madison (Bradbury, 2007, personal communication).

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 and in some cases in excess of 30 pCi/L. Approximately 35 public water systems exceed the drinking water standard of 15 pCi/L for gross alpha activity (Nelson, personal communication). New federal standards are causing many communities to search for alternative water supplies or treatment options.

Arsenic: Naturally occurring arsenic has been detected in wells throughout Wisconsin. DNR historical 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 released arsenic from rocks and unconsolidated material 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 and began implementing a new rule, NR 820, regulating high-capacity wells in FY 08. The Great Lakes Compact, signed by Governor Doyle in 2008, requires Wisconsin to have water conservation goals within the Great Lakes Basin.

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 $14.6 million has been spent by DNR, UWS, DATCP, and Commerce through FY 08 on 360 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, personal care products, and endocrine disrupting compounds

- The Atrazine Rule
- Groundwater monitoring at solid waste disposal sites
- Arsenic monitoring and research in Northeastern Wisconsin
- Groundwater movement in shallow carbonate rocks
- Developing new tools for groundwater protection
- Prevention and remediation of groundwater contamination
- Detection and monitoring of microbiological contaminants
- Groundwater drawdowns
- Comprehensive planning
- Rain garden design and evaluation
- Methylmercury formed in groundwater
- Estrogenic in groundwater

DIRECTIONS FOR FUTURE GROUNDWATER PROTECTION

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

- Protect funding for groundwater monitoring and research
- Acute and chronic impacts to groundwater from manure management practices.
- Investigate adverse impacts from groundwater withdrawals
- Other unresolved groundwater quantity issues – How water-rich are we?
- Investigate extent and origins of naturally occurring substances in groundwater
- Evaluate occurrence of recently discovered groundwater contaminants
- Research the impacts of various land uses on the groundwater resource
- Evaluate potential impacts of climate change and global warming on Wisconsin's groundwater
- Evaluate the impact of the production of biofuels on Wisconsin's groundwater. This includes concerns with farmers moving out of CRP program
- Address groundwater quantity management issues at both statewide and regional levels
- Find solutions to groundwater nonpoint pollution problems
- Meet the need for continued funding for implementation of nutrient management planning
- Provide resources to local governments for Smart Growth/Comprehensive Planning activities
- Develop methods to assess and protect against health hazards posed by exposure to 'orphan' contaminants as well as multiple contaminants in a water supply
- Support implementation of a Statewide Groundwater Monitoring Strategy
- Support Implementation of the Great Lakes Compact
- Coordinate and facilitate consistent messages on groundwater related issues
- Promote consistency between the agencies on data management issues
- Ensure access to findings of groundwater research and monitoring projects

TABLE OF CONTENTS

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 2008 (FY 08).

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 08. *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 *Directions for Future 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 Services. 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 waste and materials management, industrial and municipal wastewater, wetlands, remediation

and redevelopment, and drinking water and groundwater); 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, fertilizer storage, and agrichemical clean up program and fund); 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 - each aquifer would be classified according to its potential use, value or vulnerability, and then would be protected to that classification level. Some aquifers would not be entitled to protection and might never again be 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 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. There is limited authority under NR 151 for adoption of local restrictions on land application of

manure and waste.

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, and as the result of bipartisan effort and support in the legislature, significant groundwater quantity legislation was passed in both houses of the legislature in March of 2004. On Earth Day, April 22, 2004, Governor Doyle signed the new groundwater protection law, 2003 Wisconsin Act 310, expanding the State's authority to consider environmental impacts of high capacity wells and establishing a framework for addressing water quantity issues in rapidly growing areas of the state. This legislation recognizes the link between surface water and groundwater, and the impact wells may have on groundwater quality and quantity.

Major components of the legislation include:

1) *Tracking well construction and water use.* As of May 1st, 2005, well owners are required to obtain prior approval for construction of high capacity wells (those that pump more than 100,000 gallons per day), must pay an application 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 support increased inspections and enforcement of well construction activities, further 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 those wells with approvals issued before enactment of the law. Collection of pumping data will assist in evaluating proposed new wells, monitoring approval conditions, identifying trends, calibrating groundwater flow models, and improving water use estimates. This will contribute to a better understanding of groundwater resources throughout the state and improve management of the resource.

2*) Expanded regulation of high capacity wells.* The Act directs DNR to consider the environmental impacts (consistent with ch. NR 150, Wis. Adm. Code) associated with high capacity wells in the following situations:

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

In these cases, DNR may deny or limit an approval to assure that these wells do not cause significant environmental impact. There are also protections and exceptions for public water utility wells. For example, the DNR must weigh the public health and safety benefits of a proposed well in a groundwater protection area or near a spring if it is to be used for a public water supply. In these cases, a well may be located within a GPA or near a spring provided there

are no other reasonable locations available and the DNR is able to balance the well's environmental impact and its public health and safety benefits.

3) *Designation of groundwater management areas.* The Act directed the DNR to establish two groundwater management areas, one in Southeastern Wisconsin and another in the Lower Fox River Valley. These designated regions encompass areas 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 Brown County and portions of Outagamie and Calumet Counties, while in Southeastern Wisconsin it includes Waukesha, 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) and directed the GAC to submit two separate reports to the legislature with recommendations regarding:

- management of groundwater within groundwater management areas and any other areas of the state where a coordinated strategy may be needed.
- regulation of proposed wells that are located in groundwater protection areas, that have a water loss of 95 percent or more, or that have a significant environmental impact on a spring;
- adequacy of the definition springs;
- adaptive management approaches;
- potential for the use of general permits; and
- factors to be considered in determining whether a high capacity well causes significant environmental impact.

In 2005, Representatives from the well drilling industry and municipal, environmental, agricultural and industrial interests were appointed by the Governor and Legislature to the GAC. The GAC met regularly from April 2005 through December 2007. The committee issued a report to the Legislature in December, 2006 regarding groundwater management areas (the report is available online. A second report to the Legislature was submitted in December 2007 and focused on the environmental protection aspects of the law. Pursuant to Act 310, the GAC terminated at the end of 2007.

The DNR received appropriations and positions to administer the new legislation in the 2005-2007 biennial budget and subsequently hired five staff in late-FY 06. In FY 07, these staff began implementing the new programs created by the law including well notification and fee collection, pumpage reporting, high-capacity well application review, data management, inspections, staff support for the Groundwater Advisory Committee (GAC), and development of a new administrative rule implementing Act 310. The rule, chapter NR 820, Wis. Adm. Code, 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. Under the rule and the law, approvals for high capacity wells within groundwater protection areas or wells that could affect a spring must include conditions ensuring that construction and operation of the well will not result in significant adverse environmental

impacts. The rule also defines the extent of Groundwater Management Areas as required by Act 310.

The GCC will track progress of the implementation of the law and provide assistance on education, research, monitoring, planning, and data management needs related to the new legislation to help facilitate effective management of groundwater resources in the state.

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 08. Coordination with the Wisconsin Groundwater Research and Monitoring Program is an important function of the GCC. 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, DHS, DATCP, DOT, WGNHS, and the UW System. The GCC has created four subcommittees to assist in its work. The subcommittees are composed of members of the GCC, employees of state and federal agencies, university researchers and educators, representatives of counties and municipalities and public members. Since the creation of the GCC, the DNR has provided staff support in the form of a permanent position with at least half of its responsibilities related to coordination of the GCC.

The GCC took an active role in many groundwater issues and activities during FY 08, 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." A broad spectrum of groundwater users and stakeholders discussed groundwater issues and developed solutions to better protect Wisconsin's groundwater. Representatives from over 50 organizations, including environmental, conservation, and agricultural groups, industrial users, water utilities, local and tribal governments, planning agencies, state and federal agencies, and university researchers and educators attended the summit. Recommendations from the Summit are summarized in: *Sharing Our Buried Treasure: A Summary of the 2001 Groundwater Summit* available online.

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

Since 2001, the GCC and its Subcommittees continued to address these Key Themes. 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, GCC Subcommittee members prepared and distributed three Comprehensive Planning and Groundwater Fact Sheets to promote inclusion of groundwater information in comprehensive plans. The fact sheets were updated in 2005. Through the Wisconsin Groundwater Practice and Monitoring program, two projects have been funded to increase accessibility of groundwater information for use in comprehensive plans. The result of those projects is a website making groundwater information available to planners and all citizens that went on-line in March 2008.

The Education Subcommittee continued to connect with more 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 FY09 *(Key Themes 2, 3 and 9).*

The 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 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. 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 by making technical information and expertise available to the Department of Natural Resources and the Groundwater Advisory Committee.

Implementing a Statewide Groundwater Monitoring Strategy

In 2004 a Groundwater Monitoring Strategy was developed by a 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 FY 08 the strategy was integrated into DNR's overall water monitoring strategy. 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-Madison Water Resources Institute (WRI) published 20-page illustrated booklet and two-page executive summary describing the history and activities of GCC (*Protecting Wisconsin's Buried Treasure*). To complement the publications, a series of four fact sheets on Wisconsin's most important groundwater resource issues: nitrate, arsenic, manure and supply were written (in review). These publications are being completed in collaboration with the GCC Education Subcommittee. To date, more than half of the 200 print copies of the GCC booklet have been distributed, and an additional 290 PDF copies have been downloaded from the UW Aquatic Sciences Center's online Publications Store (*aqua.wisc.edu/publications*).

The WRI website (*www.wri.wisc.edu*) was rebuilt from ground(water) up to make it easier and faster for visitors to find information about WRI research projects and publications. One of the goals of the website redesign was to provide the public with summaries of groundwater research. In a related effort, Wisconsin's Water Library has been cataloging all WRI research reports into WorldCat and MadCat, two library indexing tools that provide both worldwide and statewide access to this research. By having this information permanently indexed, the research results are easily available to other scientists throughout the state, nation, and world. During the past year, the library also signed a memorandum of agreement with the Wisconsin Wastewater Operator's Association (WWOA) to catalog, house and loan essential technical manuals provided by WWOA to aid members in their required license examinations and support the educational needs of their daily work.

For the eighth 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 24 different schools or nature centers attended the workshops and received a free model for their school. With funding from an EPA grant, 186 groundwater models have been given to schools or nature centers since 2001.

CWSE staff continue to offer drinking water education programs that provide communities across Wisconsin the opportunity to have their private wells tested. An educational program is held to explain individual well sample analytical results and community groundwater quality. In FY 2008, nearly 1,500 private well owners in 10 different counties took part in this educational opportunity. As a result of these programs, an educational resource was developed for Dodge County which summarizes the county-wide drinking water testing results.

Attendants of this year's Farm Technology Days had an opportunity to bring in a private well water sample and have it tested for nitrate. Additional information regarding drinking water and groundwater quality was available at the UW-Extension Drinking Water Quality display. Over 200 individuals had well water tested and hundreds more stopped by to have their questions answered by CWSE staff. The DNR display focused on private well water issues and proper well construction. The Department of Commerce display contained educational information related to drinking water treatment devices for private well owners.

A series of press releases was distributed to local media outlets to promote Groundwater Awareness Week March 9-15, 2008. The issues covered in those releases included groundwater quality, quantity and water conservation. In addition, the WRI arranged for a groundwater discussion on Wisconsin Public Radio's Larry Meiller show.

The USGS in cooperation with the UW-Extension Center of Land Use Education and the DNR developed a web site 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 *(*http://wi.water.usgs.gov/gwcomp/index.html*)*. This web site provides summaries of, and access to, data and information on geology, general hydrology, and groundwater quantity and quality, potential sources of contaminants, and money spent on cleanup generated by state, local, federal, and independent sources. In addition, the website provides guidance for incorporating groundwater information into comprehensive plans, and case studies of municipalities that have worked hard to understand their ground-water resources and develop and implement groundwater goals, objectives, and policies. Since its official launch in March of 2008 the website has averaged nearly 800 successful requests for information per day. Over 950 different individuals or organizations have visited the site.

Coordination of Groundwater Research and Monitoring Program

The GCC, the University of Wisconsin System (UWS), and the Groundwater Research Advisory Council (GRAC) again collaborated on the annual solicitation for groundwater research and monitoring proposals as specified in a November 2002 Memorandum of Understanding (MOU) (Details are found later in this chapter in the section on *Wisconsin's Groundwater Research and Monitoring Program*). The GCC approved the FY 09 Solicitation for Proposals in August of 2007 (see *Appendix D*). In January 2008, members of 2 GCC Subcommittees reviewed the research and monitoring proposals and made their recommendations to the agencies and the GRAC. In March 2008 the GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. and a letter to this effect was sent to the UWS president and the Department of Administration.

In FY 07 the GCC worked with DNR and UWS on monitoring and research priorities for manure management. This led to four out of fifteen projects funded in FY 08 by UWS and DNR being related to manure management. In FY 08 the GCC further recommended that the agencies use the recommendations from a report on manure management in carbonate bedrock (Northeast Wisconsin Karst Task Force February 9, 2008) areas when setting their monitoring and research priorities for the FY 10 solicitation.

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, heard presentations, and or discussed:

- The Water Resource Institute education/outreach project which resulted in a 20-page publication on the GCC's role in groundwater research and monitoring and several groundwater fact sheets.
- UWS and agency activities for Groundwater Awareness Week (March 9-15) including an appearance by GCC member Dr. Henry Anderson and DNR Hydrogeologist Steve Ales on the Larry Meiler radio show to discuss groundwater issues.
- The Office of Energy Independence's (OEI) role in implementing Governor Doyle's vision for energy independence.
- Research on groundwater pollutant transfer and export from a Northern Mississippi Valley loess hills watershed
- FY 09 joint solicitation for groundwater proposals
- UWS FY 09 groundwater research plan
- Findings on viruses in groundwater in Door County after the May/June 2007 disease outbreak at the Log Den restaurant
- Manure management in Northeast Wisconsin
- Protecting wells and groundwater from flooding events
- Research on arsenic species distribution in Wisconsin groundwaters

- Status of the Wisconsin Groundwater Monitoring Network
- Research on mechanisms of groundwater flow across aquitards in Eastern Wisconsin

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 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 groundwater-related issues. These activities regularly create efficiencies and provide numerous 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. Many subcommittee members participated in the review of the UWS and DNR monitoring and research priorities for FY 09. The subcommittee also met with the Monitoring and Data Management Subcommittee in January 2008 to review proposals that were submitted in response to the FY 09 solicitation. Subcommittee members made recommendations that were used by the UWS and DNR in deciding which groundwater-related proposals to fund for FY 09. The projects to be funded in FY 09 are listed in Table 2.

Monitoring & Data Management Subcommittee
The goal of the Monitoring & Data Management Subcommittee is to coordinate groundwater monitoring and data management activities of state agencies to maximize efficiency and prevent duplication of efforts. In FY 09 the subcommittee met three times and continued to be a forum for information exchange to and increase the utility of monitoring data. Key monitoring and data management items included making a new DATCP well construction report search tool available to other agency staff, addressing monitoring needs in groundwater management areas, DNR's new requirements for reporting high cap well pumping and inventory, and implementing the groundwater monitoring strategy.

Subcommittee members also evaluated and discussed the 15 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 and DNR in deciding which groundwater-related proposals to fund for FY 09.

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 08. 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 provided input to Peter Boger, a graduate student from the WRI who completed a brochure highlighting the GCC accomplishments over the last 20 years, and drafted issue-related fact sheets related to nitrate and arsenic. The subcommittee also made an increased effort to promote Groundwater Awareness Day in Wisconsin by creating and distributing a series of press releases on groundwater related issues. 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. Both Subcommittees had 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 2008.

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 $14.6 million has been spent through FY 08 on approxim1ately 360 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 08, the DNR has spent approximately $6.7 million on 203 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 08, the UWS has spent $5.6 million on 156 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 08, 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 08, 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 08 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 08 was distributed in September 2006. A total of 21 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 2007 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, fifteen new projects were selected for funding; seven by DNR and eight by UWS. Five ongoing projects were carried over into FY 08. A total of 20 projects were funded through the joint solicitation at a cost of approximately $702,000 (see Table 1). DATCP and Commerce did not fund projects in FY 08.

FY 09 Proposal Solicitation. The SFP for FY 09 was distributed in October 2007 for funding in FY 09. 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 12, 2007.

As was done in the FY 08 solicitation, the entire submission and review process was conducted online through a secure Web site administered by the WRI. A total of 15 proposals were submitted, requesting a total of $864,313 in funding. A minimum of three external peer reviews were solicited for each proposal from experts within the field. Most proposals received four to five reviews, and two proposals received six reviews. GCC Subcommittee members and agency staff also reviewed the proposals and met in January 2008 to rank the proposals. In addition, the GRAC met in February 2008 to select projects to recommend to the GCC for UWS funding.

A total of seven new projects were selected for funding; three by DNR and four by UWS. Including continuing projects the DNR and UWS will fund seventeen projects during FY09 for a total of $507,919. DATCP and Commerce will not be funding new projects in FY 09. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 08 will be funded through FY 09. The projects to be funded in FY 09 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 through addition of Federal Wellhead Protection and Clean Water Act monies, and State Act 310 Groundwater Quantity funds the DNR Groundwater Monitoring and Research program has been able survive. One consequence of the change in funding sources is that only projects related to the objectives of the Wellhead Protection, Clean Water Act and State groundwater quantity programs can be supported with those funds.

Continued cuts in support 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 pollution prevention strategies cost less than groundwater cleanup. 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 as they become available (*http://www.wri.wisc.edu/Default.aspx?tabid=69*). The database includes more than 330 entries for previous projects and more than 70 summaries and final reports that are viewable online. 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.

In FY08, the WRI website (*www.wri.wisc.edu*) was rebuilt from ground(water) up to make it easier and faster for visitors to find information about WRI research projects and publications.

One of the goals of the website redesign was to provide the public with a real-time link to information about current groundwater research. In a related effort, Wisconsin's Water Library has been cataloging all WRI research reports into WorldCat and MadCat, two library indexing tools that provide both worldwide and statewide access to this research. By having this information permanently indexed, the research results are easily available to other scientists throughout the state as well as the nation and the world.

The Water Resources Library has also partnered with UW Libraries' Digital Collections Center to digitize and post WRI and DNR final project reports. As a result of this partnership, full-text reports are also available through the University of Wisconsin Ecology and Natural Resources Digital Collection at http://digital.library.wisc.edu/1711.dl/EcoNatRes.Groundwater.

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 5, *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 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 , Yang	UW-Milwaukee	$38,329
UWS	08-CTP-01	Is phosphorus-enriched groundwater entering Wisconsin streams?	Browne	UW-Stevens Point	$34,168
UWS	08-CTP-03	Occurrence and generation of nitrite in ground and surface waters in an agricultural watershed	Stanley	UW-Madison	$26,682
UWS	08-GCP-01	Geochemical characterization of sulfide mineralization in eastern Wisconsin carbonate rocks	Luczaj and McIntire	UW-Green Bay	$8,860
UWS	08-OSW-01	Monitoring Septic Effluent Transport and Attenuation using Geophysical Methods	Fratta, Hart and Masarik	UW-Madison	$29,706
UWS	08-SAM-03	A thermal remote sensing tool for mapping spring and diffuse groundwater discharge to streams	Loheide	UW-Madison	$35,866
UWS	08-WLA-02	Influence of wetland hydrodynamics on subsurface microbial redox transformations of nitrate and iron	Bahr and Roden	UW-Madison	$40,141
UWS	08-WLA-03	Controls on methylation of groundwater Hg(II) in hyporheic zones of wetlands.	Shafer, Babiarz, Armstrong and Roden	UW-Madison	$43,468
UWS*	07-SAM-02	Multi-Parameter, Remote Groundwater Monitoring with Referencing Using Crossed Optical Fiber Fluorescent Sensor Arrays	Geissinger	UW-Milwaukee	$59,67
UWS**	07-REM-02	Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses	Hickey and Payne	UW-Madison	$42,918
USGS & UWS***	N/A	"Protecting Wisconsin's Buried Treasure: Celebrating the Results of 20 Years of Coordinated Research and Monitoring	Wittman, Hurley	UW Madison	$28,892

The total cost of all projects funded through the UWS (including fringe benefits and USGS contribution) through the FY08 Joint Solicitation for proposals was $334,997 ($277,633 without USGS -- including 6% administration)

Table 1 (Continued): Groundwater Research and Monitoring Projects Funded in FY 08

Agency	Code	Title	Investigators	University	Cost
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-Stevens Point	$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-Parkside	$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 was $394,988

*	Continuing project
**	UWS continuing project funded with USGS 104 B funds
***	special project approved by GCC and funded through USGS 104(b) funds and WRI's Groundwater Administration and Reporting project

Table 2: Groundwater Research and Monitoring Projects Funded in FY 09

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, Yang	UW-Milwaukee	$31,790
UWS*	08-CTP-01	Is phosphorus-enriched groundwater entering Wisconsin streams?	Browne	UW-Stevens Point	$33,885
UWS**	08-CTP-03	Occurrence and generation of nitrite in ground and surface waters in an agricultural watershed	Stanley	UW-Madison	$33,901
UWS*	08-OSW-01	Monitoring Septic Effluent Transport and Attenuation using Geophysical Methods	Fratta, Hart and Masarik	UW-Madison	$15,920
UWS**	08-SAM-03	A thermal remote sensing tool for mapping spring and diffuse groundwater discharge to streams	Loheide	UW-Madison	$34,190
UWS*	08-WLA-02	Influence of wetland hydrodynamics on subsurface microbial redox transformations of nitrate and iron	Bahr, Roden	UW-Madison	$39,869
UWS*	08-WLA-03	Controls on methylation of groundwater Hg(II) in hyporheic zones of wetlands.	Shafer,Babiarz ,Armstrong and Roden	UW-Madison	$44,400
UWS	09-REM-01	Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water	Li	UW - Parkside	$9,954
UWS	09-CTP-02	Assessing Levels and Potential Health Effects of Endocrine Disrupting Chemicals in Groundwater Associated with Karst Areas in Northeast Wisconsin	Bauer-Dantoin, Fermanich, Zorn	UW – Green Bay	$43,063
UWS	09-BEP-01	The lethal and sublethal effects of elevated groundwater nitrate concentrations on infaunal invertebrates in the Central Sand Plains	Stelzer, Eggert, and Muldoon	UW - Oshkosh	$17,769
UWS	09-SOS-01	Use of the 2009 Behavioral Risk Factor Surveillance Survey to Assess the Safety of Private Drinking Water Supplies	Kanarek and Knobeloch	UW-Madison and DHS	$20,250

The total cost of all FY 09 UWS –funded projects selected through the joint solicitation (including fringe benefits and USGS contribution) proposals is $324,991 ($275,028 without USGS, and incl. 6% administration)

Table 2 (Continued): Groundwater Research and Monitoring Projects Funded in FY 09

Agency	Code	Title	Investigators	University	Cost
DNR *	08-BEP-01	Assessing the Potential of Hormones from Agricultural Waste to Contaminate Groundwater	Hemming, Landreman and Hedman	UW-Madison	$25,461
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-05	Water Balance Modeling for Irrigated and Natural Landscapes in Central Wisconsin	Lowery and Bland	UW-Madison	$44,426
DNR	09-HDG-01	Drawdown in the Northeast Groundwater Management Area (Brown, Outagamie, and Calumet Counties, WI)	Luczaj and Hart	UW-Green Bay WGNHS	$40,863
DNR	09-CTP-04	Human viruses as tracers of wastewater pathways into deep municipal wells	Bradbury, Borchardt, and Gotkowitz	UW-Extension	$59,843
DNR	09-SAM-02	Development and Validation of a PCR-based Quantification Method for Rhodococcus coprophilus	Long and Kluender	UW-Madison (State Lab of Hygiene)	$40,894

The total cost for all FY 09 DNR-funded projects selected through the joint solicitation was $246,340.

*Continuing project

**UWS continuing project funded with USGS 104 B funds

Table 3: Groundwater Research and Monitoring Projects Funded from FY 99 through FY 08

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
2008	15	545,415	7	288,195	8	257220	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
2008	5	121,957	3	101,544	2	20,413	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
2008	20	654,451	10	389,739	10	277633	0	0	0	0
Total	234	5,990,830	86	2,660,211	126	2,809,554	21	463,065	1	58,000

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

2001-08 UWS figures do not include matching USGS funds (approximately $60,000 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 123 substances of public health concern, 8 substances of public welfare concern and 15 indicator parameter substances in NR 140.

Revisions to NR 140 groundwater quality standards were approved by the Natural Resources Board in 2007. These revisions established new state NR 140 groundwater standards for alachlor-ESA, a degradation product of the corn herbicide alachlor. The Legislature adopted these proposed revisions to NR 140 and they are now in effect.

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 provide input on stormwater management guidance for developers, land use planners and government agencies to help assure that stormwater practices meet performance standards while preserving groundwater quality.

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 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 2003 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 required to assess potential impacts from proposed high capacity wells in the following situations:

- 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 springs that have a flow of at least 1 cubic foot per second
- 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 updating the high-capacity well inventory, collecting annual pumping information, 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 – Chapter NR820 – went into effect on September 1, 2007. 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.

Chapter NR 820 also imposes a requirement that all owners of high capacity wells submit annual reports documenting the volume of water pumped from their wells on a monthly basis. To facilitate this reporting, DG staff has been updating the inventory of high capacity wells in the state. Starting in late 2006 and continuing through 2007, substantial progress was made in verifying ownership and collecting basic well information for the roughly 10,000 existing high capacity wells in the state. Using this updated and verified information, over 7,600 pumpage report forms were mailed to owners of high capacity wells in late 2007 and early 2008. Information received from well owners using these pumpage reports, in combination with pumpage data already collected for municipal and certain public water supplies, will help to establish baseline information regarding water use in the state.

The GAC completed its charge in 2007 with submission of a second report to the Legislature assessing the effectiveness of Act 310. The GAC concluded that Act 310 is working as originally intended as a first step in integrated water management. The GAC, while acknowledging that more work remains to build upon initial improvements in groundwater management provided under Act 310, also recognized that the law has provided an added level of environmental protection for trout streams, outstanding resources waters, exceptional resource waters and springs. The 2007 report contains extensive recommendations and alternatives for enhancing the effectiveness of Act 310.

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 develop revisions to Ch. 280, Wis. Stats. that will result in increased protection of groundwater (as well as increased public health protection.) The changes went 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 has 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 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 and 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. The technique is proposed as a solution to a problem that water utilities may face in managing peak seasonal

water demands. If the injected water does not need to be conditioned (deoxygenated, pH adjusted, dechlorinated, etc.) to prevent the mobilization of minerals from the rock matrix of the receiving aquifer, ASR may prove to be a lower cost alternative to more traditional water supply management approaches involving the construction of water storage facilities, expansion of water treatment facilities or the drilling of additional wells.

State administrative rules (Chapter NR 811, Wis. Admin. Code) regulate the use of ASR in Wisconsin. Only municipal water systems are allowed to operate an ASR system and only treated drinking water may be injected. Demonstration testing is required before routine operation of an ASR system may be approved by the DNR. These restrictions help to ensure that this type of underground injection practice complies with federal regulatory requirements.

To date, only the municipalities of Oak Creek and Green Bay have sought approval to develop ASR wells. Work at the Green Bay ASR well was terminated after significant concentrations of arsenic and other contaminants were mobilized during the injection and storage phases of the ASR demonstration test.

Oak Creek completed its ASR demonstration test and received conditional approval to operate its ASR well provided that any minerals mobilized do not exceed state groundwater quality enforcement standards. However, after performing several additional ASR cycles, monitoring of groundwater has demonstrated that concentrations of manganese and iron have increased to levels that are above their respective enforcement standards. The utility is currently evaluating operational changes that will reduce these concentrations and allow the water system to return to compliance with the conditions of their approval to operate an ASR well.

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 updating existing rules dealing with lead and copper, groundwater disinfection, water system design and operation, 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 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. During FY 08, wellhead protection staff responded to nearly 50 requests for information to assist communities in their WHP efforts.

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.

Other highlights include:
• *New wellhead protection plans*. In FY 08, 25 communities received DNR approval of required WHP plans (for new wells) and 15 submitted voluntary plans to the DNR. There are now 336 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 eighth 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 and February. Fifty-three educators from 24 schools or nature centers took part in the workshops held at Jefferson, Stevens Point and Green Bay 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. Results from this program include students from one school stenciling storm drains in the community and hanging information on neighborhood doors talking about stormwater and groundwater issues. Another school had families keep track of water usage for 4 days and write a report on the findings. Some of the schools that did not incorporate families or local communities reported that they were planning on doing so in future years. 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 186 schools or nature centers since 2001.

• *Working with Wisconsin Rural Water Association.* The DNR continues to work with the Wisconsin Rural Water Association (WRWA) staff in providing assistance to local communities in their protection efforts. WRWA staff work on both plans for individual communities and area wide 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*. The DNR provided information to nearly 50 Wisconsin communities, to other states and EPA. Staff answered questions, sent publications, made presentations, and reviewed draft plans and ordinances. The DNR updated the WHP website to keep current information available to communities interested in wellhead protection and made copies of the WHP video available in DVD as well as VHS format.

• *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. The Groundwater Section is working with EPA Region V and the other Region V states to propose an increase in the acreage eligible for CRP in wellhead protection areas on a nationwide basis.

Groundwater Information and Education. As noted in the wellhead protection discussion above, staff from the DNR and other agencies led three groundwater workshops for educators to provide training in the use of the groundwater sand tank model and provide the model and additional resources to the educators.

In the fall of 2007, the DNR Groundwater Section added three groundwater exercises to its education website. All three exercises use the groundwater sand tank model. The Section also purchased a model for demonstration purposes which is shared with the Bureau of Education and Information.

The DNR continued to have significant demand for the *Groundwater: Wisconsin's Buried Treasur*e publication and the *Groundwater Study Guide* folder. Both publications were updated within the past two years.

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 program 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 08, $394,988 was spent on ten projects. Three new projects were selected for funding in FY 09. 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 08, DG staff continued to work 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

These components of the strategy have been 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 on the following website: *http://dnr.wi.gov/org/water/dwg/data.htm*. GRN accesses groundwater data from database systems in the Waste & Materials Management, Drinking Water & Groundwater and Watershed Management 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 09, 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 08. 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 high-capacity wells, trout streams, springs, outstanding water resources, and exceptional water resources, public wells, source water areas, and potential contaminant sources within source water areas in a format consistent with high-capacity well approval, 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 and resource 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. When 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, 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 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, a web interface, possibly using the Department's Data Portal and/or Web Access Management System, will allow facilities to upload environmental monitoring data into GEMS. Currently, funding is not 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. Review of all the sites identified in the screening as possibly impacting the environment will be completed by the end of 2008.

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 review 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 spent $2.0 million in Environmental Fund dollars to initiate or continue environmental cleanup actions at over 75 locations where

groundwater contamination is known or suspected. The Environmental Fund is used when contamination is significant but no identifiable private party 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. 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 08, DNR awarded 46 Site Assessment Grants totaling approximately $1.7 million to 31 communities across the state. Small grants up to $30,000 make up 35 of the awards, while nine are large grants between $30,000 and $100,000. Local governments have also pledged more than $1.9 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 230 acres of land. Activities include 69 site assessments and investigations, the demolition of 74 buildings or structures and the removal of 37 tanks, drums and other abandoned containers. Since 2000, 398 grants have been awarded to over180 communities around the state for work on 1,415 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 08, the RR program awarded a $19,000 grant for the cleanup of one brownfields site and expects to award $981,000 in grants to additional brownfield sites in FY 09.

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. Through a $400,000 EPA Brownfields Site Assessment Grant, the partners have begun site investigation activities on more than 30 sites in the Corridor since 2004.

In FY 08 the partnership continued with significant progress by:
- completing Phase I environmental site assessments at 16 properties;
- completing or continuing Phase II work at 14 properties; and
- identifying additional sites for Phase I or II assessment work.

Completion of the first grant will occur in the fall of 2008. However, the partners were awarded a completive grant of an additional $400,000 EPA site assessment grant in May 2007. The DNR Urban Reinvestment Initiative and 30th Street web page is located online.

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 08.

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 08, DNR issued a Certificate of Completion at 6 properties for completed cleanups and 13 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 160 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.

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 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 2008, additional layers regarding financial tools and liability clarification actions were added, so RR Sites Map now provides even 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 360 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 which 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 DNR is currently in the process of implementing revisions to NR 243 that became effective on July 1, 2007.

There are currently 171 WPDES permits issued for livestock operations (84% dairy; 8% poultry; 5% swine; 3% beef). 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 216 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 216 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 became effective for the remainder of the state on January 1, 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 maps for 102 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. In 2008 DATCP prohibited the use of a simazine, a related triazine herbicide, in a small area of the Lower Wisconsin River Valley near Spring Green. DATCP is conducting additional sampling of private wells to determine if additional actions are needed to protect groundwater from simazine.

Nutrients. Through its land and water resource management program, DATCP provides funding primarily to counties to assist in the protection of water resources through farmer adoption of nutrient management planning. In FY 07, $520,000 was allocated to provide cost-sharing to farmers for the development and implementation of nutrient management plans (NMP) for their cropland. In 2007, Wisconsin attained a record number of cropland acres under NMPs, achieving 1,006,342 acres, a 28% increase over acres reported in 2006.

Increasing attention on the role of land use practices in achieving water quality goals was recognized in the 2008-2009 state budget. Funding for the land and water resource management program's cost-share allocation increased to $6.5 million for the 2008-2009 biennium. A portion of those funds have been directed to provide support for nutrient management implementation, including farmer outreach and education, Snap-Plus Nutrient Management Planning Software, farmer training and program evaluation activities. Nearly $6 million will be used to provide cost-sharing to farmers for the development and implementation of NMPs in 2008-2009 on over 200,000 cropland acres statewide.

DATCP nutrient management program staff has worked to train farmers, consultants, and local agencies on the principles of sound nutrient management, how to comply with performance standards, and how to use available tools to create and evaluate an ATCP 50 compliant NMP. The 2008-2009 state budget also allocated funds to DATCP for the creation of a Manure Management Advisory System. This system is currently focused on helping farmers develop a good understanding of field-specific soils and their ability to accept nutrients and manure for optimal crop production while protecting water quality. In order to accomplish this goal, two new tools in development include web-accessible WI "590" Nutrient and Manure Application Restriction Maps and a model based website for predicting the likelihood for runoff events to take place on a given day. The 590 Restriction maps will be available on a statewide basis at the section level to assist farmers in making sound decisions about manure and nutrient applications to their cropland.

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.

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. In the fall of 2007, prescription

drug collection authority was given to the Department and the annual program budget expanded to $1 million. In 2007, nearly 2.3 million pounds of chemical wastes were collected by municipalities and counties with grants from the Department.

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 began in 2000. Its purpose is to reduce the amount of agrichemicals that escape into the environment. Participation in the program is voluntary, with the agrichemical industry and the Department working together to identify 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 2007, DATCP received authority to manage a pollution prevention grant program. DATCP is preparing rules to govern how this grant program will be implemented.

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 and reimburse responsible parties for cleanup costs related to pesticide and fertilizer contamination. To date, about 500 cases involving soil and/or groundwater remediation related to improper storage and handling of pesticides and fertilizers have been initiated at storage facilities. Over this same time period DATCP has also cleaned up over 850 acute spills of agrichemicals. The ACCP staff have reviewed over 1060 reimbursement applications and provided over $32.5 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
Due to budget constraints, DATCP did not have funding for new pesticide research projects in FY08. 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. 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 sample analytical 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 plumbing programs have the responsibility of safeguarding public health and the waters of the State. Graywater reuse and stormwater is regulated by the General 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).

Also within the Safety and Buildings Division the Soil Erosion and Sediment Control Program has statutory jurisdiction over stormwater runoff on building sites that are regulated under Chapter 101 of the statutes.

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 wastewater and stormwater. Currently, the Chapter 82 stormwater rules create the ability for plumbing to 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 communicates with the Department of Natural Resources regarding mutual issues of interest such as large onsite sewage systems, mixed wastewater treatment systems, Underground Injection Control (UIC) regulations and water well regulations. The Department also communicates with the USEPA Region 5 office regarding POWTS related matters. Department staff continues to participate in efforts to develop a regional and national model code related to onsite sewage systems.

Soil Erosion and Sediment Control and Post Construction Stormwater Management
The Department works with the Department of Natural Resources in regulating the erosion and sediment control issues on building sites under the authority of s. 101, Stats. Post construction stormwater management is linked through the Notice of Intent (NOI) to the erosion and sediment control program.

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, which is currently in the process of revision, is expected to be implemented in early 2009 to address technical requirements associated with current day concerns, trends and technology.

Since 1991 the database inventory of petroleum product and CERCLA hazardous substance tanks regulated under Chapter Comm 10, Wis. Admin. Code has increased from 143,681 to 180,871 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 23, 2008, the database reflects 81,189 federally regulated tanks with only 12,391 tanks in use and 303 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 will have a 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. This next year the department will be working with the regulated community to develop and implement owner / operator training to complete the state mandates presented in the Federal Energy Bill of 2005.

Petroleum Environmental Cleanup Fund Act (PECFA)
Since 1989, the PECFA program has reimbursed approximately $1.49 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 $20 million in FY08 and is $20 million for FY09. In FY07, the PECFA program reimbursed $20.2 million to 815 claimants. In FY08, the PECFA program reimbursed $14.9 million to 796 claimants. The Program currently reimburses claimants within three months of receiving a claim.

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 for the 2009 Fiscal Year that will be utilized for redevelopment awards of up to $1.25 million. Funds may be used for the environmental activities including investigation, remediation or groundwater monitoring. Expenditures for site acquisition, demolition, building rehabilitation or infrastructure improvements may also be eligible for reimbursement.

The BEBR program has awarded $63,950,000 in grants since the inception of the initiative in 1998. Funds have been used to remediate 164 properties with soil or groundwater contamination. Program staff has reviewed 310 applications requesting a total of over $159 million.

Data Management
Commerce is continuing its data integration information technology (IT) initiative. With regard to groundwater protection, Commerce maintains databases of underground petroleum storage tank systems and properties with petroleum contamination either in the past or currently. The database also stores information on activities associated with 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 upgrading the 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 proceeds with a rule revision to begin 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 Berni.Mattsson@Wisconsin.gov.

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 28 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 1,266 salt storage sites listed in the database and 2,439 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 59 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 SERVICES (formerly Department of Health and Family Services)

Chapter 160, Wis. Stats., directs the Department of Health Services (DHS) 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. When requested, DHS staff also provide interim drinking water advisories for substances that do not have a current enforcement standard. During FY 2008, DHS staff provided drinking water advisories to DNR for 4 isomers of dinitrotoluene, and 5 degradation products of dinitrotoluene. DHS 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. DHS 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 DHS explain the health effects of specific contaminants and suggest strategies for reducing exposure until a safe water supply can be established. DHS 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. DHS 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 08
Over the past four years, DHS 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, DHS 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, DHS 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, DHS has overseen the implementation of multiple environmental public health projects relating to groundwater-related issues. DHS 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. DHS 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 2007-2008, DHS partnered with DATCP in their groundwater survey of private wells throughout the state by adding a survey questionnaire component to examine consumption of private well water among Wisconsin residents. Three hundred and ninety-eight random samples were collected from Wisconsin private wells in 2007. After the sample was collected, an adult within the household was asked to answer the short survey of ten questions about their consumption and use of water. Three hundred and eighty two surveys were completed. This project has allowed us to gain insight into population behavior patterns of consumption and filtration of private well water and supports the need for increased research and monitoring of private drinking water supplies throughout the state of Wisconsin. Results suggest opportunities for increased research and education regarding private well testing, consumption patterns and health impacts, particularly with regards to nitrates.

In 2007-2008, DHS 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. DHS 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, DHS established partnerships with the U.S. Geological Survey (USGS) to map and explore geological predicators of groundwater contamination in the state. DHS 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, DHS 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.

In June of 2008, twenty-nine counties in southern Wisconsin were affected by severe flooding. DHS partnered with the Wisconsin State Lab of hygiene and local health departments to provide no cost well sampling to homeowners affected by the floods. By the end of June 2008, 3,540 well sampling kits were sent to local health departments. Seven-hundred thirty-one samples had been returned to the lab by June 30, and 208 of those tested unsafe. DHS will continue to work with flooded communities and provide sampling into the next fiscal year.

For over fifteen years, DHS and DNR have provided local health departments with fee exempt well water testing. Local health departments may provide these tests to new and expectant mothers who are served by a private well and otherwise could not afford to test their wells. The tests have historically included bacteria, nitrates, and fluoride. This past year DHS added a metals' test, including arsenic, due to growing health concerns about prenatal and early childhood exposures to arsenic in drinking water.

For more information, visit http://DHS.wisconsin.gov/eh/Water/, or contact Henry Anderson (608-266-1253; Henry.Anderson@wi.gov), Lynda Knobeloch (608-266-0923; Lynda.Knobeloch@wi.gov) or Mark Werner (608-266-7480; Mark.Werner@wi.gov), 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 08 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 high capacity well pumping, the response of groundwater levels to droughts, the effects of land-use changes on groundwater systems, and the impacts of climate change. The long-term data are also used for calibration of regional groundwater models. 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 08, the Survey initiated or carried out geologic and/or groundwater studies in the following counties: Brown, 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 Brown, Iowa, Pierce, Polk, St Croix, and Waupaca Counties. Many of these new maps are now available digitally and have been released as open-file reports (see http://www.uwex.edu/wgnhs/wofrs.htm).

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. Aquitard investigations continued in 2008.

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 (see Borchardt and others, 2007). 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 FY08 the WGNHS has conducted 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; this work will continue in FY 09.

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. In 2007 this method was applied to the SEWRPC area in SE Wisconsin for use in regional water supply planning.

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 08 the WGNHS completed 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 compares it 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 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 FY08 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 inventory of springs. Over 10,000 springs have been cataloged. 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. The data on spring location and flow is now available in a digital database, and the report and data are available as WGNHS Open-File Report 2007-03.

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, which 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 Well Constructor's Reports from wells installed between 1936 and 1995. These reports were 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 drillhole 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.

Recent WGNHS Publications

Attig, J.W., Clayton, Lee, Hooyer, T.S., and Mode, W.N., 2007, A bursting ice dam, a big flood, and sub-lake moraines—The transition from Glacial Lake Wisconsin to Glacial Lake Oshkosh: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 81.

Bellile, T.E., Isbell, J.L., Kean, W.F., and D.J. Hart, 2008, Formation and evolution of bars within a sandy braided reach of the lower Wisconsin River: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 26.

Beyer, S.R., Simo, J.A., and Byers, C.W., 2008, Lithofacies, K-bentonite geochemistry, and sequence stratigraphy of the Ordovician (Mohawkian-Cincinnatian) Galena Group, northeastern Iowa: Geoscience Wisconsin, v. 19, pt. 2

Borchardt, M.A., Bradbury, K.R., Gotkowitz, M.B., Cherry, J.A., and Parker, B.L., 2007, Human enteric viruses in groundwater from a confined bedrock aquifer: Environmental Science and Technology, http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2007/41/i18/abs/es071110+.html

Bradbury, K.R., and Cobb, M.K., 2008, Delineation of areas contributing groundwater to springs and wetlands supporting the Hine's Emerald Dragonfly, Door County, Wisconsin: Wisconsin Geological and Natural History Survey Open-File Report 2008-04, 34 p.

Bradbury, K.R., Hart, D.J., and Feinstein, Daniel, 2007, Where is the deep groundwater divide in southeastern Wisconsin?: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 134.

Bradbury, K.R., Nel, J., Raitt, L.M., El Kahloun, M., Masvopo, T., Nhiwatiwa, T., and Brendonck, L., 2008, Hydroecologic studies in the Save Valley Conservancy, southeastern Zimbabwe: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 38.

Bradbury, K.R. and Rayne, T.W., 2008, Sustainability analysis for shallow groundwater use in the SEWRPC region: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 49.

Carter, J.T., Gotkowitz, M.B., and Anderson, M.P., 2007, Vertical hydraulic connection between a perched carbonate aquifer and an underlying regional aquifer: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 515.

Cherry, J.A., Parker, B.L., Bradbury, K.R., Eaton, T.T., Gotkowitz, M.B., Hart, D.J., and Borchardt, M.A., 2007, Contaminant Transport Through Aquitards: Technical Guidance for Aquitard Assessment: AWWA Research Foundation, 270 p.

Clayton, Lee, Attig, J.W., Ham, N.R., Johnson, M.D., Jennings, C.E., and Syverson, K.M., 2008, Ice-walled-lake plains: Implications for the origin of hummocky glacial topography in middle North America: Geomorphology, v. 97, no.1-2, p. 237-248.

Cordua, W.S., and Evans T.J., 2007, Geology of the Rock Elm Complex, Pierce County, Wisconsin: Wisconsin Geological and Natural History Survey Open-File Report 2007-02, 1 color plate.

Evans, T.J., Cordua, W.S., and LePain D.L., 2007, Preliminary geology of the buried bedrock surface, Pierce County, Wisconsin: Wisconsin Geological and Natural History Survey Open-File Report 2007-08, 1 color plate, scale 1:100,000.

Gotkowitz, M.B., Hart, D.J., and Dunning, Charles, 2008, Groundwater sustainability in a humid climate: Groundwater pumping, groundwater consumption, and land-use change: Wisconsin Geological and Natural History Survey Open-File Report 2008-02, 63 p.

Gotkowitz, M.B., Shelobolina, E.S., Roden, Eric, West, Nicole, and Schreiber, Madeline, 2007, Mineral transformation and release of arsenic to solution under the oxidizing conditions of well disinfection: Wisconsin Geological and Natural History Survey Open-File Report 2007-07, 40 p.

Hart, D.J., Bradbury, K.R., Feinstein, Daniel, and Tikoff, Basil, 2008, Mechanisms of groundwater flow across the Maquoketa Formation: Wisconsin Geological and Natural History Survey Open-File Report 2008-03, 51 p.

Hart, D.J., Furbish, W.B., and Koperski, Cindy, 2007, Finding the connection between a trout stream and a quarry well using borehole geophysics: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 521.

Hart, D.J., Luczaj, J.A., and Chase, P.M., 2008, A large scale pumping test in the northeastern Wisconsin Groundwater Management Area: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 50.

Hooyer, T.S., Hart, D.J., Moeller-Eaton, C.A., and Batten, W.G., 2008, Vertical distribution of δ18O in a clay-rich aquitard: Implications for groundwater recharge: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 16.

Hooyer, T.S., and Mode, W.N., 2007, Preliminary Quaternary geologic map of the northern Fox River lowland, Wisconsin: Wisconsin Geological and Natural History Survey Open-File Report 2007-05, 1 color plate, scale 1:100,000.

Komiskey, M.J., Stuntebeck, T.D., Madison, F.W., and Frame, D.R., 2008, Nutrients and Sediment in Surface-Water Runoff from Frozen Fields at a Crop and Livestock Farm in Southwest Wisconsin, 2004-2007: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 24.

LePain, D.L., Bradbury, K.R., and Cobb, M.K., 2008, Hydrostratigraphy of west-central Wisconsin: A new approach to groundwater management: Wisconsin Geological and Natural History Survey Open-File Report 2005-04, 30 p. + appendixes.

Macholl, J.A., 2007, Inventory of Wisconsin's springs: Wisconsin Geological and Natural History Survey Open-File Report 2007-03, 1 CD-ROM.

McLaughlin, Patrick, and Brett, Carlton, 2007, Characteristics of falling stage systems tracts from the carbonate margin of the Taconic Foreland Basin: Implications for cratonic sequence

stratigraphy: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 149.

Mode, W.N., Hooyer, T.S., Clayton, Lee, and Attig, J.W., 2007, Details of Glacial Lake Oshkosh stratigraphy and history revealed through geologic mapping: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 162.

Moeller-Eaton, C.A., Mickelson, D.M., Hooyer, T.S., Hart, D.J., and Batten, W.G., 2008, An analysis of hydraulic conductivity with depth and stress in a clay aquitard: American Water Resources Association Wisconsin Section, 32nd Annual Meeting Program and Abstracts, p. 15.

Muldoon, M.A., and Bradbury, K.R., 2007, Modeling of hydraulic response and tracer migration in a fractured-carbonate aquifer: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 515.

Rawling, J.E. III, Hanson, P.R., Young, Aaron, Attig, J.W., and Hart, D.J., 2007, Late Pleistocene dune activity in the Glacial Lake Wisconsin basin: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 79.

Rayne, T.W., and Bradbury, K.R., 2007, Comparison of a finite-difference model to an analytic element model: Results, costs, and benefits: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 475.

Rayne, T.W., and Bradbury, K.R., 2007, Effective ways of presenting model results to non-hydrogeologists: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 523.

Robertson, J.M., 2007, Moving from an analog past to a digital future: Geoscience data preservation at The Wisconsin Geological and Natural History Survey: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 294.

Schoephoester, P.R., Evans, T.J., and Cordua, W.S., 2007, Using GIS to integrate diverse datasets to support geologic mapping: Geological Society of America Abstracts with Programs, v. 39, no. 6, p. 164.

Syverson, K.M., Pleistocene geology of Chippewa County, Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 103-DI, 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 publications, media relations, public meetings, teleconferences, and water testing and satellite programs. Activities of several specific programs are described below.

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 FY08 included research on the movement and survival of pathogenic bacteria in groundwater, controls on the formation of methylmercury in groundwater, and a remote-sensing tool to improve estimates of natural groundwater discharge across the state.

During FY 08, the WRI directed a wide-ranging program of priority groundwater research consisting of 11 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 issues investigated during the past year include:

- Understanding the ecological importance and important characteristics of springs in Wisconsin;
- Evaluating optimal conditions for biodegradation of organic contaminants in groundwater;
- Developing optical-fiber sensors for real-time monitoring of contaminants in groundwater;
- Assessing the viability of bacteria from dairy manure as it travels through soil and groundwater;
- Quantifying elevated phosphorus levels entering streams via groundwater;
- Understanding nitrite production in the groundwater of an agricultural watershed;
- Measuring trace metal content of sulfide minerals in carbonate aquifers as a source of groundwater contamination;
- Developing a remote-controlled airplane for mapping and quantifying groundwater discharge using sensors that measure ground temperature;
- Understanding how septic tank effluent travels through soils so that drinking water wells can be strategically sited;
- Understanding the processes that govern agriculturally derived nitrate remediation in wetlands, and
- Assessing the importance of methylmercury formation in shallow sediments of wetland stream beds.

These 11 projects, funded by the UWS, 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 and UW-Green Bay.

The UWS selected four new groundwater research projects from this year’s Solicitation for Proposals for support during FY 09 (July 1, 2008–June 30, 2009) (see Table 2). Seven projects, selected from the previous year’s solicitation, will receive continuation support during FY 09. The new projects are based at UW-Madison, UW-Parkside, UW-Oshkosh 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 continuing education for K-12 teachers as an important 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 maintains an extensive curriculum collection of guides with innovative approaches to teaching water-related science in K-12 classrooms. The curricula are available for checkout by all teachers and residents in Wisconsin.

Grants Administration

In FY 07 WRI staff members developed a Web site (iPROPOSE) that enabled online submission and review of the Joint Solicitation for Groundwater Research and Monitoring proposals. Prospective investigators submit a proposal by filling out a series of forms and uploading their full proposal and budget. Assigned reviewers then complete their reviews through iPROPOSE by answering a series of questions online. Once all of the reviews are completed, the UW Groundwater Research Advisory Council is given access to anonymous reviews and original proposals to help decide which proposals to recommend for funding. The Web site provides a framework for consistently capturing the same information from all of the prospective investigators and reviewers, thus helping to ensure that each proposal is treated equally and fairly. In FY 08, the site was refined to increase the efficiency of the review process, including updates to the reviewer database, keywords and generating reports.

Water Resources Publications

In August 2007, the UW Water Resources Institute published a 20-page illustrated pamphlet and two-page executive summary describing the activities of Groundwater Coordinating Council (GCC) since its creation 20 years ago. The pamphlet, entitled *Protecting Wisconsin's Buried Treasure*, was designed to document the accomplishments, impacts and benefits of the Groundwater Research & Monitoring Program. The publication included a series of four fact sheets on Wisconsin's most important groundwater resource issues: nitrate, arsenic, manure and supply. These publications provide a complementary packet of information with long-term usefulness to all GCC member agencies. Coordinated by the GCC Education Subcommittee, this project represents a truly collaborative effort involving all GCC members. More than half of the printed copies of the pamphlet have been distributed, and a free electronic copy of the pamphlet in the ASC's online Publications Store has been downloaded 438 times between the date it was posted (11/1/07) and the end of May 2008

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. This document continues to be extremely popular at our ASC Publications Store. In FY 07, over 250 printed copies and 10,775 downloads were recorded. During FY 08, another 160 printed copies and 8,400 downloads were recorded.

UW Water Resources Library Outreach Activities

During the past year, Wisconsin's Water Library (WWL) has continued its involvement in outreach efforts while providing a full range of library services to faculty, staff and students of

the University of Wisconsin System (UWS). During the reporting period, in partnership with Wisconsin Department of Natural Resources and the Wisconsin Wastewater Operator's Association (WWOA), library staff initiated outreach projects to reach new users. The library signed a memorandum of agreement with WWOA to catalog, house and loan essential technical manuals provided by WWOA to aid members in their required state license examinations, as well as support the educational needs of their daily work.

Wisconsin's Water Library continues to catalog all groundwater research reports from projects funded by the Water Resources Institute into WorldCat and MadCat, two library indexing tools that provide both worldwide and statewide access to WRI research. By having this information permanently indexed, the research results are easily available to other scientists throughout the UWS as well as across the nation and the world.

Library staff continued to be involved in the Allied Drive Story Hours outreach program. Allied Drive is a neighborhood of Madison that has the highest concentration of children of any urban neighborhood in Dane County, and many of the families live in poverty. The program is a partnership of eight specialized UW-Madison campus libraries, the UW-Madison School of Library and Information Studies, and the Madison School and Community Recreation Safe Haven Childcare Program in which each month a different campus library hosts a reading hour with themes relating to its specialized subject area.

Library Web Sites

The main outreach tools used by the library are three library-related Web sites, each with a focus on a different user group. The Water Resources Institute (WRI) Library Web Site (*http://wri.wisc.edu/library*) introduces UW-Madison faculty, staff and students to services tailored to them. Three of the most popular pages on that site are "Finding Water Jobs", "Water Journals", and "Water Web Sites for Kids".

Wisconsin's Water Library (*aqua.wisc.edu/waterlibrary*) is an outreach site for those who want to know more about our state's water resources. It makes books and other materials in the library accessible to any Wisconsin resident. During the past year, library staff produced six bimonthly lists of *Recent Acquisitions* and added several special features or annotated reading lists on such popular topics as "Flooding in Wisconsin," "Understanding and Protecting Groundwater—Recommended Reading," and "Readings on Aquaculture." The most popular pages on the site are "Water Facts", a special feature page on Native Americans and the environment and a reading list on Landscaping & Ponds.

Wisconsin's Water Library also includes the Water Library for Kids Web site (*www.aqua.wisc.edu/waterlibrary/kids*). This site 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 provides ideas and resources for story hours. Users can browse recommended reading lists by topic (frogs, fish and fishing, Great Lakes, water pollution, etc.) and by age group. Any adult Wisconsin resident can check out books online and pick them up at their local public library.

The popularity of the all the library Web sites continues to grow. From July 1, 2007 through June 30, 2008, the WRI Library received 44,593 visits with 54,202 page views. Wisconsin's Water Library (including the Water Library for Kids) had 156,981 visits with 191,506 page views during the same period. The average time spent on these sites is about 12 minutes, an indication that Web surfers are finding information they want. On average, our library Web sites (Wisconsin's Water Library + WRI Library + the *Finding Water-Related Information Guide* on

the UW-Madison Libraries site) currently receives 575 unique visits per day, increasing by 15 percent during the year.

Other Web Sites

WRI maintains several other Web sites in addition those described above. The UW Water Resources Institute Web Site (*http://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, *Protecting Wisconsin's Buried Treasure* was added to the online store (see above). WRI fact sheets on arsenic in groundwater (446 downloads), groundwater drawdown (1091 downloads) and Wisconsin's groundwater resources (134 downloads) continue to be popular. Four hundred forty one printed publications and 10,627 downloaded publications were distributed via the Publications Store from 7/1/07 through 6/18/08. Making publications available online saved more than $15,000 in postage costs.

Information and Outreach Activities

The UW-Madison Water Resources Institute Web site (*www.wri.wisc.edu*) was rebuilt from ground(water) up to make it easier and faster for visitors to find information about WRI research projects and publications. Construction of the new site was a yearlong team effort led by James Hurley, assistant director for research & outreach, and his assistant Liz Albertson, a recent graduate from the UW-Madison Water Resources Management program. One of the goals of the Web site redesign was to provide the public with a real-time link to information about current research. To that end, the site was integrated with the UW Aquatic Sciences Center's interactive Project Reporting Online (iPRO) system, an online tool that allows principal investigators to report on the progress of their projects. The new site features a fresh design with better readability and vivid photography. The redesigned WRI Web site went online February 15, 2008, and through June 24 it had logged 16,548 page views and 2,588 unique visitors. The month of March was the most active with 4,622 page views and 680 visitors.

Regional Climate Change Seminar Series

The WRI helped support "Climate Change in the Great Lakes Region: Starting a Public Discussion," a seminar series sponsored by the UW Sea Grant Institute and Wisconsin Coastal Management Program. From March through September 2007, eight climate-effects experts spoke at seven sites around Wisconsin to discuss what is known, what is predicted and what can be done to adapt to a changing climate. The series began with a keynote presentation by Dr. Kevin Trenberth, a leading climate researcher from the National Center for Atmospheric Research and one of the authors of the 2007 report of the Intergovernmental Panel on Climate Change. Subsequent talks highlighted how climate change could affect public health, lakes and other water resources, fisheries, Great Lakes water levels and coastal infrastructure. To continue and expand public discussion of what climate change means for the Great Lakes region, a written summary and video of each seminar PowerPoint® presentation can be downloaded free of charge from the "The Seminars" section of the project Web site (*www.seagrant.wisc.edu/ ClimateChange/*). An 80-page summary report and a DVD featuring all eight seminars are available from the UW Aquatic Science Center's online Publications Store (*aqua.wisc.edu/publications/*).

Groundwater Awareness Week

A series of five press releases for the March 2008 "Groundwater Awareness Week" were distributed via the UW-Madison WRI's statewide media mailing list and the UW-Extension

network. Phone calls from media looking for more information indicate at least some of the information made it into several Wisconsin newspapers and on radio and television. The WRI also arranged for Stephen Ales, drinking and groundwater team supervisor for the Wisconsin Department of Natural Resources, and Dr. Henry Anderson, chief medical officer for the Wisconsin Department of Health Services, to be guests on the March 12 broadcast of Wisconsin Public Radio's popular "Larry Meiller Show," a 45-minute live call-in talk show. Aired on WPR stations statewide, the program attracted a dozen callers from throughout the state, mainly with questions related to well water contaminants and testing issues. Program producers said the number of calls indicated strong enough statewide interest in the topic to merit additional shows on groundwater topics in the future. This was reinforced by the strong follow-up interest in this topic as evidenced by more than 200 downloads of streaming audio from the show that has been logged on the WPR Web site since the broadcast.

AWRA Annual Conference

The WRI once again cosponsored the American Water Resources Association-Wisconsin Section's annual conference, "Great Waters of Wisconsin," held March 6-7, 2008, in Brookfield, Wis. Other sponsors included the UW-Stevens Point Center for Watershed Science & Education, Wisconsin Department of Natural Resources and U.S. Geological Survey-Wisconsin District. About 150 water managers and scientists from throughout Wisconsin attended the conference, which featured more than 50 oral and poster presentations on a wide range of water resources topics. Plenary session topics included national-state water policies, surface water-groundwater interactions, hydrogeologic investigations, lake management, groundwater management areas, organic and microbiological contaminants, water resources planning and management, and stormwater, streams and runoff. This year's event also included a free post-conference career workshop for students.

UW System Publications Resulting from Groundwater Research & Monitoring Program Projects

WRI Reports—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, Wis. 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.

WRI Reports—2007

Anderson, Mary P., and Christopher S. Lowry, 2007. Transient Functioning of a Groundwater Wetland Complex, Allequash Basin. Wisconsin, Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 16 p.

Anderson, Mary P., Haijiang Zhang, and Chris Muffels. 2007. Application of LSQR to Calibration of a Regional MODFLOW model: Trout Lake Basin. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 16 p.

Bravo, Hector. 2007. Climate Signals in Groundwater and Surface Water System: Spectral Analysis of Hydrologic Processes. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 13 p.

Lowery, Birl, and John Norman. 2007. Measuring and Modeling Macroporous Soil Water and Solute Flux below the Root Zone of a Plano Silt-Loam Soil. Water Resources Institute, University of Wisconsin, Madison, Wisconsin, 12 p.

McMahon, Katherine D., and Erin E. Seyfried. 2007. Evaluation of On-site Wastewater Treatment as a Source of Antibiotic Resistance Genes in Groundwater. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 15 p.

Shafer, Martin M.; Joel T. Overdier and Sara C. Kerr. 2007. Arsenic Species (III, V) Distribution in Wisconsin Groundwaters: Field Measurements and Pediction Using Multivariant Analysis of Geochemical Data. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 21 p.

Swanson, Susan K.; Kenneth R. Bradbury and David J. Hart. 2007. Assessing the Ecological Status and Vulnerability of Springs in Wisconsin. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 40 p.

Theses

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

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

Namdar-Ghanbari, R. 2007. Climate signals in groundwater and surface water system: spectral analysis of hydrologic processes. Ph.D. dissertation. College of Engineering and Applied Science, University of Wisconsin-Milwaukee. 202p

Other Publications

Creswell, J.; C. Babiarz, M. Shafer, E. Roden and D. Armstrong. (In Press). Temporal and spatial distribution of total mercury and methylmercury in hyporheic sediments of the Allequash Creek wetland. *J. Geophys. Res.–Biogeosci.*

Gu, C.; K.G. Karthikeyan, S.D. Sibley and J.A. Pedersen. 2007. Complexation of the antibiotic tetracycline with humic acid. *Chemosphere* 66:1494-1501.

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):286-96.

Lowry, C.S., and M.P. Anderson. 2006. An assessment of aquifer storage recovery using groundwater flow models. *Ground Water* 4:661–67.

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, Colo.

Muffels, C.; M. Tonkin, H. Zhang, M. Anderson and T. Clemo. 2006. Application of LSQR to Calibration of a MODFLOW Model: A Synthetic Study. In: *Managing Groundwater Systems.* International Ground Water Modeling Center, Colorado School of Mines Golden, Colo. Pages 283-87.

Pedersen, J.A.; K.G. Karthikeyan, H.M. Bialk. (in press). Sorption of human and veterinary antibiotics to soils. In: *Natural Organic Matter and Its Significance in the Environment*, F. Wu and B. Xing, eds.; Science Press, Beijing, China.

Sibley, S.D., and J.A. Pedersen. 2008. Interaction of the macrolide antimicrobial clarithromycin with dissolved humic acid. *Environmental Science & Technology* 42:422-28.

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. More information can be found online at *http://www.uwsp.edu/cnr/watersheds/*.

Drinking Water Programs. In 2007, the Center assisted over 3,400 households in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and Environmental Analysis Laboratory. Of these, 16% exceeded drinking water standards for nitrate-nitrogen. Seventeen percent of samples were unsafe because of coliform bacteria. Fourteen Drinking Water Education Programs helped nearly 1,500 well users in 10 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 522,483 individual test results for approximately 67,753 samples covering the state; including 21 counties with 100 to 500 samples and 31 counties with 500 or more samples. 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. Reports that summarize county-wide results have been generated for Iowa, St. Croix and Dodge Counties.

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 Task Force.

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, UW-Extension County Faculty and Basin Educators, Groundwater Guardian groups, and many local watershed based groups.

Ongoing Research

- Knowledge Development for groundwater withdrawal management around the Little Plover River, Wisconsin
- A Survey of Baseflow in the Fox-Wolf Watershed
- Understanding the effects of groundwater pumping on lake levels and streamflows in central Wisconsin
- Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer

Recent Publications and Reports

Kraft, G.J., B.A. Browne, W.D. DeVita, and D.J. Mechenich. 2008. Agricultural Pollutant Penetration and Steady-State in Thick Aquifers. Ground Water Journal 46(1):41-50.

Browne, B.A., G.J. Kraft, W.D. DeVita, and D.J. Mechenich. 2008. Collateral Geochemical Impacts of Agricultural N Enrichment from 1963 to 1985: A Southern Wisconsin Groundwater Depth Profile. J. of Env. Quality.

Lowery, B., G. J. Kraft, W. L. Bland, A.M. Weisenberger, and Phillip E. Speth. 2008. Trends in Groundwater Levels in Central Wisconsin. In Proceedings of Wisconsin's annual potato

meetings. University of Wisconsin - Madison College of Life Sciences and UW-Extension. Madison WI.

Lowery, B., W.L. Bland, G.J. Kraft, A.M. Weisenberger, M.L. Flores, and P.E. Speth. 2008. Local groundwater levels in Wisconsin. In Proceedings of the Wisconsin Fertilizer, Aglime & Pest Management Conference. University of Wisconsin - Madison College of Life Sciences and UW-Extension. Madison WI.

Masarik, K., D. Neuendorf, D. Mechenich. 2007. Dodge County Groundwater: A community resource. County Groundwater Report. Center for Watershed Science and Education, Stevens Point, WI.

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 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

Environmental Management Systems (EMS) on Wisconsin dairies. Also, through a grant from the North Central Region Sustainable Agriculture, Research and Education Program (NCR-SARE), Extension 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; Natural Resource Conservation Service; UW-Extension; Wisconsin DNR; the Basin Education Program and Discovery Farms, have contributed funding and time to this 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 has 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, program staff provided integrated pest management education and coordinated Wisconsin extension's WeedSoft development and delivery. WeedSoft is a computer program that helps growers make 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, UW-Madison, 445 Henry Mall, Room 202 Madison, WI 53706, 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 DHS 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 08.

- 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)

- Assessment of the potential of hormones from agricultural waste to contaminate groundwater. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene. (funded by GCC's Groundwater Research and Monitoring Program).

- 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).

- Development of a PCR method for Adenoviruses as a means of distinguishing human from bovine contamination. Sam Sibley, University of Wisconsin State Laboratory of Hygiene. (funded by the Groundwater Coordinating Council)

- Development and validation of Hollow Fiber Ultrafiltration for concentration and detection of multiple organisms for groundwater monitoring. Sam Sibley, Jeremy Olstadt, Sharon Kluender and Sharon C. Long, PhD, Wisconsin State Laboratory of Hygiene. (funded by the Wisconsin Department of Natural Resources State and Tribal Assistance Grant)

- Microbial source tracking tools for monitoring Wisconsin drinking water wells. Sharon C. Long, PhD and Jamie Stietz. Wisconsin State Laboratory of Hygiene. (funded by the Wisconsin Alumni Research Foundation)

One research project funded through the GCC's Groundwater Research and Monitoring Program was selected for funding in FY 09:

- Development and validation of a PCR-based quantification method for Rhodococcus coprophilus. Sharon C. Long, PhD, and Sharon Kluender. Wisconsin State Laboratory of Hygiene.

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-Wisconsin Water Science Center 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 Systems, UW-Extension (Wisconsin Geological and Natural History Survey and Center for Land Use Education), 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 USGS Federal programs. Recent and current projects that have a significant groundwater component are listed below.

Cooperatively funded projects with state and local agencies:

1. Operation and maintenance of the Wisconsin groundwater observation-well network; data collection, processing, archiving, and presentation.
2. Development of the Water Use in Wisconsin 5-year summary; data collection and estimation, development of use coefficients, compilation by aquifer, geographic, and political criteria.
3. Hydrologic investigation and groundwater-flow model development for southeastern Wisconsin; development of a Regional Water Supply Plan with SEWRPC.
4. Simulation of groundwater/surface-water systems in Pierce, St. Croix, and Polk Counties.
5. Simulation of groundwater/surface-water systems in the Rock River Basin of Wisconsin.
6. Evaluation of drinking water vulnerability and source and transport of potential contaminants in unconfined and confined aquifers.
7. Simulation of the effects of water diversion from Shell Lake, 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. Relation between ground-water flow and beach health (water quality) at Horseshoe Bay in Door County (USGS funded)
3. Hydrologic and biogeochemical budgets in temperate lakes and their watersheds, northern Wisconsin (USGS funded) http://infotrek.er.usgs.gov/doc/webb/index.html.

4. Western Lake Michigan Drainages National Water-Quality Assessment (USGS funded) http://wi.water.usgs.gov/nawqa/index.html.
5. Spatial and temporal shallow groundwater recharge rates in Wisconsin (USGS funded).

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 *(*http://wi.water.usgs.gov/gwcomp/index.html*)*. Comprehensive plans that adequately address the range of ground-water issues 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 for 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. Since its official launch in March of 2008 the website is averaging nearly 800 successful requests for information per day, and over 150 successful requests for pages per day; 950 different individuals or organizations have visited the site. 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. Long term hosting and maintenance of the site is undetermined. 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.

Compilation of Wisconsin 2005 Water-Use Data
Every 5 years the USGS Wisconsin Water Science Center is responsible for presenting data collected and/or estimated for water diversions and withdrawals to the USGS National Water-Use Information Program. A report, detailing water use in Wisconsin, is published using the data collected for this program. This program serves many purposes such as quantifying how much, where, and for what purpose water is used, tracking and documenting water-use trends and changes, and facilitating cooperation with other agencies on hydrologic projects. The Water-Use Information Program is evolving from being a data-collection and database management program to a water-use science program, emphasizing applied research and development of techniques for statistical estimation of water use, as well as analysis of water using behaviors (National Research Council, 2002). The USGS Wisconsin Water Science Center will continue to develop new and strengthen existing partnerships to broaden the understanding of water use in Wisconsin.

In 2008, the number of investigations that the USGS Wisconsin Water Science Center was involved with that incorporated a water-use component had risen to ten. The majority of these investigations sought to integrate water-use data into hydrologic models that evaluate the impact of water use on water budgets, ground-water-flow paths, and baseflow contribution to surface-water features.

The USGS Wisconsin Water Use 2005 report is in review and is expected to be released in late 2008. Additionally, information about this study along with summaries of data and information on Wisconsin water use can be found at the following web site: *http://wi.water.usgs.gov/wateruse/*.

National Research Council, (edited by R. Bitterli) 2002, Estimating water use in the United States; A new paradigm for the national water-use information program: Washington D.C., National Research Press, 176p.

US Geological Survey, 2008, Water for America Initiative, accessed February 7, 2008 at http://water.usgs.gov/wsi/

Evaluating land use and climate change effects on a southern Wisconsin trout stream: Results of the Black Earth Creek modeling study

A well-known trout stream and Outstanding and Exceptional Resource Water – the Black Earth Creek (BEC) watershed in northwest Dane County – is undergoing land use conversions from agricultural to residential and commercial. Currently the long-term impacts of urbanization on the base flow and stormflow (flood peaks) is not well characterized. Urbanization may increase both stormflow (Steuer and Hunt, 2001) and non-point source loads of nutrients, pesticides, and sediments. Because increased surface flows divert water that would normally recharge to the ground-water system; urbanization can result in less ground water being discharged as base flow to streams. By understanding the interactions between surface water and ground-water systems, the effectiveness of water management alternatives used to mitigate the effects of urbanization can be evaluated. A coupled ground-water/surface-water computer model of the basin has been constructed using the newly developed USGS code GSFLOW (Markstrom et al. 2008). This approach includes all elements of the hydrologic cycle including rainfall, snowmelt, evapotranspiration, interflow, streamflow, baseflow, and ground-water flow resulting in a quantitative characterization of the entire hydrologic system.

There have been three phases of recent study of the Black Earth Creek watershed cooperatively funded by communities in the watershed, WDNR, and USGS. The first phase of the project involved modeling surface and groundwater flow using existing data for the area. Results of the modeling effort provided direction for additional fieldwork needed to enhance the model in Phase 2 of the study. In Phase 3 the model was used to assess the effects of climate change and possible land-use development scenarios and mitigation strategies.

Rock River Basin Ground-Water-Flow model

A study of the shallow ground-water-flow system in the Rock River Basin was undertaken in 2007 and 2008 by the U.S. Geological Survey in cooperation with the Rock River Coalition. The primary objectives of the study are to improve understanding of the hydrogeology of the Rock River Basin, evaluate ground-water/surface-water interaction and base flow contribution to the Rock River and its tributaries, estimate amounts and rates of ground-water flow, and highlight areas that would benefit from additional data collection. These objectives are being achieved through the development of a numerical screening model to simulate the ground-water-flow system of the basin. The screening model describes the regional characteristics of the ground-water-flow system, and is a tool that can be used to test alternative plans to manage the resource (for example, effects of pumping well locations and rates on stream base flows). Additionally, the screening model provides a framework from which local or site-specific models can be developed with little additional data collection.

Development and use of the USGS Coupled surface-water ground-water model code at the Northern Wisconsin Long Term Ecological Research site

Simulations of climate-change effects on ground-water systems have often been simplified, using estimates to characterize changes in the hydrologic cycle. The recently developed USGS ground-water/surface-water code, GSFLOW (Markstrom et al., 2008), combines two widely used models: PRMS and MODFLOW. Using this approach, the effect of projected rainfall and

temperature changes, due to climate change, on stream flow and groundwater recharge can be predicted.

Two relatively simple climate scenarios were examined using a GSFLOW model of the USGS Trout Lake Water, Energy and Biogeochemical Budgets (WEBB) study site in northern Wisconsin, USA (Hunt et al. 2008). The first evaluated a uniform 4.4^{o} C increase in air temperature that represented one projected year 2100 condition. The second evaluated the same uniform increase in air temperature, but added the effects of extreme precipitation events by combining weekly precipitation into a single day in each week (changing precipitation timing, but not total annual amounts). Expected decreases in lake stage and stream flow were observed; more interestingly, results suggested that climate change may result in changes in the sources of water to ecosystems, as illustrated by a rain-dominated soft-water lake changing to a ground-water influenced flow-through lake. Inclusion of extreme precipitation events was somewhat mitigated when combined with the increase in temperature because the soil zone had more storage available. The effect on the biotic system was evaluated using simulated changes in hydrograph shape metrics. Both climate scenarios resulted in decreases in expected macroinvertebrate abundance and richness, with the lowest expected quality at a stream site that periodically went dry during the simulations. Even though the simulations could be improved with more sophisticated climate processes and scenarios, these results demonstrate a potential utility for GSFLOW modeling for today's resource management actions.

References Cited:

Hunt, R.J., Walker, J.F., and Doherty, J., 2008, Using GSFLOW to simulate climate change in a northern temperate climate, p. 109-113 in *MODFLOW and More 2008: Ground water and public policy, Proceedings of the 9th International Conference of the International Ground Water Modeling Center.* Golden, CO: Colorado School of Mines.

Markstrom, S.L., R.G. Niswonger, R.S. Regan, D.E. Prudic, and P.M. Barlow. 2008. GSFLOW—Coupled ground-water and surface water flow model based on the integration of the Precipitation-Runoff Modeling System (PRMS) and the Modular Ground-Water Flow model (MODFLOW-2005). USGS Techniques and Methods 6-D1. Reston, Virginia: USGS.

Steuer, J.J., and Hunt, R.J., 2001, Use of a Watershed-Modeling Approach to Assess Hydrologic Effects of Urbanization, North Fork Pheasant Branch Basin near Middleton, Wisconsin. USGS Water-Resources Investigations Report 01-4113. 49 p.

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),* pfjuckem@usgs.gov, *Cheryl Buchwald (608-821-3873),* cabuchwa@usgs.gov*, 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 works with private landowners to promote conservation of natural resources. In Federal fiscal year 2007 (Oct. 1, 2006 to Sept. 30, 2007), NRCS planned over 552,000 acres of conservation systems and implemented conservation practices on over 504,000 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. In 2007, 1236 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 implemented on 73 farms and plans developed for 211.
- *Animal waste storage*: Proper waste storage siting and design is imperative to protect groundwater from contamination by animal waste. Last year 71 animal manure storage structures were planned and 22 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 206 farms, and 179 completed.
- *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 25,000 acres. Prescribed grazing was applied to 19,500 acres.
- *Wetland Reserve Program*: Restores wetlands through permanent or 30-year easements or 10-year contracts. The total number of acres enrolled in WRP is approximately 47,000.
- *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 2007 a total of 1,100 contracts for $17.36 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 71 well decommissionings, and completed 20.
- *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*: CSP is 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 from six watersheds in the three years that CSP has been offered. No signup was held in 2007. In 2006, 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 with its 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. Recommended approaches to the issues presented in this chapter 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. The primary contaminants in groundwater 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. Long term exposure to some VOCs may cause cancer. Sources of VOCs in Wisconsin's groundwater include landfills, underground storage tanks (USTs), and hazardous substance spills.

Thousands of wells have been sampled for VOC analysis. Fifty-nine different VOCs have been found in Wisconsin groundwater, though only 34 of those have health based 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.

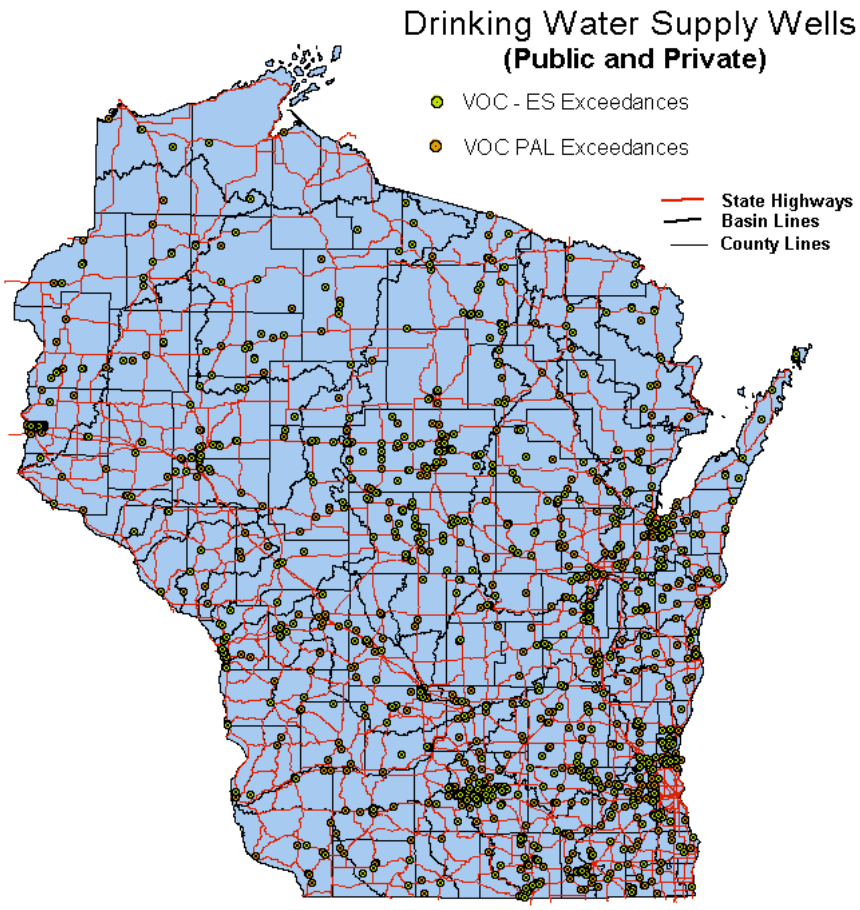

Figure 4.1 Volatile Organic Compounds (VOCs) past enforcement standard (ES) and preventive action limit (PAL) exceedances for public and private drinking water supply wells. Source DNR

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 DHS 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 DHS, 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 180,946 USTs of which over 81,226 are federally regulated and only about 12,406 tanks are in use. A federally regulated tank is any tank, excluding exempt tanks that is over 1,100 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.

References cited:

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

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 Atrazine and its metabolites.

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. 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. ATCP 30, 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.

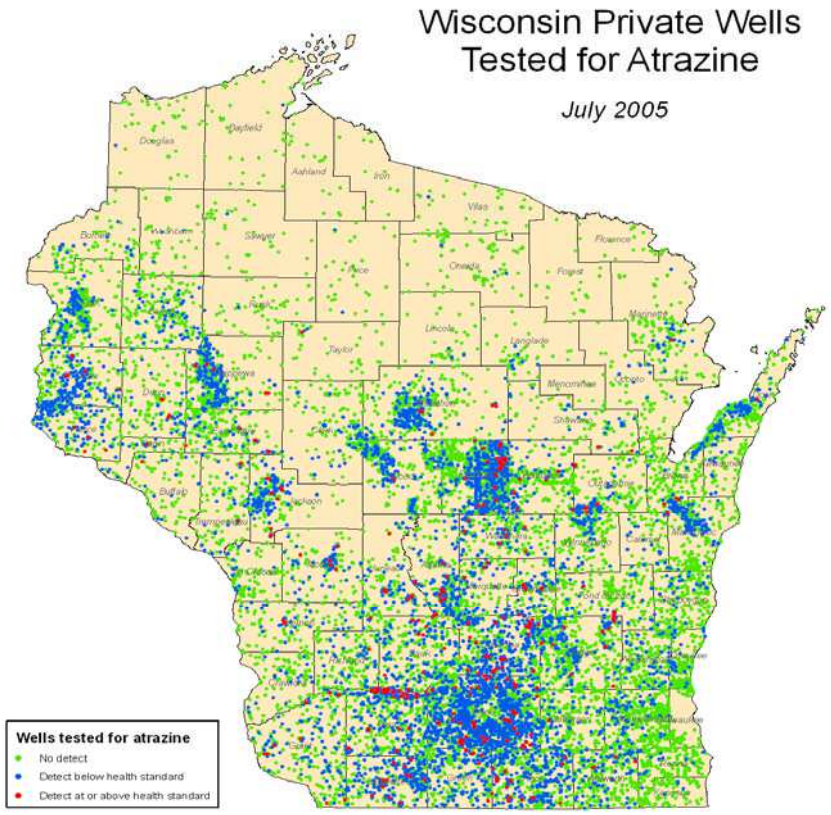

Figure 4.2 Private wells tested for atrazine in Wisconsin as of July 2005. Source: DATCP

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 - 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.

2000 Groundwater Survey - 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 an 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 2007, with samples collected from 150 different wells at least once during this time period. As of 2007, 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 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 2007 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, and metolachlor and its ESA and OA metabolites.

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.

2007 Survey of Agricultural Chemicals in Wisconsin Groundwater - In 2007 DATCP conducted a statewide statistically designed survey of agricultural chemicals in Wisconsin groundwater. Three hundred and ninety-eight private drinking water wells were sampled as part of this survey. The purpose of the survey was to obtain a current picture of agricultural chemicals in groundwater, relate findings to land use, and compare results to previous surveys conducted in 1994, 1996, and 2001. Based on the statistical analysis, it was estimated that the proportion of wells in Wisconsin that contained a pesticide or pesticide metabolite was 33.5%. Areas of the state with a higher intensity of agriculture generally had higher frequencies of detections of pesticides and nitrate. The two most commonly-detected pesticide compounds were the herbicide metabolites metolachlor ESA and alachlor ESA which each had a proportion estimate of 21.6%.

References cited:

DATCP, 2008. Groundwater Quality: Agricultural Chemicals in Wisconsin Groundwater. Wisconsin Department of Agriculture, Trade and Consumer Protection, Water Quality Section, ARMPUB180.qxd. 22 p. Copies of this survey, as well as summaries of other DATCP monitoring projects are available at.*http://datcp.state.wi.us/arm/agriculture/land-water/environ_quality/monit_proj.jsp*

Hayes, T; K, Hason; M. Tsui; A, Hoang; C. Haeffele; and A. Vonk. 2002 Feminization of male frogs in the wild. *Nature*, 419:895-896.

Hayes, T; K, Hason; M. Tsui; A, Hoang; C. Haeffele; and A. Vonk. 2003 Atrazine-Induced Hermaphroditism at 0.1 PPB in American Leopard Frogs (*Rana pipiens*): Laboratory and Field Evidence. *Environmental Health Perspectives* 111:111:568-575.

Nitrate

Based on data collected by the Wisconsin Departments of Natural Resources and Agriculture, Trade and Consumer Protection and UW-Extension's Central Wisconsin Groundwater Center, nitrate is currently our most widespread groundwater contaminant. Nitrate contamination 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 such as fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris.

Approximately 80% of nitrate inputs into our groundwater originate from manure spreading, agricultural fertilizers, and legume cropping systems (Shaw, 1994). Nitrate contaminated wells are more prevalent in agricultural districts. Studies have repeatedly shown that agricultural counties in southern and west-central Wisconsin have a higher percentage of nitrate-contaminated water supplies.

A 2007 random survey of private wells conducted by DATCP estimated that 9% of wells statewide exceeded the Nitrate Enforcement Standard of 10 mg/L. The highest percent of wells exceeding the ES occurs in highly cultivated areas (largely in south-central counties) where an estimated 21% of the wells had unsafe nitrate levels.

In 2005 and 2007, DNR aggregated and analyzed data from three groundwater databases: 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). The dataset included only the most recent nitrate sample analytical result for each private well sampled. Out of the 48,818 samples, 5,686 (11.6 %) equaled or exceeded the ES of 10 mg/L. As seen in ***Figure 4.3***, the percent of wells exceeding the ES varied across the state. Calumet, Columbia, Dane, La Crosse and Rock counties all showed the highest percent exceedances with 20% to 30% of the samples from private wells exceeding the 10 mg/L ES.

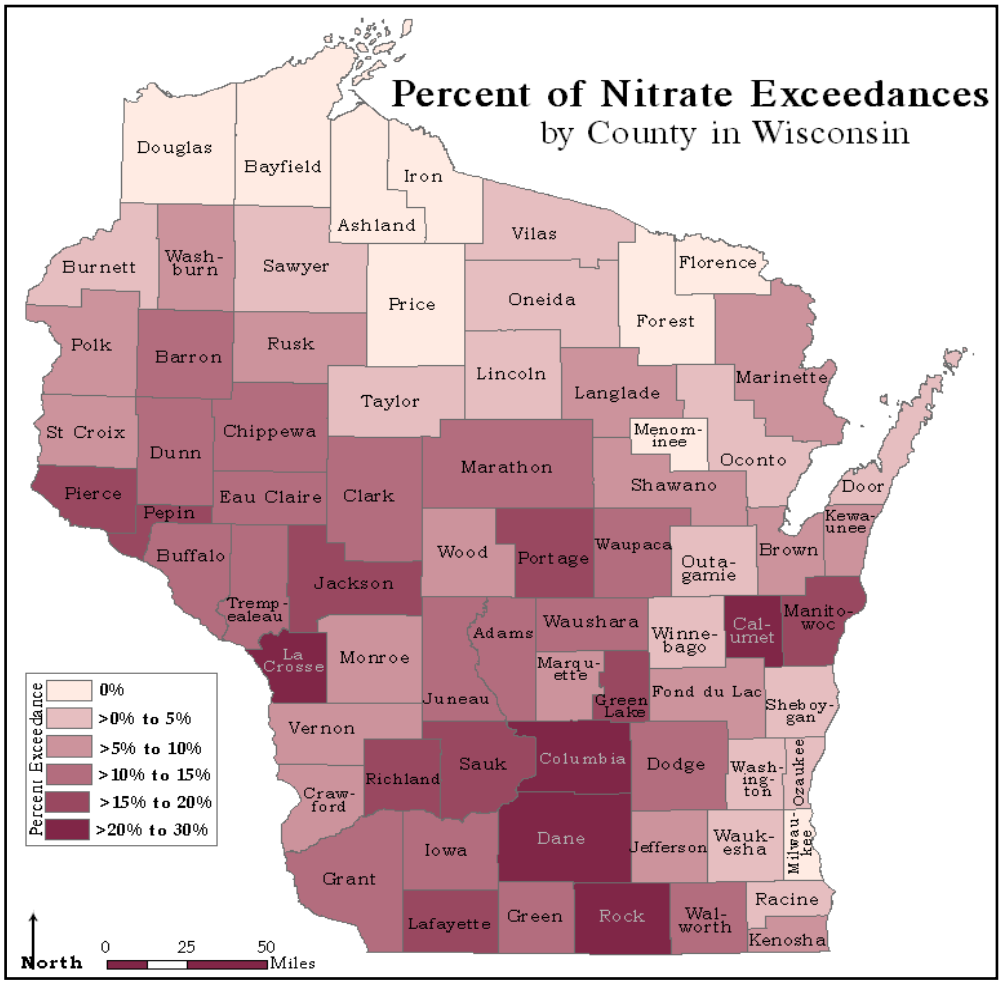

Figure 4.3 - Percentage of nitrate samples from private wells exceeding 10mg/L by county. Date sources: DNR, Center for Watershed Science and Education, and DATCP groundwater databases.

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 DHS has investigated several cases of suspected blue-baby syndrome and associated at least three with nitrate contaminated drinking water. Non-fatal cases were reported in Trempealeau County (June, 1992), 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).

Once 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 treat drinking water to the federal drinking water standard of 10 mg/L. 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 advised for privately owned wells that supply drinking water; however, the individual owners carry the responsibility of making sure their wells are tested. The DNR and Department of Health Services recommends that new private wells be tested for nitrate and at least every five years during their use. Testing is strongly recommended for wells used by pregnant women and infants less than 6 months of age. Owners of nitrate-contaminated private wells do not qualify for well-compensation funding unless the nitrate level in their well exceeds 40 mg/L and the water is used for livestock. 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 use bottled water. A study published by DHS 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.

References cited:

Knobeloch L, Salna B, Hogan A, Postle J, Anderson H. 2000. Blue babies and nitrate contaminated well water. Environ Health Perspectives 108(7): pgs.675-678.

Moltchanova E, Rytkonen M, Kousa A, Taskinen O, Tuomilehto J, Karvonen M. 2004. Zinc and nitrate in the ground water and the incidence of Type 1 diabetes in Finland. Diabetic Medicine 21: pgs.256-261.

Parslow RC, McKinney PA, Law GR, Staines A, Williams R, Bodansky HJ. 1997. Incidence of childhood diabetes mellitus in Yorkshire, northern England, is associated with nitrate in drinking water: an ecological analysis. Diabetologia 40(5): pgs.550-556.

Schubert C, Knobeloch L, Kanarek MS, Anderson HA. 1999. Public response to elevated nitrate in drinking water wells in Wisconsin. Arch Environ Health 54(4): pgs.242-247.

Shaw B, 1994. Nitrogen Contamination Sources: A Look at Relative Contributions in Conference Proceedings – Nitrate in Wisconsin's Groundwater: Strategies and Challenges: p.23.

Ward MH, Mark SD, Cantor KP, Weisenburger DD, Correa-Villasenor A, and Zahm SH. 1996. Drinking water nitrate and the risk of non-Hodgkin's lymphoma. Epidemiol 7(5): pgs.465-471.

Weyer PJ, Cerhan JR, Kross BC, Hallberb GR, Kantamneni J, Breuer G, Jones MP, Zheng W, Lynch CF. 2001. Municipal drinking water nitrate level and cancer risk in older women: The Iowa Women's Health Study. Epidemiology 11(3): pgs.327-338.

Xu G, Song P, Reed PI. 1992. The relationship between gastric mucosal changes and nitrate intake via drinking water in a high-risk population for gastric cancer in Moping county, China. Eur J Cancer Prev 1(6): pgs.437-443.

Yang CY, Cheng MF, Tsai SS, Hsieh YL. 1998. Calcium, magnesium, and nitrate in drinking water and gastric cancer mortality. Jpn J Cancer Res 89(2): pgs.124-130.

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). Forty percent 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 outbreaks at two Door County restaurants in December 2004 and May 2007. In the case of the May 2007 outbreak, contamination by both coliform and *E. Coli* occurred after the restaurant started operating.

Researchers at the Marshfield Clinic Research Foundation have investigated the association between pathogenic viruses and bacteria in private wells with incidences of infectious diarrhea as indicators of well water contamination (Borchardt et al. 2003b). In general, infectious diarrhea did not correlate with drinking from private wells or drinking from wells that had positive sample analytical results for total coliform. However, wells which tested positive for enterococci were

associated with children having diarrhea of unknown etiology likely caused by Norwalk-like viruses. A subsequent study of 50 private wells throughout the state indicates that 8% of private wells may be subject to virus contamination (Borchardt et al. 2003a). Wells positive for viruses did not show seasonal trends 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 above described private well study, there was no correlation 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.

Public and private water samples are not regularly analyzed for viruses. Viral testing is expensive and very few labs are capable of conducting the test. The presence of coliform bacteria has historically been used to indicate the water supply is not safe for human consumption. However, virus data complicates this interpretation since the presence of coliform and viruses do not always match. Water samples from private residences in Door County found low levels of some viruses but water samples did not contain coliform (Wisconsin DNR). Additional study is needed to determine what virus results mean to human health.

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) promulgated the Groundwater Rule, on November 8, 2006 which modified Safe Drinking Water Act requirements to increase monitoring for fecal contamination in groundwater and reduce the occurrence of illness from drinking water borne microbial pathogens. The Groundwater Rule includes preventative strategies that prior EPA drinking water legislation did not adequately address. Implementation of the requirements of Groundwater Rule will begin on December 1, 2009.

The first strategy includes sanitary surveys of public systems to identify deficiencies. The second strategy is source water monitoring. Currently, the Safe Drinking Water Act focuses on sampling for microbial indicators in the distribution system. Third, the law requires 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 forth strategy of the law is monitoring requirements to ensure that treatment equipment is maintained.

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

References cited:

Borchardt, M. A., P. D. Bertz, S. K. Spencer, and D. A. Battigelli. 2003a. Incidence of enteric viruses in groundwater from household wells in Wisconsin. Applied and Environmental Microbiology, 2003, Vol 69, Iss 2, pp 1172-1180.

Borchardt, M. A., P. H. Chyou, E. O. DeVries, E. A. Belongia. 2003b. Septic system density and infectious diarrhea in a defined population of children. Environmental Health Perspectives, 2003, Vol 111, Iss 5, pp 742-748

Borchardt MA, Haas NL, Hunt RJ. 2004. Vulnerability of municipal wells in La Crosse, Wisconsin, to enteric virus contamination from surface water contributions. *Applied and Environmental Microbiology* Vol 70: 5937-5946.

Braatz, L., 2004. A study of fecal indicators and other factors impacting water quality in private wells in Door County, Wisconsin. Master of Science thesis submitted to Univeristy of Wisconsin-Green Bay, December 2004. 124 p.

Hunt, R., and M. Borchardt. 2003. Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions. Final report submitted to Wisconsin Department of Natural Resources, June 23, 2003.

Hunt, R.J., T.B. Coplen, N.L. Haas, D.A. Saad, and M.A. Borchardt. 2005. Investigating surface water–well interaction using stable isotope ratios of water, Journal of Hydrology vol 302 (1-4):154-172.

Lee SH, Levy DA, Craun GF, Beach MJ, Calderon RL. 2002, Surveillance for waterborne-disease outbreaks--United States, 1999-2000. MMWR Surveill Summ 2002;51:1-47.

Peterson, H. G., 2001. Rural Drinking Water and Waterborne Illness. Safe Drinking Water Foundation, Saskatoon, SK, p. 162-191.

Warzecha, C., R. Gerhardt, and S. Kluender. 1995. Wisconsin private well water quality survey. Wisconsin Department of Health and Social Services, Department of Natural Resources, and State Laboratory of Hygiene. Unpublished report.

Wisconsin DNR, 2004. Unpublished Door County Files, Sturgeon Bay office.

Arsenic

Naturally-occurring arsenic was discovered in Wisconsin's groundwater in 1989 during a routine investigation conducted by the DNR. Investigations done in the early 1990s found that approximately 4% of the private wells located in Winnebago and Outagamie Counties had arsenic levels that exceeded 50 µg/L which was the federal drinking water standard at that time. The most seriously contaminated water supply had an arsenic level of 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 which was the primary source of the arsenic. Increasing the casing length was successful in bringing arsenic concentrations below 50 µg/L in about 85% of the wells studied. Over the years the department has continued to work with drillers to improve well drilling and construction techniques to minimize arsenic levels in potable wells.

Arsenic is released from aquifer materials by several mechanisms. The primary mechanism in NE Wisconsin is breakdown of sulfide minerals when groundwater is drawn down and the rock is exposed to air, or air is introduced to the rock formations during well drilling. When this happens, other metals present as sulfide minerals can also be released and may increase health risks. These metals include nickel, cobalt, cadmium, chromium, lead and iron. In SE Wisconsin and along glacial moraines in Northern Wisconsin, arsenic is bound to iron oxides in the aquifer material and is released under reducing conditions.

With a new federal standard for arsenic on the horizon, the department coordinated with DHS and local health departments to sample private wells in several towns in Outagamie and Winnebago Counties. Nearly 4,000 wells were sampled between 2000 and 2002. Test results, which were delivered to homeowners at a series of public meetings, indicated that approximately 20% of the wells had concentrations over the proposed standard of 10 µg/L (the same as the earlier sampling). In some areas, over 40% of the wells exceeded 10 µg/L. A high density development in the Town of Algoma became 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. To avoid creating a 'hodge-podge' of small SWCDAs scattered over a two-county region, DNR decided to seek a more comprehensive regional approach. Based on the success of the SWCDA and the large number of wells involved, the DNR expanded the SWCDAs to include all of Winnebago County and Outagamie County. Information on the specifics of the SWCDAs requirements can be found online under special casing areas. (See more under interagency coordination).

Understanding the occurrence of arsenic in Wisconsin's groundwater has been a good example of interagency cooperation. Initial work with DHS 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.

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
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, DHS, Commerce and others continue to work on arsenic problems around the state. Arsenic has been found in groundwater in every county in the state. DHS has conducted two separate studies on the health effects of arsenic on Wisconsin citizens. In addition there are 2 known cases of confirmed arsenic poisoning from drinking water. (In both cases neurological damage was moderate to severe.) Ongoing efforts to address arsenic in groundwater include:

- Refinement of the geology in the Outagamie and Winnebago county area and updating casing requirements,
- DHS 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 school and community wells
- DHS, 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 DHS.
- DHS 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 study funded through the joint solicitation completed in 2007 involving researchers from WGNHS, DNR and West Virginia added new data to the geologic model for the SWCDA and refined 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. Historically, about 80 public water systems have exceeded a radionuclide drinking water standard. Over 50 public water systems exceeded both the drinking water standards of 15 pCi/L for gross alpha activity, and 5 pCi/L for combined radium, (**Figure 4.4**). The DNR is enforcing the radionuclide standard adopted into NR 809. The DNR has been working with these systems since 2003 to ensure that they develop a compliance strategy and take corrective actions. The vast majority of these systems are now serving water that meets the radium and gross alpha standards.

Drinking water monitoring completed since 2006 has shown a few more systems that have exceeded a radionuclide standard. Currently, there are less than 10 systems that are serving water that exceeds a radium or gross alpha standard. The DNR continues to work with these systems to gain compliance with the drinking water standards for radionuclides.

Previous studies have shown that radium concentrations in excess of 5 pCi/L cannot 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. High radium activity occurs in the Cambro-Ordovician in a band within the Maquoketa shale (Grundl, 2001). This band 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 within the Maquoketa shale that extends along the entire eastern portion of the state.

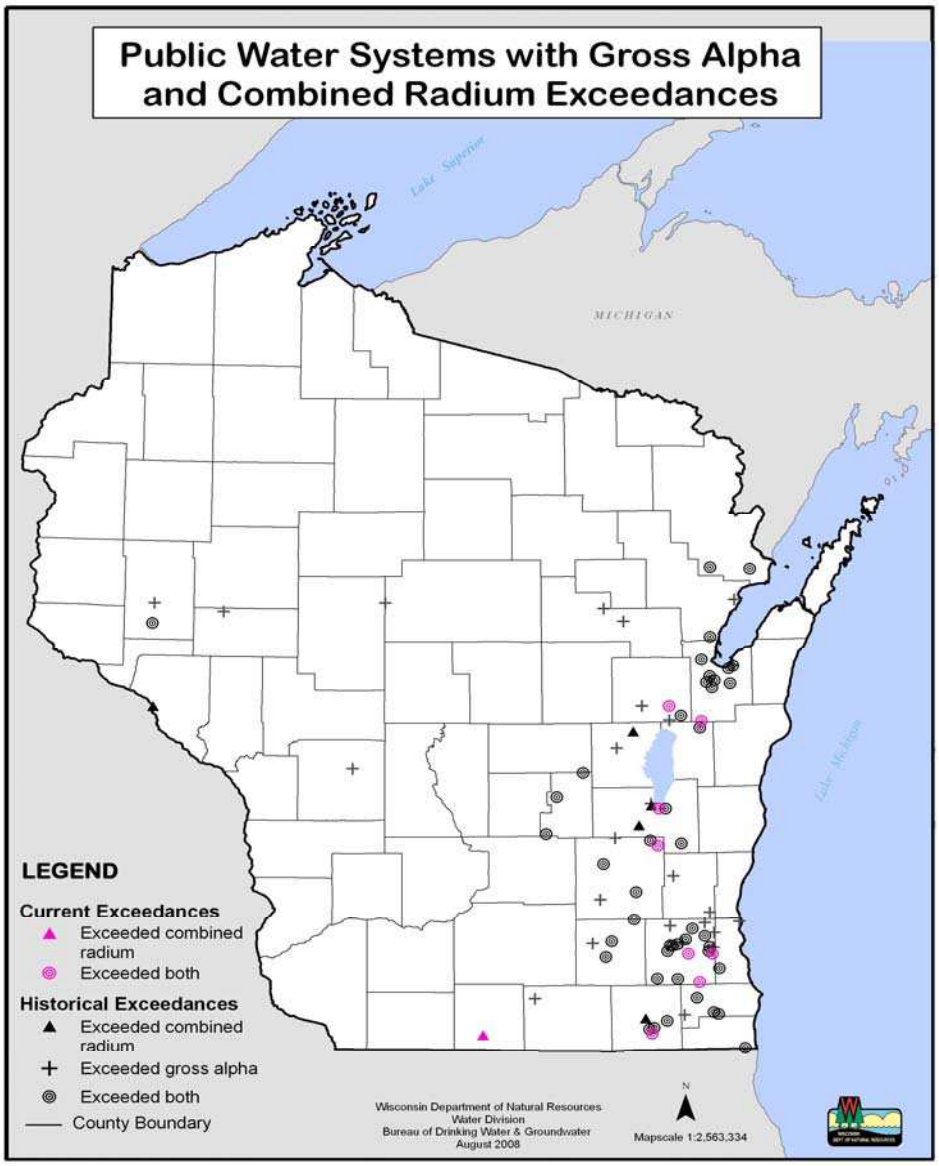

Figure 4.4 Public water systems that exceed radionuclide standards as of August 2008 or have exceeded radionuclide standards in the past. Source: DNR

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

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.

The same 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 2008, EPA has not finalized the drinking water standard for radon. The standard will likely be set at 3,000 pCi/L.

References cited:

Arndt, M. F., and L. West. 2004. A Study of the Factors Affecting the Gross Alpha Measurement, and a Radiochemical Analysis of some Groundwater Samples from the State of Wisconsin Exhibiting an Elevated Gross Alpha Activity. Final report submitted to the Wisconsin Department of Natural Resources, DNR Project Number 176.

Grundl, T. 2001. Maquoketa Shale as Radium Source for the Cambro-Ordovician Aquifer in Eastern Wisconsin. Final report submitted to the Wisconsin Department of Natural Resources, DNR Project Number 141.

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. Although Wisconsin's Groundwater Advisory Committee (GAC) and its technical advisory committees expended significant effort attempting to develop new public policy related to groundwater quantity during 2007, relatively little progress was made, and significant issues remain unaddressed

Water Use

As part of the National Water-Use Information Program, the U.S. Geological Survey (USGS) collects, compiles, and estimates data for different categories of water use. Information about sources of water, amounts of water withdrawn, and how the water was used, 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 in final preparation. Recent groundwater quantity legislation has stressed the value of collecting these data, and it is hoped that revenues from permit fees for new wells will enable the USGS and DNR to institute state-of-the-art techniques in water-use science and to dedicate staff time to this effort.

Groundwater use statewide in 2005 is estimated to be 986 million gallons per day (Mgal/d) (Buchwald, 2008). The estimate for 2005 is 380 Mgal/d greater than the estimate of groundwater use for 1979, and 146 Mgal/d greater than the estimate in the 2000 compilation. Total groundwater use in 2005 can be divided into public-supply water use (305 Mgal/d) and self-supplied water use (681 Mgal/d). Reporting of public-supply water use is required by the state, therefore, confidence is high in these water-use estimates. In 2005, none of the self-supplied water use categories were required to report use to the state, and as a result confidence is relatively less in these water-use estimates. Irrigation water use is the largest category of self-supplied use (387 Mgal/d), and the reported 2005 estimate is believed to be at the higher end of the range of possible irrigation water use. The methodology for estimating irrigation water use is expected to be refined in 2010 to better reflect the irrigation variables for each county such as crop type, soil type, topography, and climate.

Statewide Groundwater Level Network

Understanding groundwater quantity issues depends on data collected by Wisconsin's statewide groundwater level monitoring network, jointly operated by the Wisconsin Geological and Natural History Survey and the U.S. Geological Survey. This program collects baseline data on groundwater level fluctuations across the state. This network currently consists of 102 wells, and the data are publicly available on the internet: *http://wi.water.usgs.gov/public/gw/*.
Funding levels for this program have steadily declined since 1995. The current funding level is inadequate to maintain the existing network, as wells go out of service due to age, equipment failure, or ownership issues. In spite of major public and regulatory interest in groundwater quantity and groundwater management in the designated management areas there has been little financial support from the state for additional data collection. The criteria for designating Groundwater Management Areas's is based on the amount of drawdown caused by regional

pumping, yet Wisconsin currently has no funded program for measuring this drawdown In 2006, project managers at the USGS and WGNHS presented the DNR with a prioritized proposal and request for funding for enhancing the water-level network, but to date no funds have been made available.

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***) although water levels in the Green Bay area are currently recovering. In August of 2007, six suburban communities in the Lower Fox Valley reduced consumption of groundwater by about 8.2 million gallons per day by switching to surface water supplied by pipeline from Lake Michigan. As a result, water levels in the deep sandstone aquifer near Green Bay have begun to recover. In mid-2007 the WGNHS began an effort to monitor the water level recovery in the deep sandstone aquifer near Green Bay with the objective of documenting the recovery and improving our understanding of the deep hydrogeologic system in this region of the state. This monitoring has shown that the reduction of pumping has resulted in water levels rising more than 100 feet in some wells. Although the water levels are approaching a new stable level, a smaller additional rise is expected.

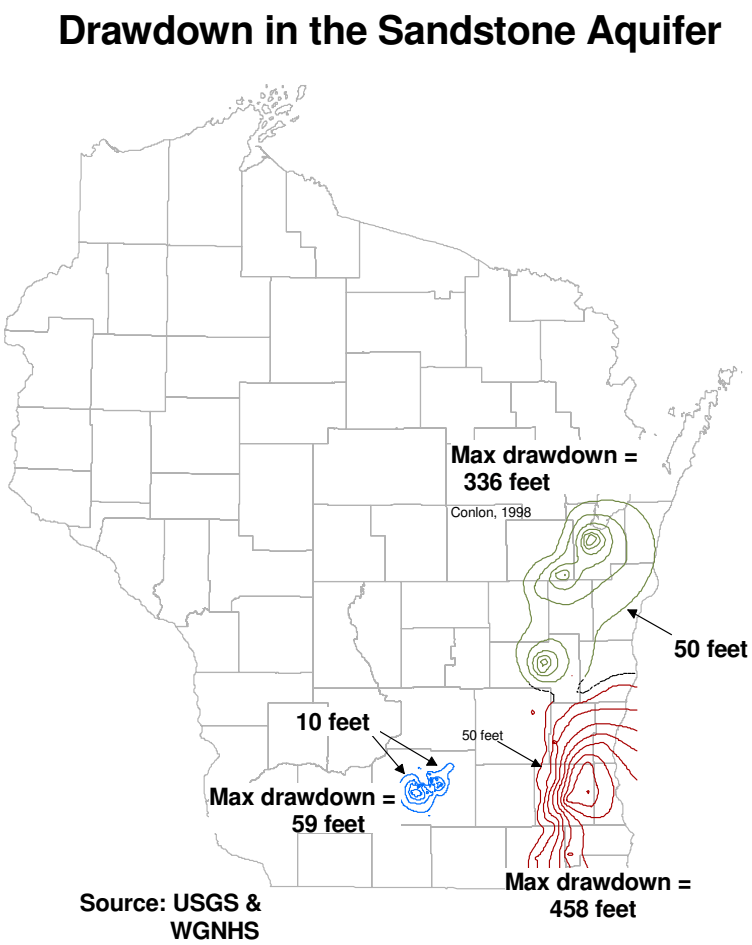

Figure 4.5 Simulated drawdown in the Sandstone Aquifer as of 1998-2000. Contour intervals represent levels of equal hydraulic head and are 50 feet in eastern Wisconsin and 10 feet in Dane County. Sources: USGS and WGNHS

A 2004 study by the University of Wisconsin Extension - Wisconsin Geological and Natural History Survey and the USGS shows that groundwater withdrawals throughout southeastern Wisconsin and Illinois have been substantial enough to slow and reverse groundwater flow in some areas (Feinstein et.al., 2004). Before the area was settled by Europeans', all the groundwater east of the deep groundwater divide in the Sandstone Aquifer flowed to the east under the southeastern Wisconsin coastline toward Lake Michigan. The Southeast Wisconsin Ground-Water-Flow Model simulates that the flow under the coast in the deep sandstone aquifer amounted to 2.84 mgd. Due to pumping in the Sandstone Aquifer, groundwater flows westward, toward municipal and irrigation wells in southeastern Wisconsin, at a simulated rate of 3.70 mgd.

Quantity and Quality

An example of how regional drawdown can bring about quality concerns is seen in Southeastern Wisconsin. 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. 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. The most available alternative source is the shallow aquifer. This is problematic because 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 such as nitrate and pesticides. Fortunately, several communities voluntarily went beyond what state law requires, to protect surface waters and other water users in siting their wells and managing their water use.

Another example 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 also highlight the importance of groundwater quantity. The cities of Oak Creek and Green Bay sought approval to use aquifer storage recovery (ASR) wells to address water shortages during peak demand periods. ASR is a water management tool that involves injecting treated municipal drinking water back into the aquifer during times of less water use and pumping this water back out when demand is high, typically during the summer. Both communities worked with DNR to conduct pilot studies to see if this practice is feasible in Wisconsin.

Pilot testing of ASR at Oak Creek demonstrated that the technique is possible; however, concentrations of manganese and iron have been found to increase with each successive cycle. DNR conditionally approved routine ASR operations as long as groundwater monitoring continued to show that concentrations of mobilized substances do not exceed state groundwater quality standards. Groundwater quality data submitted to the DNR in 2007 indicated that the concentrations of manganese and iron in the groundwater around the ASR well are now above state groundwater quality standards. The water utility is currently evaluating operational changes

that will bring the system back into compliance with the conditions set forth in the DNR's letter of approval which allows the utility to operate an ASR system.

In Green Bay it was determined that ASR, as pilot tested, will not be allowed because significant concentrations of arsenic and other contaminants were mobilized from the rock matrix of the aquifer during the demonstration test. The Green Bay Water Utility elected not to proceed with developing an ASR well after learning that the Central Brown County Water Authority would construct a pipeline and purchase drinking water from the Manitowoc Water Utility rather than buy additional drinking water from the Green Bay utility.

Great Lakes Compact

For some communities tapping Lakes Superior and Michigan is a potential solution to quantity problems. But, for other communities, there are barriers. 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 regional lead in protecting the Great Lakes. The Council signed a Great Lakes Charter in 1985. A key provision of the Charter limited large water withdrawals and diversions from metropolitan centers bordering the lakes 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 states and provinces have agreed to collectively manage water usage according to the shared goals expressed in this agreement. The agreement has been approved by the eight state Legislatures. Now Congress must approve it 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 proposed well would interfere with a municipal water supply well. With the promulgation of Act 310, the DNR's authority was expanded so that it could consider impacts to some springs, trout streams, and other high quality surface waters as part of the high capacity well approval process.

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, due to pumping

during drought periods. The river is located in an area with a large density of high capacity wells, including multiple municipal wells. Its situation may be indicative of conditions on other headwaters streams located in similar areas.

Awareness of extreme low flow conditions in the Little Plover began in 2003, when measurements revealed that flow in the stream was becoming low to the detriment of the ecosystem. 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 which 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 that 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 decline in lake levels in several small lakes in Central Wisconsin has illustrated that lakes, in addition to rivers and streams, may also be affected by groundwater pumping and should be considered in future groundwater management discussions.

2003 Act 310

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

- A very high percentage of lakes, streams, small springs, and wetlands are afforded little to no protection under Act 310.

- The adequacy of the 1200 foot buffer provided by GPAs to trout streams and exceptional and outstanding resource waters was not extensively analyzed and a protection scheme based on such and approach may not be sufficient to protect these resources from impacts due to pumping from high capacity wells.

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.

The legislative recommendations put forward by the GAC would 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. The GAC included comprehensive recommendations regarding future rule-making needed to implement the GMA concept. 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 likely be identified. The 2006 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.

As directed under Act 310, the GAC continued its work in FY08 and submitted another report to the Legislature at the end of 2007. That report focused 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.

Overall the GAC concluded Act 310 is working as originally intended and that the law is an effective first step in integrated water management. The 2007 report contains a consensus recommendation concerning the need for a comprehensive statewide water management plan or strategy. While this was not explicitly part of its charge for the year, the Committee determined that it was an important, long-term recommendation representing a critical element in a sound state water management policy.

The GAC reached unanimous positions on the definition of "adverse environmental impact" and the regulatory approach applied to wells with high water loss. The committee also reached consensus on a recommendation for a statewide groundwater management plan or strategy.

Much of the GAC's work in 2007 was related to evaluating the definition of "springs" and the adequacy of the existing groundwater protection area approach to protecting specified high quality surface waters. The GAC considered a number of approaches to revise the definition of "spring" and formulated a near-unanimous recommendation providing for deferral of a determination of the appropriate threshold spring flow (currently 1 cfs) until an updated comprehensive survey of springs is completed. The GAC was unable to reach consensus positions on these issues and subsequently developed two alternatives for the Legislature to consider in addressing the issues related to springs: 1) maintaining the existing definition and; 2) reducing the threshold flow requirement.

The GAC was unable to reach unanimous agreement on the merits of the existing regulatory review process applicable to high capacity wells within groundwater protection areas and the need for enhancement of the current regulatory framework. Committee members developed alternatives that range from maintaining the current structure and review process to suggesting that the system be completely restructured to eliminate the 1,200' groundwater protection area

and require hydrologic analysis of all high capacity well applications. Other alternatives suggest expansion of the scope of waters protected under the law and expanding the area of a groundwater protection area.

Many state groundwater experts believe that the existing regulatory review process used by the DNR to evaluate permits for new high capacity wells is inadequate and outmoded, and this was the subject of much debate within the GAC. Other states, notably Florida, Kansas, and Michigan, use sophisticated and well documented technical hydrogeologic review processes to determine the potential impacts of new high-capacity wells, including analyses of the combined impacts of several wells pumping simultaneously. State and university hydrogeologists indicated that such quantitative methods, including computer modeling, are currently the state of the practice in modern groundwater analyses. These methods can be data-intensive but are also systematic, transparent, unbiased, and reproducible. These hydrogeologists presented the committee with example "decision-tree" schemes that would apply hydrogeologic analysis to well-approval issues in an organized, systematic, and scientifically defensible way. The DNR responded that several of these quantitative techniques are currently used by DNR staff to evaluate the extent of impacts for proposed high capacity wells within groundwater protection areas. Under the existing regulatory framework, the department uses quantitative tools that it believes are appropriate for the given high capacity well application. Thus, a proposed high capacity well that is quite distant from a sensitive protected surface water resource receives little hydrogeologic scrutiny, whereas a proposed high capacity well of significant capacity that is close to a protected surface water undergoes much more complex quantitative analysis. DNR also contends that routinely requiring such analyses for all high capacity wells, regardless of their size and location, would be unnecessary, overly time-consuming and beyond the technical expertise of the applicant. Several state hydrogeologists, members of the GAC science and technical work group, disagreed with this view, and argued that by evaluating only one well at a time the present system can underestimate the combined impacts of multiple wells in the same area. These hydrogeologists also suggested that research projects carried out during the past two decades, many with funding from the Department, have gone a long way toward developing data, models, and techniques that can be used for modern regulatory decision making.

Both in 2006 and 2007, the GAC identified several issues of immediate need that would improve the ability of the state to implement Act 310. In its 2006 report, the Committee recommended enhancement of the statewide groundwater monitoring network and there was general agreement in 2007 that the DNR should initiate a process to update available information concerning springs. The GAC expressed general support for efforts by the DNR to reallocate existing appropriations in order to fund these activities as long as adequate funds remain available to meet future needs related to assistance to local governments.

Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded approximately 360 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, PERSONAL CARE PRODUCTS AND ENDOCRINE DISRUPTING COMPOUNDS IN GROUNDWATER

Pharmaceuticals, personal care products (PCPs) and endocrine disrupting compounds (EDCs) are a large group of substances present in human generated waste streams that potentially could contaminate 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. EDCs adversely affect the behavior of natural hormones in humans and other animals. They include both anthropogenic chemicals, such as pesticides and plasticizers, and naturally occurring compounds like steroids and plant produced estrogens. EDCs are found in domestic and industrial wastewaters and in agricultural run-off. Some pharmaceutical and PCP compounds act as endocrine disruptors. New analytical methods, allowing detection of very small quantities of a substance, have helped improve investigations into the occurrence of pharmaceuticals, PCPs and EDCs in the environment.

Discharges of treated wastewater through land treatment systems, leachate leaking from solid waste landfills, sludge biosolids landspreading activities and infiltration of polluted surface waters 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 characteristics of any soil through which the substance percolates before reaching groundwater. Recent studies in other states have shown that pharmaceuticals, PCPs and EDCs 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 some pharmaceuticals, PCPs and EDCs.

A University of Wisconsin (UW) study, conducted by K.G. Karthikeyan and William F. Bleam (Project No. DNR-169), 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 treated wastewater effluents tested for the project. Very small concentrations of these two

antibiotics were also detected in groundwater monitoring wells located directly adjacent to one of the study land treatment system seepage discharge sites.

A second UW study, conducted by Joel Pedersen and K.G. Karthikeyan (Project No. 04-CTP-02), investigated the soil adsorption properties of common antibiotics. This study found that under certain soil conditions some antibiotics, such as the sulfonamide antibiotics, have the potential to be mobile in the subsurface.

A study of the use of a screening assay to evaluate the occurrence of estrogenic endocrine disrupting chemicals in groundwater was conducted by the Wisconsin State Lab of Hygiene (Project No. 05-BEP-01). This study included testing of both high capacity water supply wells located in close proximity to surface waters into which treated wastewater effluent was being discharged, and water supply wells located in areas of home on-site wastewater treatment system discharge to groundwater. A State Lab of Hygiene developed breast cancer cell line assay (E-screen assay) technique was used to test study samples for the presence of estrogenic endocrine disrupting compounds. Estrogenic EDCs were detected in surface waters tested but multiple groundwater samples from high capacity water supply wells located near those surface waters showed no estrogenic endocrine disruptor activity. Samples for estrogenic EDC analysis were collected from home on-site wastewater treatment systems and from groundwater monitoring wells located adjacent to two of the systems. Estrogenic activity was detected in wastewater treatment system effluent but was not detected in groundwater monitoring well samples.

A research project conducted in Dane County (Project No. DNR-178) assessed groundwater impacts from on-site wastewater treatment system discharge. This project included an assessment of pharmaceuticals, PCPs and estrogenic EDCs in treatment system effluent, soil pore water and groundwater. Four compounds, acetaminophen (Tylenol), paraxanthine (caffeine metabolite) and the hormones estrone and β-estradiol, were detected in wastewater treatment system effluent samples. No pharmaceuticals, PCPs or estrogenic EDCs were detected in the groundwater or soil pore water samples collected for the study.

The Department is using the results of pharmaceutical, PCP and EDC 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 pharmaceuticals, PCPs and EDCs present in wastewater influent with treatment system effluent levels provides information on the removal effectiveness of wastewater treatment processes. Research into the behavior of pharmaceutical, PCP and EDC substances in soil and groundwater is helping the Department develop effective monitoring strategies. Studies evaluating new sampling techniques and analytical test 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 quantification.

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 DHS 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, DHS 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.

More than 2200 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, DHS 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 was recently completed (Gotkowitz, 2007).

GROUNDWATER MOVEMENT IN SHALLOW CARBONATE ROCKS

Shallow carbonate bedrock (dolomite and limestone) underlies much of Northeastern Northwestern, and Southwestern Wisconsin (***Figure 5.1***). During the 1980's and 1990's Door County was 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 (see 2007 Report to the Legislature. This research in Door County laid groundwork for a recent non-joint solicitation project that delineated the areas contributing water to springs providing critical habitat to the endangered Hine's emerald dragonfly (Cobb and Bradbury, 2008). Results of this project are being used to protect the spring contribution areas from contamination and development that might harm the dragonfly.

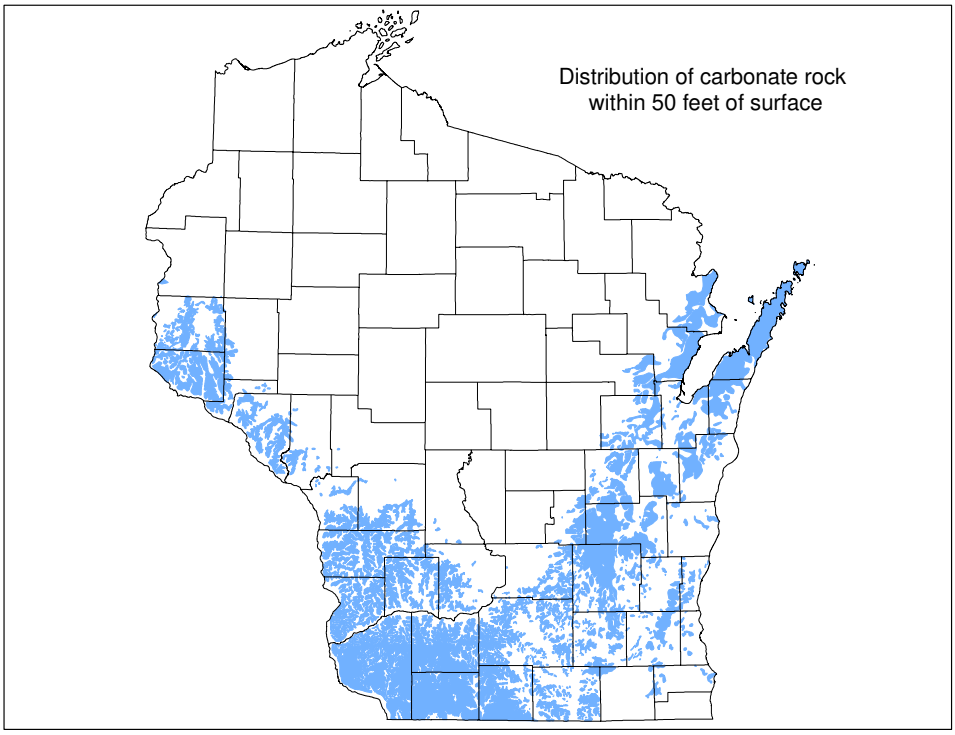

Figure 5.1 Location of shallow carbonate bedrock in Wisconsin

The techniques developed in the Door County research are being applied to carbonate rocks in other parts of Wisconsin. In 2007, researchers (Muldoon and Bradbury) began monitoring shallow groundwater adjacent to agricultural fields in areas of moderately thick soil (30 feet) over carbonate rock in Brown, Calumet, Manitowoc, and Kewaunee Counties, with the goal of assessing water quality variations in areas of significant soil cover. This work helps address the question "how much soil is enough?" when making management decisions in carbonate rock areas.

The Door County work also laid the groundwork for a follow-up project supported without state funds where shallow carbonate rock is being studied at a contaminated site in Pierce County (Cobb, 2007). Groundwater remediation activities at the Town of Warren TCE site provided an opportunity to conduct a multi-well tracer test in dolomite below over 20 feet of soil cover. The tracer revealed that very rapid (10's of feet per day) groundwater movement is occurring at the site, and that most movement is along bedding-plane conduits. These results show the necessity

of conduit monitoring in such environments and demonstrate the potential rapid movement of groundwater.

A third recent study to benefit from the Door County work is occurring at a site on the Platteville Pioneer farm, located a few miles southeast of Platteville in Lafayette County (Kraft, 2008). Initial work at this site has again shown the value of detailed hydrogeologic characterization in designing monitoring systems. The Pioneer Farm data is being used to assess the effects of cropping practices on groundwater.

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 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 (e.g., Mickelson 1994-95; Bradbury et al., 2000; Hunt and Steuer 2001, Swanson 2002; Anderson 2003). 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 or multi-county models have been applied to regional groundwater issues in other parts of Wisconsin including Sauk County, Rock County, Eau Claire County, Fond du Lac area, Sawyer, 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 quantitatively evaluate the impacts of 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 (DeVita and Dawson, 2005-06), (Li, 2004-05), (DeVita and Dawson, 2003-04), (Evangelista and Pelayo, 2003), (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 2006-07), (Edil, Benson and Connelly, 2004-05), (Edil and Benson, 2000), (Edil 1997), (Benson, 1995-96), (Edil and Park, 1992-93);
- New technologies for the treatment and removal of Arsenic and heavy metals from groundwater. (Benson and Blowes, 2005-06), (Anderson, 2003), (Park, 2002-03), (McGinley, 2002-03)
- 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 (Kraft and Browne, 2006-07), (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

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. 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 *E. coli,* which is one of the major species of bacteria associated with human waste. This method is capable of distinguishing *E. coli* DNA from that of its closest relative, *Shigella* and detecting the DNA equivalent to about 20 cells.

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 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 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 is 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.

WSLH researchers in the Water Microbiology Unit recently completed testing of a hollow fiber ultrafiltration method for concentrating low levels of microorganisms from large volumes (up to 100 L) of drinking water. Acceptable levels of organism recoveries were demonstrated for bacteria (*E. coli* and enterococci), viruses (MS2 coliphage) and parasites (*Cryptosporidium* and *Giardia*). Quantitative recoveries were recorded for concentrations as low as 0.3 organisms per 100 mL. Establishing testing with lower detection limits for pathogens and indicators adds an additional margin of safety in the protection of public health from waterborne diseases.

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 (Olstadt and others, 2007). 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 ssp*., 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.

The release of antibiotics into our water resources is driving efforts to characterize the occurrence, fate, and transport of resistant bacteria in the environment. In a recent WRI sponsored project, onsite-wastewater treatment systems were evaluated as a potential source of genes that encode antibiotic resistance in bacteria (McMahon and others, 2007). The concentrations of resistance genes in the septic tanks were several orders of magnitude higher than those observed in treated municipal wastewater effluent. The investigators hypothesize that past agricultural activity may have contributed to the presence of resistance genes in subsurface bacteria, but long term sampling with higher spatial resolution is required to adequately confirm the hypothesis.

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. Recent work between Marshfield Clinic and USGS targeted the source and transport of viruses to drinking water wells. This work was funded by the WDNR and USGS, and involved field investigation using physical measurements, wastewater tracers, and virus analyses. Water sampling screening in 14 Wisconsin communities again documented virus occurrence in wells without surface water sources, and a second sanitary sewer source was supported by wastewater tracer presence. Using more intensive characterization at one municipal well in 3 Wisconsin communities, the relation between high wastewater tracer and virus occurrence was documented, and also demonstrated sufficiently short travel times such that viruses would be expected to remain infectious even in a 400 foot deep municipal well. Given the wide extent and age of infrastructure, these findings suggest that viruses may be more common than previously expected in Wisconsin drinking water. Recent work by Marshfield Clinic has begun to evaluate whether the viruses are inactivated through disinfection processes, or result in illness in the community. This type of research into the link between virus occurrence and human health will provide the overall context to this extensive Wisconsin research topic.

Very recently viruses have also been to found in deep bedrock wells that are thought to be protected by low permeability confining units. Studies funded by AWWARF and DNR examined virus occurrence in three deep (>400 feet) confined bedrock wells serving Madison. The surprising result was that infectious viruses were repeatedly present in two of three wells sampled. Examination of potential virus sources and pathways was inconclusive, but sampling results suggest that the deep groundwater is more vulnerable to virus contamination than previously thought (Borchardt and others, 2007). A follow-up study is currently underway. One outcome of the initial study was the use of increased disinfection by the Madison Water Utility in order to assure public health.

A combined microbial and chemical target toolbox is being tested, validated and applied at WSLH to conduct microbial source tracking. The toolbox uses microbial and chemical tracers that are specific or unique to waste sources to determine sources of contamination and allows for a weight-of-evidence approach for identifying sources of contamination. Current methodology discriminates between human sewage-related sources and animal fecal contamination and can identify grazing animal contamination. This suite of tests has been applied to contamination events in Dodge and Door Counties, among others. In one instance, an improperly installed septic system was the culprit. In another instance, farm field manure runoff during heavy rains was identified. By identifying the source of microbial contamination, remediation or correctional actions can be targeted and the spending limited funds on "false sources" can be avoided. Research to improve on the methods in this toolbox is being funded by the DNR and UWS.

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, lakes, 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 worked 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. This protocol is currently being applied to the entire 7-county SEWRPC region of southeastern Wisconsin.

The Maquoketa shale forms an important aquitard, or low permeability geologic layer, in eastern Wisconsin. Restriction of recharge to the deep sandstone aquifer by the Maquoketa is the major reason that drawdowns in the deep sandstone aquifer in SE Wisconsin are so severe. Hart and others (2008) investigated groundwater flow across the Maquoketa and in particular studied how cross-connecting wells and fractures control flow across the shale. Cross connecting well are generally older wells that are open to aquifers both above and below the shale. These wells form conduits from one aquifer to another and can cause drawdown in the upper aquifer while also causing water-quality degradation in the lower aquifer. Hart and others searched state records and discovered that approximately 170 such wells exist in SE Wisconsin. They also investigated faults and fractures through the Maquoketa and discovered that such features, although sparse, also can have a major impact on the overall rate of flow across the shale. The implication is that naturally occurring low-permeability formations, such as the Maquoketa, may transmit more water than originally thought due to the presence of cross-connecting wells and fractures.

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 provided 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- and USGS-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 web pages 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 available at *http://wi.water.usgs.gov/gwcomp/index.html*. Since its official launch in March of 2008 the website has averaged nearly 800 successful requests for information per day. Over 950 different individuals or organizations have visited the site. 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. Long term hosting and maintenance of the site is undetermined.

RAIN GARDEN DESIGN & EVALUATION

In February 2006, WRI and the UW-Madison Department of Civil & Environmental Engineering published "Design Guidelines for Stormwater Bioretention Facilities" (Atchison and others). 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. The model, which was based on WRI supported research, 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. The manual continues to be extremely popular at our ASC Publications Store. In FY 07, over 250 printed copies and 10,775 downloads were recorded. In FY 08, over 160 printed copies and 8,400 downloads were recorded.

METHYLMERCURY FORMED IN GROUNDWATER

A UW 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.

References:

Anderson, M.A.2003, Photocatalytic Adsorption Media and Processes for Enhanced Removal of Arsenic from Groundwaters. Project 03-WSP-02

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

Benson and Blowes, 2005-06, Foundry Slag for Treating Arsenic in Groundwater and Drinking Water. Project 05-REM-02

DeVita and Dawson, 2003-04, Monitoring the Effectiveness of Phytoremediation and Hydrogeologic Response at an Agricultural Chemical Facility. Project 03-REM-06

DeVita and Dawson, 2005-06, Monitoring Environmental Effects at an Established Phytoremediation Site. Project 05-REM-01

Edil, Benson and Connelly, 2004-05, Evaluation of Contamination of Groundwater Around Landfills. Project 04-CTP-04

Edil and Benson, 2006-2007, Validation of Transport of VOCs from Composite Liners. Project 06-CTP-06

Evangelista and Pelayo, 2003, F Test for Natural Attenuation in Groundwater: Application on Benzene. Project 03-REM-08

Evans and Li, 2002-03, Removal of heavy metals and radionuclides from soils using cationic surfactant flushing. Project 02-REM-3

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.

Kraft, Browne, 2006-07, Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer. Project 06-CTP-07

Li, 2004-05, Combination of Surfactant Solubilization with Permanganate Oxidation for Groundwater Remediation. Project 04-REM-04

McGinley, 2002-03, Co-occurrence and removal of arsenic and iron in groundwater. Project 02-REM-2

McMahon, Katherine D. and Erin E. Seyfried, 2007, Evaluation of on-site wastewater treatment as a source of antibiotic resistance genes in groundwater, Water Resources Institute, University of Wisconsin–Madison, Madison, Wisconsin, 15 p.

Olstadt, J., J. Schauer, J. Standridge and S. Kluender. 2007. A comparison of ten USEPA approved total coliform/E. coli tests. Journal Water Health. 5:267-282.
Park, 2002-03, Removal of arsenic in groundwater using novel mesoporous sorbent. Project 02-REM-5

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.

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 five 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 and test cost-effective groundwater pollution 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. 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 practices.:** Groundwater contamination from manure has been an increasing problem in recent years for private well owners. The continued replacement of high quality historically recharged water with poor quality recently recharged water is degrading our groundwater resource and, in some cases, has made it unusable for human consumption. 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, nitrate, pharmaceuticals, viruses, other pathogens, etc) all need to be understood better to address the problem. Several manure management research and monitoring projects started 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.

- **Other unresolved groundwater quantity issues – How water-rich are we?** A common perception is that Wisconsin has an abundance of water – more than enough to support our current usage. But, the truth is expected to be more complicated. As Hunt (2003) describes, in Wisconsin we receive about 31 inches of precipitation a year—some 29 trillion gallons of water—falling as snow and rain (WDNR 2006). So why do we hear about possible water shortages in our water-rich state? Most of this water (around 75%) is transferred back to the atmosphere by evaporation and plant transpiration before it makes it to groundwater or surface water (WDNR 2006). A significant amount of the remaining water does eventually make it to groundwater and surface water bodies, but the issue of availability is more subtle: water supply problems are typically not statewide problems but rather local supply problems. That is, the flow of water in the natural system cannot, in some cases, keep up with the local demands placed upon it; our ability to extract water locally exceeds the natural replenishment. In addition, water cannot be transported easily around the state to meet local shortages. So although we do have an ample amount of water in our state, we can still experience water shortages locally.

- **Investigate extent and origins 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. Recent sampling funded by the WDNR and USGS documented wastewater tracers occurring in some drinking water wells in Wisconsin. In addition, studies have found evidence of viruses and other microbial agents in both municipal water supplies and domestic wells. More research is needed to determine whether these substances pose a threat to Wisconsin's groundwater resource, and also to human health.

- **Research the impacts of various land uses 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, Juckem et al. (2008) show that land management mitigates or magnifies stresses such as climate change; 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. Another example is the impact of storm water infiltration on groundwater. Recently enacted stormwater infiltration rules require storm water infiltration trenches in many commercial and multi-family residential settings in Wisconsin. This will help reduce runoff in urban areas, but the impacts of trenches on

groundwater are not fully understood. Also, there are no requirements regarding abandonment of trenches. Research is needed to determine the impact of infiltration trenches on local groundwater, and to assess the need for signage or abandonment criteria to protect the groundwater resource.

- **Evaluate potential impacts of climate change and global warming on Wisconsin's groundwater:** Climate change will likely increase the frequency and severity of inclement weather patterns that may produce unprecedented flooding or drought conditions. As a result, land use patterns may also change and bring new threats to the groundwater supply. These may include biological or chemical contamination issues or increased demand for groundwater by agricultural, municipal, and commercial users. Additionally, recent groundwater/surface-water modeling by USGS suggests that climate change will affect timing of groundwater recharge, amount of baseflow in streams, whether lakes will be groundwater fed or rain fed, and the wetland distribution on our landscape. More work is needed on the range of possible climates in Wisconsin's future. Work is also needed on feedback mechanisms between climate and groundwater to fully characterize the envelope of possible changes to Wisconsin's groundwater resource. This research will help identify ways to properly manage Wisconsin's groundwater supply under changing conditions.

- **Evaluate the impact of the production of biofuels on Wisconsin's groundwater. This includes concerns with farmers moving out of Conservation Reserve Program (CRP).** Biofuels requires relatively large quantities of water – in some cases a single plant can pump as much as a municipality. Unlike a municipality, biofuel production is largely consumptive, removing the water from the system rather than returning the majority back to the local hydrologic system through sewage treatment return flows. In addition to the potential direct water use effects, an indirect effect on Wisconsin's groundwater is expected: the conversion of marginal crop land put in fallow by the CRP into corn or other biofuel source crops. CRP lands have been shown to enhance infiltration of precipitation by 8 to 10 times more than the same soils in active agriculture (Steuer and Hunt, 2001). Thus, converting the CRP land back to crop production is expected to reduce groundwater recharge and increase runoff and related flood peaks. The combination of direct and indirect effects has the potential to significantly change the local hydrologic flows in some watersheds. More work is needed to identify vulnerable watersheds, and quantify the carrying capacity of other watersheds.

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 and the overall of effectiveness of the law. There is a need for proactive regional groundwater planning in certain areas of the state where development/population growth pressures intersect limited groundwater resources leading to water availability and sustainability issues. The GCC will continue to serve as a resource for addressing scientific and technical questions related to groundwater quantity and facilitate further dialogue among all parties on potential approaches and solutions as well as identifying additional areas with developing or potential groundwater quantity problems.

- **Find solutions to groundwater nonpoint pollution problems**: A 2008 DATCP report indicates that 33.5% of wells contain a detectable level of at least one pesticide or pesticide

metabolite and 11.7% of Wisconsin's wells still contain detectable atrazine residues. In addition, 9% 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.

Meet funding needs for nutrient management plan implementation and evaluation of its effectiveness in resource protection. From 2005 to 2007, nitrogen fertilizer sales increased 25% resulting in the application of approximately 400 million pounds of N in excess of UW recommendations. A recent DATCP survey of private well water quality shows increasing probability of nitrogen contamination of drinking water as the percentage of nearby agricultural land use increases. The adoption of nutrient management plans by farmers would reduce nitrogen loading to groundwater. However, only 1 in 8 Wisconsin cropland acres are currently farmed under an approved nutrient management plan. Nutrient management plans can be required if cost-sharing is provided to the farmer. Maintaining and expanding the funds for nutrient management cost-sharing is critical if groundwater quality is to be improved. While nutrient management planning is a necessary first step, the plans must be implemented and maintained over time. Additionally, the individual practices that make up nutrient management plans need to be researched and evaluated to ensure both practicality for farmers as well as effective groundwater and surface water protection. No funds for this needed research are currently budgeted.

- **Provide resources to local governments for Smart Growth/Comprehensive Planning activities**. Legislation enacted in 1999 requires 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), and presents a unique opportunity to address and implement groundwater protection at the local level. The GCC has helped guide a DNR-funded project that has developed a website to provide groundwater information to communities involved in comprehensive planning. The website provides a suggested process for integrating groundwater information into comprehensive plans. It also includes 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. Since its official launch in March of 2008 the website has averaged nearly 800 successful requests for information per day. Over 950 different individuals or organizations have visited the site. Maintaining and enhancing the site over the next several years is critical for communities to incorporate ground-water information into their comprehensive plans. However, long term hosting and maintenance of the site is undetermined, and a source of continued funding has not been identified. As a result the site will not be updated, nor will it be possible to provide agency support for anything but basic questions from users.

- **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 GAC, in its 2006 and 2007 reports, stressed the value of an enhanced monitoring network and included recommendations urging sufficient funding. However, at this time funding has not been found to support significant improvement of the monitoring 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.

- **Support Implementation of the Great Lakes Compact:** The Great Lakes Compact establishes a consistent framework oversight of withdrawals and use of water, including groundwater, in the Great Lakes basin. Implementing legislation includes mechanisms for review and approval of water withdrawals and interbasin transfers and also requirements for development of water conservation and efficiency programs. Effective implementation will rely on sound data and research and development of innovative approaches to water use and management. The GCC will play an important role in supporting these research and management initiatives.

- **Coordinate and facilitate consistent messages on groundwater related issues:** The public has benefited from the consistent educational messages that have been endorsed by the GCC. Through the Education Subcommittee, the GCC will continue to provide its leadership and assistance to state agencies that provide educational materials to the public. In FY 05, the Subcommittee created a "Groundwater Information Network" with non-governmental organizations to further its mission of promoting consistent messages regarding groundwater protection and building a groundwater consistency. The GCC will continue to use this network and other means to promote water stewardship and awareness, 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 Monitoring and Data Management Subcommittee's two publications *Directory of Groundwater Databases* and *Recommended Minimum Data Elements for Groundwater Databases*, state and local government agencies now have more convenient access to groundwater data and guidance on multi-user-friendly data element choices. These efforts must be maintained by continuing to identify data needs and ways to make data easily accessible and promote data consistency. This commitment to management of the resource through sound scientific methods needs to be continued by the GCC providing leadership and communication on data management.

- **Ensure access to findings of groundwater research and monitoring projects:** The UW-Madison Water Resources Institute website (www.wri.wisc.edu) was rebuilt in FY 08 to make it easier and faster for visitors to find information about WRI research projects and publications. To provide the public with a real-time link to information about current research the site was integrated with the UW Aquatic Sciences Center's interactive Project Reporting Online (iPRO) system, an online tool that allows principal investigators to report on the progress of their projects. The new site features a fresh design with better readability and vivid photography. The redesigned WRI website went online February 15, 2008 and by the end of the fiscal year has logged more than 200 visitors and 1,000 page views per week. More than 70 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 has digitized and posted the full text of many WRI and DNR project final reports. New summaries and reports are added as they become available. 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.

References Cited:

Hunt, R.J., 2003, A water science primer. Wisconsin Academy of Sciences, Arts and Letters *Transactions* 90: 11-21.

Juckem, P.F., Hunt, R.J., Anderson, M.P., and Robertson, D.M., 2008, Effects of climate and land management change on streamflow in the Driftless area of Wisconsin. *Journal of Hydrology* 355: 123-130.

Steuer, J.J., and Hunt, R.J., 2001, Use of a Watershed-Modeling Approach to Assess Hydrologic Effects of Urbanization, North Fork Pheasant Branch Basin near Middleton, Wisconsin. USGS Water-Resources Investigations Report 01-4113. 49 p.

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 24th, 2007
Department of Agriculture, Trade and Consumer Protection Board Room
28911 Agriculture Drive, Madison.

Members Present: Todd Ambs (DNR); James Robertson (WGNHS); Lori Bowman for Kathy Pielsticker, and (DATCP); Eric Scott for Berni Mattsson (Commerce), Anders Andren (UWS), Henry Anderson (DHFS), George Kraft (Gov. Rep), Bob Pearson for Dan Scudder (DOT).

Others Present: Judy Ziewacz (Office of Energy Independence); Chris Babiarz, Steve Wittman and Peter Boger (WRI); Kevin Masarik (UW-SP); Jim Vanden Brook and Matt Karnowski (DATCP); Ed Morse (WRWA); Mike Lemcke and Jeff Helmuth (DNR).

The meeting began at 10:00 AM.

Introductions and general business – Introductions were made. The minutes of the May meeting were approved.

Consideration of 2007 GCC Report to the Legislature – Jeff Helmuth reported that only a few minor changes (corrections of typos, elimination of redundancies) has been proposed since the second draft of the annual report was distributed on August 13th. The document was briefly discussed and then approved unanimously by the council.

Plans for the FY 09 Joint Solicitation – Anders Andren introduced Chris Babiarz who will be filling in for one year for Jim Hurley who is in Washington D.C. on a Sea Grant appointment. Chris presented a timeline for the joint solicitation for FY 09 similar to the preceding year. Mike Lemcke reported that DNR was attempting to estimate funding levels but it would be difficult due to the multiple funding sources and budget uncertainties. Todd Ambs emphasized that the 2006 Groundwater Advisory Committee report to the Legislature and the Great Lakes Compact both identified a need for more research on water quantity issues. Mike said that those issues would be included in the DNR's monitoring and research priorities.

Update on WRI education/outreach project – Steve Wittman passed out some sample copies of the WRI's brochure on the GCC's role in groundwater research and monitoring. Anders asked for input on how the brochure should be "rolled out", and how many copies each of the agencies would like. It was agreed that Groundwater Awareness Week (March 9-15) would be a good time for to publicize it. Noting the cost ($7/copy) there was substantial interest in developing a webpage and Internet links rather than printing numerous paper copies. A downloadable pdf file would be the most useful format. There was also interest in a shorter (1-page) version referencing the website. A news release should be planned. Todd suggested that important Legislative contacts be made one-on-one. Anders suggested that WRI ghost-write a guest column for a local newspaper for Todd's review. Todd agreed and thanked Peter and Steve for their hard work so far.

Governor's 25x5 Goals: Office of Energy Independence's (OEI) role in implementing – Judy Ziewacz, the Director of OEI, introduced the Office which was created in April 2007. The mission of the office is to advance Governor Doyle's vision for energy independence. OEI's

Energy Independence Mission ("Achieving Energy Independence by 2025") consists of three main goals: 1) generating 25% of electricity and transportation fuels from renewable resources by 2025; 2) capturing 10% of the emerging bio industry and renewable energy market by 2030; and 3) becoming a national leader in groundbreaking energy research.

The current focus of OEI includes serving as a single point of contact for businesses, local units of government and NGOs pursuing bio development, energy efficiency, and energy independence as well as developing energy independence policy options for consideration by the Governor. Judy has also been engaged in identifying federal funding opportunities and identifying barriers to implementation of the Governor's energy independence initiatives.

The OEI's first year plans include developing the biomass marketplace, increasing consumption of biofuels and establishing energy efficiency as a state priority. The goal for 2025 is 1 billion gallons of biofuels (versus ~320 million in 2007). Other considerations for biofuels include cellulosic ethanol, the setting of Corporate Average Fuel Economy (CAFE) standards at the federal level, plug-in hybrid electric vehicles, and hydrogen fuels.

BioPower generation is also a focus, with the 2025 goal set at 21,000 gWh (up from 2313 in 2005). This huge increase will rely on great increases in wind and biomass power generation. New technology (i.e. fuel cells) and new feedstocks from waste streams & research are also important. Judy said the OEI would need to find Wisconsin's competitive advantage in diverse feedstocks and distributed energy and rely on sectoral & communities strategies.

Biomass power generation uses organic matter such as plant material, vegetation, agriculture waste, or forestry waste as a fuel or source of energy. Use of biomass as an energy source results in little net production of carbon dioxide. Primary potential sources of biomass in Wisconsin are crop residues, planting switchgrass on CRP, forest residues, hybrid poplars, and primary mill waste. Judy cited several examples of biomass projects in Wisconsin including the Nelson Dewey Power Plant where they have offset 10% of their coal use with biomass, and a Biomass Exchange which brokers for biomass across the Midwest. Judy also pointed to the state fleet using E85 fuel, wood pellets used to heat water at water parks, campuses getting off the grid, and milk truckers using biodiesel fuel.

Anders Andren pointed out that in Scandinavia and Northern Europe nuclear power has gained prominence in power generation. Eric Scott pointed out that there are materials compatability issues with ethanol fuels (i.e. ethanol is corrosive to many metals) and thought the conservation element was largely missing. Todd Ambs also wondered why there wasn't more of an emphasis on reducing demand noting the large amounts of energy used to process drinking water.

Several GCC members brought up the difficulties in siting ethanol plants. George Kraft offered that at 4 gal water per gallon of fuel produced, the production plants should be located on rivers and not be utilizing groundwater. Jamie noted the environmental legacy that the plants were leaving in areas where they are inappropriately located and asked if the state should have a siting standard. Todd suggested that the policy and technology was not yet caught up with the industry.

Judy said it must be taken one step at a time and that her emphasis was on how to position Wisconsin in the biofuels/biomass market.

Education Subcommittee report – Kevin Masarik reported that the subcommittee had been working closely with Peter and Steve on the WRI pamphlet. Another long-term project that the subcommittee has been involved with is Lynn Markham's Groundwater in Comprehensive

Planning website. The subcommittee has provided substantial input to both projects.

Groundwater Pollutant Transfer and Export from a Northern Mississippi Valley Loess Hills Watershed – Kevin Masarik reported that this 2003-04 study assessed the role of groundwater in the export of nutrients and pesticides from the Fever River Watershed; an agriculturally dominated watershed. Over 100 water bodies in this area are listed as impaired on the State 303(d) list, and half of the land area is in impaired watersheds. About two-fifths of the area is in cropland and another fifth in permanent pasture. Streamflow is baseflow dominated by groundwater discharge occurring through well defined riparian springs, ill-defined riparian seeps, and streambed discharge.

Groundwater pollutant transfer to a receiving stream was estimated and compared with that from runoff. Then the following approach was used to determine whether groundwater transfer and export were likely at a steady-state or increasing:

1. Groundwater pollutant transfer to the receiving stream was determined through repetitive sampling of stream water quality and discharge during the study period.
2. Comparisons with runoff transfer and export were made at a gauging and sampling station which measured water quality and discharge during runoff events.
3. Questions about steady-state vs. increase were inferred by sampling water quality and groundwater age-date at groundwater discharge features, such as riparian springs.

Groundwater age-dates ranged from 1969 – 1989. Nitrate-N ranged from 4.7 to 23.5 mg L^{-1} while dissolved reactive P ranged from 0.003 to 0.052 mg L^{-1}; both showed a positive relationship to groundwater age-date. Denitrified N ranged from 0 to 4.5 mg L^{-1} and was negatively correlated to groundwater age-date. Metolachlor ESA was the most pervasive pesticide residue detected in groundwater samples, followed by de-ethylatrazine, alachlor ESA, atrazine, and de-isopropylatrazine, the summed concentration of pesticides ranged from 2.1 to 9.1 µg L^{-1}.

Baseflow accounted for approximately 86% of the total streamflow in the Fever River. Nitrate accounted for the largest nutrient loss; groundwater NO_3 export (23.4 kg ha^{-1} yr^{-1}) accounted for 80% of the total annual N loss. Even though runoff represented only a small portion of the annual streamflow, 85% of total P was transported during runoff events. Pesticide concentrations were generally highest during spring runoff events, however; pesticide residues were present in baseflow year round and show that the amounts transported by groundwater can be significant.

The land-use practices, geology and hydrological settings in the Fever River watershed are representative of much of southwest Wisconsin. Kevin concluded that the watershed is not yet in equilibrium with current land-use and denitrification within the aquifer is not capable of sufficiently denitrifying current NO_3 loading rates to groundwater. As a result, concentrations of NO_3 in the surface waters of these systems will likely increase before finally stabilizing because of the time it takes for groundwater to penetrate the aquifer and reach discharge locations. Understanding groundwater surface water relationships are critical for interpreting stream water quality data and understanding past and future impacts of land management decisions.

The presentation was well-received and GCC members thanked Kevin for his hard work on the project.

Agency Updates

DATCP – Lori Bowman and Jim Vanden Brook

- Statewide survey is winding down - going to the Board in November.

- Alachlor ESA hearing
- Senate hearing on banning phosphorus in turf fertilizer.
- The new nutrient standard went into effect on August 1.
- DATCP will seek funding for research in the next budget. Very few leaching studies have been done on nitrogen or phosphorus applied at recommended rates. DATCP needs leaching indices for both nutrients. George Kraft suggested that a mass balance approach would work for nitrogen.
- The NE WI karst task force recommendations are not very restrictive and are largely based on professional judgement. There is also a need for research on this issue.

DOT – Bob Pearson

- DOT has worked closely with Ken Bradbury and Chuck Dunning over the years in providing access, maintaining and looking for new sites for groundwater level observation wells on DOT property. Currently there are 24 wells in the network on DOT property.

UW – Anders Andren

- After several iterations in the federal budget the Water Resources budget will be the same as in the past.
- Madison campus out-of-state tuition remission has led to increased costs of projects.
- USGS national strategic plan released and one area is groundwater. A groundwater census is the main focus.
- There is a new Office of Technology document that looks at quality, quantity and institutions and concludes that the institutions need more support.

DHFS – Henry Anderson

- DHFS has been working with DATCP on the survey, added several questions.
- Work continues on the Blue Cross/Blue Shield arsenic project at the school of health.
- Encouraging private well testing for pregnant women

DNR – Todd Ambs and Mike Lemcke

- The flooding crisis had made the previous couple weeks extremely busy but had shown the value of county zoning in preventing problems.
- The alachlor ESA hearing was a beneficial Legislative process.
- DNR has had success in increasing private well inspections (>400% increase). Numerous problems were found resulting in referrals, prosecutions and getting a positive message across.
- British Petroleum Corporation earned a permit earlier this year to discharge more ammonia and suspended solids into Lake Michigan as part of an expansion of the company's Whiting, Ind., refinery that would create 80 permanent jobs. Reaction to the increase has been showing an appreciation for the importance of the Lake. [Note: reaction to this permit has led to Indiana reconsidering it.]
- One joint solicitation contract was recently cancelled. Poor communication and lack of work products forced the cancellation.

WGNHS – Jamie Robertson

- The survey has been trying to characterize the presence of manganese in the Madison water supply. Cutting samples were useful in determining the source.
- Viruses are also being found in the Madison water supply. This indicates that the water supply and wastewaster infrastructure have not been adequately maintained.
- The survey is helping the DNR develop a process for permitting high-capacity wells.

WRWA – Ed Morse

- WRWA is trying to restore their funding for wellhead protection.

Set next meeting location and adjourn – The next meeting will be held 10:00 – 1:00 on November 16th at the Department of Natural Resources, Room 875, GEF 2 building, 101 S. Webster Street, Madison. The meeting adjourned at 1:00 pm.

Respectfully submitted,

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

Wisconsin Groundwater Coordinating Council
Meeting Minutes – November 16, 2007
Department of Natural Resources, Room 613

Members Present: Todd Ambs(DNR); James Robertson (WGNHS); Lori Bowman for Kathy Pielsticker (DATCP); Eric Scott for Berni Mattsson (Commerce); Chris Babiarz for Anders Andren (UW-System); and Chuck Warzecha for Henry Anderson (DHFS).

Others Present: Mike Lemcke & Laurel Braatz (DNR); Bruce Rheineck (DHFS); Ed Morse (WRWA)

Introductions and General Business – The meeting began at 10:00 AM. Introductions were made. Chuck Warzecha made a motion for approval of the minutes. Lori Bowman seconded the motion. The August meeting minutes were approved as presented.

FY 09 Joint Solicitation – Christopher Babiarz reported that the deadline for proposals was November 12th, and the online submittal process went well. Chris handed out a list of the 15 proposals received. The requested funding level totaled about $864,000 over two years (~$582,000 in FY 09 funds). As stated in the Joint Solicitation, the estimated funding level for FY 09 is approximately $340,000. The proposals cover a broad range of topics and originate from a geographically diverse group of Wisconsin research institutions. The next step is to audit the budgets and to prepare proposal packages for the review process. As in previous years, at least three outside reviews will be sought for each proposal. The deadline for outside reviews will be in January 2008 prior to the meetings of the GCC Research Subcommittee and the UWS Groundwater Research Advisory Council.

Request for Pre-approval of UW-System Continuing Projects – Christopher Babiarz proposed that the GCC consider approving a UW Water Resources Institute strategy to optimize federal funds from their USGS 104(B) base support. If approved by the GCC, two projects originally funded with FY 08 state funds during their first year would be transferred onto federal funds for their second year. The transfer would free additional state dollars to fund new projects in FY 09. Selection of the two projects would be based on sufficient progress during the first year and the impact of potential outcomes. The candidate projects are "A Thermal Remote Sensing Tool for Mapping Spring and Diffuse Groundwater Discharge to Streams" (Steven Loheide, Principal Investigator), and "Occurrence and Generation of Nitrite in Ground and Surface Waters in an Agricultural Watershed" (Emily Stanley, Principal Investigator). A motion to endorse this strategy was offered by Chuck Warzecha and seconded by Lori Bowman. The motion passed unanimously.

Education Subcommittee Report – Mike Lemcke reported that the Education Subcommittee met on October 24, 2007. The majority of the meeting was spent on discussing the upcoming fact sheets that Peter Boger will be drafting for the Water Resources Institute. The first fact sheet will be on manure. The GCC Subcommittee will be heavily involved in their review to provide consistency and adequate input from the GCC members. Secondly, it was noted that the Groundwater Comprehensive Planning website that USGS and UW-Extension Center for Land Use Education (CLUE) created is now up and running. It is anticipated that it will be a well-used resource by communities in their comprehensive planning efforts. Lastly, this round of Groundwater teacher workshops will be held in January of 2008 in Green Bay, Stevens Point, and Jefferson. Twenty-four schools will be selected to attend. Each school will send 2 teachers to

receive training on how to use the model effectively in the classroom and will take a model back to their school.

Agency Updates

WGNHS - Jamie Robertson noted that there has been quite a bit of interest in the potential impact of ethanol plants on the environment. He wants to make sure people understand what the development and expansion of the ethanol plants may mean to the resource. It appears that market forces are currently limiting plant expansions. However, ethanol is now being touted as a bridge to future technology based on cellulosic renewables.

Jamie commented that the lowering of lake levels in different areas of the state continue to generate a lot of calls and point to climatic change. He also noted that Ken Bradbury was selected for a Fulbright Senior Specialists project in South Africa at the University of the Western Cape where he will present professional development courses in groundwater protection. Recipients of Fulbright Scholar awards are selected on the basis of academic or professional achievement. The Fulbright Program, the U.S. flagship international educational exchange activity, is sponsored by the Department of State, Bureau of Educational and Cultural Affairs.

DHFS - Chuck Warzecha commented that DHFS has been providing free well tests to expectant mothers for bacteria, nitrate, and fluoride since mid 1990s. The agency has now begun mining the data to see if any trends can be seen. Initially they are looking for missing geographic areas of the state, and an exposure assessment. During the past year DHFS has added a metals package (14 metals) to this free testing. In cooperation with DATCP they have also added it to sampling that DATCP conducts. Chuck expressed hope that mining of this data will provide information akin to work done by Kammerer, and past CDC surveys.

DHFS has also been heavily involved in activities surrounding this past year's flood. A lot of work was done in the LaCrosse area and in South Eastern Wisconsin. Although the agencies handled the floods well we need to be better prepared for the next such event. We need to use the information that was provided to landowners and others and create a pamphlet or other informational material that will let people know what they can do to prepare their private well for the next time it floods.

All joined in on a discussion on the preparedness for flooding topic. What should the GCC do to be involved in getting ready for the next flooding event? What lessons did we learn? How does groundwater fit into the bigger scheme of preparedness? What statistics can be put together? Wisconsin had about as much rain as South Eastern Minnesota yet Minnesota lost a lot more structures. Vernon County had a lot of damage and it has limited zoning. We also learned a lot about dam structures. At the conclusion of the discussion it was decided that the GCC needs to be the point of contact for groundwater. At a minimum a pamphlet/brochure needs to be developed on how to prepare citizen's private well for the next flooding event. It should also be determined what information staff needs to take with them when going out into the flood.

The GCC will have further discussion on this topic at next meeting to determine who should be invited to attend a separate meeting on this issue, what the sideboards should be, and what the desired outcomes should be.

DATCP - Lori Bowman reported that they are working through post-budget issues. A primary need is to develop a strategy to optimize the use of an additional 6 million dollars they received. Nitrate and water quality continues to require their attention and they are trying to proactively get

a handle on its many issues. For the upcoming December DATCP board meeting staff will present on what nitrate analysis they have conducted and its resource implications. Through the budget the Clean Sweep program has been expanded to include prescription drugs. With this expansion comes a whole host of medical issues that will need to be worked through. The agency also continues to lead a task force on lead arsenate.

Commerce - Eric Scott noted that the agency is involved with the energy independence group. The group has begun by looking at what size biodiesel tanks to regulate. There is a long way to go on this issue. The sunset of the PECFA program was vetoed in the budget. They are now looking at tightness of piping and dispensers. The Department will soon have a new Secretary. His name is Jack Fischer and he is from the business sector.

DNR - Todd Ambs noted that a standard for alachlor-ESA had passed and would become effective on February 1, 2008. Part of the budget was to make well filling and sealing available through the well compensation program. The end of 2007 marks the deadline for the Groundwater Advisory Committee to document how the new groundwater quantity law is working and to propose modifications to the law. The committee is still deliberating on its recommendations. It is hoped that a bill supporting the Great Lakes Compact will be introduced in early 2008 and be enacted before the session over. The bill will propose a sustainable water management system for the Great Lakes.

Monitoring and Data Management Subcommittee Report – Mike Lemcke reported that the subcommittee met on September 25, 2007. There was a comprehensive update from DNR staff on activities surrounding the implementation of Groundwater Quantity Law. The current focus is on establishing ownership and usage of the approximately 3,700 historic high capacity wells. The task is well underway with over 3,000 of the wells having been inventoried. As work continues on tracking the remaining wells the agency has sent its first mailing asking for pumping information for the known high capacity agricultural wells. Data is just beginning to be returned. Over the next several months the agency will begin requesting pumping data from the other high capacity wells. There will be a lot of effort put into this initiative over the next year.

Log Den – Questions Raised (Viruses in Groundwater in Door County) – Laurel Braatz reported on many aspects of this water-borne disease outbreak that occurred at the Log Den restaurant in late May – early June 2007. Due to the severity of the illness and the numbers affected there was significant media attention. The contaminant source investigation concluded that the main cause was norovirus due to its presence in stool and water samples. Investigative techniques included well logging, illness surveys, area of contribution mapping and offering of free sampling. State Lab of Hygiene testing revealed a large suite of microbes and anthropogenic compounds. Nearby private well testing revealed a smaller number of microbes, including virues. County dye-tracing showed a probable leak prior to the dose tank. Treatment was installed in June and included ultraviolet disinfection, filtration and softening. In July, a chlorination system was put into place and Log Den water was safe to drink.

This contamination event will undoubtedly be cited as a benchmark for future viral contamination cases. It was a test of our abilities to work on this type of issue. The incident raised many good questions and pointed out areas where progress is needed. It set a baseline of data for future investigations to improve upon. Source tracking played a key role and allowed the investigation to deal with the source of the contamination problem rather than just address the symptoms. Options for source tracking were improved and options for treatment were scrutinized. While Log Den's treatment option works it may not be the best option for small systems in the long run.

Laurel suggested that the approved technology for small systems treating drinking water and wastewater could be improved and that research is needed to develop better options.

The group thanked Laurel for her hard work and excellent presentation.

Adjourn – The meeting was adjourned at 12:45. The next meeting will be held on March 3rd at the Water Resources Institute.

Respectfully submitted,

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

Wisconsin Groundwater Coordinating Council
Meeting Minutes – March 3, 2008

UW Water Resources Institute Conference Room
2nd Floor of Goodnight Hall, 1975 Willow Drive, Madison

Members Present: Anders Andren (UW-System); Kathy Pielsticker (DATCP); George Kraft (Gov. rep.); Dan Scudder (DOT); Mike Lemcke for Todd Ambs (DNR); Ken Bradbury for James Robertson (WGNHS); and David Swimm for Berni Mattsson (Commerce).

Others Present: Lori Bowman (DATCP); Chris Babiarz (WRI); Martin Shafer (UW-Madison Env. Chem. & Tech); Bob Pearson (DOT); Jeff Helmuth (DNR);

1) Introductions and General Business – The meeting began at 10:00 AM. Introductions were made. Anders Andren chaired the meeting. The November meeting minutes were approved as presented.

2) Education Subcommittee Report – Jeff Helmuth reported that the Education Subcommittee met on January 14, 2008. Kevin Masarik, with assistance from Tom Braun and other subcommittee members, had shared plans to prepare a draft fact sheet or fact sheets on water re-use and conservation.

Groundwater Awareness Week (March 9-15) activities planned by the group include Kevin Masarik and Steve Wittman preparing a variety of groundwater-related press releases and Steve Wittman arranging a Larry Meiller Show program for March 12 with Henry Anderson and Steve Ales (DNR).

The subcommittee has also been reviewing drafts of fact sheets prepared by Peter Boger at WRI highlighting GCC-coordinated research on nitrate, arsenic, groundwater quantity and manure-related issues. Progress has been only moderate due to the controversial nature of these issues. Mike Lemcke asked if the effort should be continued. Consensus was that work should continue and the controversies should be identified in the fact sheets.

Jeff added that several members of the subcommittee were involved in the Groundwater Teacher Workshops in late-January in Jefferson, Stevens Point, and Green Bay. The workshops continue to be beneficial and in-demand.

3) FY 09 Joint Solicitation Update – Chris Babiarz reviewed the FY 09 joint solicitation process. The automated online submittal process worked well and the proposal reviews went smoothly. The Groundwater Research Advisory Council (GRAC) meeting on February 18th provided a prioritized list of 9 projects of interest to UW with a limitation of 1/3 of the FY 09 UW groundwater research budget for any one project.

Jeff Helmuth added that the subcommittee review process had also gone smoothly and added that he was concerned with the trend towards fewer proposals. The reduced interest this year is likely influenced by the relatively small amount of funding available, but the higher cost of graduate students is also a big factor. Several proposals exceeded $50,000 this solicitation. There was continued discussion on the increasing costs of research and monitoring and how the research and monitoring budgets are not keeping up.

Chris described the proposals approved by GRAC for funding, showed the priority order and

explained the rationale used to develop the list. Chris finished by stating that both the UW and DNR intend to have funding decisions made before the March 1st graduate student signing date.

4) Request for Approval of the FY 09 UW-System Groundwater Research Plan Chris Babiarz asked the GCC for approval of the UWS Groundwater Research Plan. George Kraft moved, Mike Lemcke seconded and the GCC unanimously approved the plan. Jeff Helmuth was directed to prepare a request to the Secretary of DOA for expenditure of FY09 UW System funds for groundwater research for Todd Ambs signature.

5) Manure Management in Northeast Wisconsin – Ken Bradbury and George Kraft gave some background on several well contamination incidents related to manure and on the activities of the Northeast Wisconsin Karst Task Force, including their February 9th report. Both Ken and George are members of the task force. The Task Force focused on practices to protect groundwater from manure pollution. Reactions have been varied with the dairy industry concerns and counties considering the recommendations for their codes. Kathy Pielsticker stated that the report needs to take into account common sense economics and other sources of nitrogen and bacteria. DATCP is currently working towards a legislative solution to find resources to focus on the issue through nutrient management planning. George Kraft noted that Robin Shepard (UWEX) was preparing a letter to the DATCP and DNR Secretaries regarding a more comprehensive approach than nutrient planning; an approach that would take industrial and municipal waste spreading into consideration too. George opined that 3 feet of soil was just not enough to attenuate year-after-year manure applications and that other parts of the state offered more appropriate settings for livestock operations.

Kathy Pielsticker said there was a need for new tools and resources. George noted that the UWEX proposal would be convened with more involvement from the dairy industry. Ken suggested that Dan Scudder said that DOT had a strong interest in the issue too. Bob Pearson added that promoting the use of the karst reporting form by agency staff would be helpful. Anders Andren said he would recommend that the GRAC consider the report's recommendations in putting together next year's research priorities and Jeff Helmuth said he'd do the same at DNR.

6) Preparedness for Flooding – Following up from the November meeting, Mike Lemcke asked what role the GCC wanted to play in protecting wells from the next flooding event. Although the agencies handled the 2007 floods well there was consensus that any problems should be documented before discussion at the next meeting. Additionally DNR and UWS should consider prioritizing "vulnerability of private wells to flooding" as a monitoring and research priority in the next joint solicitation. [Note: since this meeting the DNR has put up a new webpage called "Recommendations for Private Wells Inundated by Flooding"

7) Agency Updates

DATCP – Kathy Pielsticker reported that DATCP had received $6.5 million for nutrient management and the program is now starting up. The arsenate report is expected out very soon and the groundwater survey is due out in May. The new pharmaceutical Clean Sweep program has $80,000 this year for grants to municipalities and counties to pick up un-wanted prescription drugs. The agency is also giving $250,000 in grants for capital improvements related to pollution prevention.

DOT – Dan Scudder reported that DOT had created a Water Resources Team. Bob Pearson is the Team Leader and will lead internal coordination on water issues. Other groundwater-related staff are Mike Sproul for road salt issues and Dan Reid, a geologist.

WGNHS – Ken Bradbury reported that WGNHS was working on two SEWRPC projects; one on estimating recharge and the other on the sustainability of the shallow aquifer for private wells. Another project is monitoring the rebound of the piezometric surface in the Lower Fox River Valley since six municipalities have switched to surface water. There have also been inquiries from Fond du Lac County regarding the potential impacts of a recently-approved expansion (to 7000-cows) of an animal operation in Rosendale. Kathy Pielsticker noted that the operation is the best-managed operation in the area. Ken added that there was continuing concern in Sheboygan County over low lake-levels and that meetings were occurring regarding potential groundwater studies.

Commerce – Dave Swimm reported that Commerce was working with DNR on guidance for closure of groundwater contamination sites with residual contamination.

DNR - Mike Lemcke noted that Todd Ambs was working on the Great Lakes Compact. It is still hoped that the compact will pass this legislative session

UWS – Anders Andren reported that UW-Madison and most other campuses have implemented higher fringe benefits thus making proposals even more costly. This follows last year's addition of $8,000/research assistant for tuition remission. Anders has been visiting Washington D.C. trying to restore Water Resources Institute funding which has been zeroed out in each of the last seven years budget negotiations. Anders is also taking the lead on drafting a National Water Resources Strategic Plan which he will share with the GCC. Anders noted that USGS has started a water census initiative; "Water for America". Its purpose is to describe the status of U.S. water resources and identify trends over time. It will look at water quality problems including emerging contaminants such as virues, bacteria and pharmaceuticals; drought and groundwater quantity problems; ethanol production impacts and more (http://water.usgs.gov/wsi/). Part of the initiative is a pilot study of water availability in the U.S. portion of the Great Lakes Basin (http://water.usgs.gov/wsi/study_units.html).

8) Arsenic Species (III,V) Distribution In Wisconsin Groundwaters: Field Measurements And Prediction Using Multivariate Analysis Of Geochemical Data - Martin Shafer explained that the environmental fate, toxicity, and mitigation strategies of As are dependent upon it's complex chemical speciation. Thus it is important to identify arsenic release mechanisms in a species-specific manner. Arsenate (As V) is the oxidized form of arsenic and is anionic at relevant groundwater pH ranges. Arsenite (As III) is the reduced form of arsenic and is uncharged at relevant groundwater pH ranges. Arsenite is more toxic to humans and is retained more efficiently in human tissues. Arsenate has a stronger capacity to sorb to aquifer surfaces and is therefore less mobile in groundwater systems. Questions Martin set out to answer include: "What are the concentrations?", "What is the dominant arsenic species?", and "Can the speciation be predicted by aquifer geochemistry?"

The study included meta-analysis of existing groundwater data, a field study of 60 wells in Wisconsin, and multivariate statistical analyses.

Analysis of >5300 records compiled from nine states showed that the data sets have limited information on arsenic speciation, redox sensitive species, and are compromised by poor detection limits. Meta-analyses identified co-varying geochemical analytes (calcium, iron II,

sulfate, and sodium) and identified the most likely inorganic arsenic species (III or V) for each identified arsenic release mechanism based on known geochemical mechanisms.

The field study focused on measuring arsenic speciation and important geochemical parameters in 57 of the previously analyzed sites (all in Wisconsin) to test our predictions. Arsenic speciation is strongly tied to oxidation state and so on-site separation is required. HPLC-ICPMS analysis was used for both inorganic and organic arsenic species.

Multiple-Linear Regression Models showed a high correlation of % As III with low Eh and low pH conditions. Remaining work includes incorporating oxygen isotope data, additional statistical analyses and preparing manuscripts.

9) Adjourn – The meeting was adjourned at 12:45. The next meeting will be held at 10:00 on May 16th at the Wisconsin Geological and Natural History Survey.

Respectfully submitted,

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

Wisconsin Groundwater Coordinating Council
Meeting Minutes – May 16, 2008

Wisconsin Geological and Natural History Survey Conference Room
3817 Mineral Point Road, Madison

Members Present: James Robertson (WGNHS); Henry Anderson (DHS); George Kraft (Gov. rep.); Chris Babiarz for Anders Andren (UW-System); Mike Lemcke for Todd Ambs (DNR); Lori Bowman for Kathy Pielsticker (DATCP); Bob Pearson for Dan Scudder (DOT); and Eric Scott for Berni Mattsson (Commerce).

Others Present: Ken Bradbury and Dave Hart (WGNHS); Steve Wittman and Peter Boger (WRI); Barb Lensch (NRCS); Chuck Dunning (USGS); Jeff Helmuth (DNR);

1) Introductions and General Business – The meeting began at 10:00 AM with Jamie Robertson as chair. Introductions were made. The March meeting minutes were approved.

2) Preparedness for Flooding – Following up on discussion at the November and March meetings, Mike Lemcke described DNR efforts to help well owners be prepared for flooding. Jeff Helmuth handed out DNR's advice on flooded wells and printouts of the DNR's webpage, *Recommendations for Private Wells Inundated by Flooding*, including a link to a video demonstrating how a water sample should be collected from a well. Mike asked if there was anything else that should be done to address flooding impacts on groundwater. Hearing none Mike and Jeff asked that any comments on the web pages be sent to Jeff.

3) FY 09 Joint Solicitation Update – Chris Babiarz gave a brief overview and a handout detailing the results of the FY 09 joint solicitation process. Tables of continuing and new UW and DNR projects were included as were abstracts of each.

Jamie Robertson asked if the goals of the agencies were met through the process. Chris and Mike Lemcke noted that both UWS and DNR priorities were met by the selected projects. Jamie asked if there was a need to hold another proposal writing workshop. Jeff Helmuth replied that the automated proposal submittal system implemented by the WRI largely addressed that need. Henry Anderson added that the proposal process could be streamlined with an abstract preproposal review but that would add more time to the review process. Henry added that overall the joint solicitation was not onerous relative to other similar grant processes.

4) Update on WRI Education/Outreach project – Steve Wittman reported on WRI activities during Groundwater Awareness week that included Henry Anderson and Steve Ales (DNR) on Larry Meiler's public radio show and several press releases. Peter Boger reported on progress on the series of fact sheets. The arsenic and nitrate fact sheets were nearing completion. The fact sheet on manure is more problematic. Upon recommendation of the Education Subcommittee Peter had met with Ken Bradbury and Fred Madison who suggested a more factual approach. Peter presented a handout showing statistics on annual manure and nitrogen production by animal in Wisconsin. Peter asked how far he should go with this approach and Jamie Robertson and others suggested going as far as the data could support. The use of maps of livestock density, karst potential, "brown water" incidents, fish kills, and groundwater susceptibility were also discussed. Lori Bowman noted that when the recent statewide survey was presented to the DATCP Board, the Board asked if there was a correlation with cattle, dairy, or potato production. No direct correlation could be found at the scale of the data (square mile). The correlation was

also weak with soil texture at this scale. Lori advised against speculating on correlations that can't be supported by the data. Lori and Ken Bradbury agreed that brown water incidents are mostly anecdotal and not well documented. Ken added that the most relevant facts were how many cows, how much manure and how much land it is applied on. Henry Anderson emphasized the need for a map to show the relevance to Legislators. George Kraft said it would be a disservice to omit mention of the brown water incidents.

5) Education Subcommittee Report – Jeff Helmuth reported that the Subcommittee met on April 7th, 2008. Kevin Masarik, with assistance from Tom Braun and other subcommittee members, shared a draft fact sheet on water re-use. Tom had been working with 25 systems now operating in the State. There is a need for consistent education on this issue.

In addition to the WRI press releases noted above, Kevin had produced a series of 5 press releases for groundwater awareness week and distributed through the UW-ES network. The subcommittee also spent considerable time reviewing and discussing the WRI fact sheets reported on in item 4). At the April 7th meeting Jim Vanden Brook and Sara Walling from DATCP were on hand to provide information and advice for the manure fact sheet. Jim had suggested focusing on implementation of existing code i.e. nutrient management planning.

6) Draft Outline for the 2008 GCC Report to the Legislature – Jeff Helmuth said he planned to use the same approach to preparing this report as in past years and presented a timeline for the reports completion, suggestions for highlights, and an outline of the report. Jeff emphasized that he would need significant input in writing the "directions for Future Groundwater Protection" section. There was discussion which resulted in numerous suggestions for the section, including:

- A new paragraph on the Great Lakes Compact
- Surface water impacts of high-capacity wells
- Other unresolved groundwater quantity issues – How water-rich are we?
- Nitrate
- Manure
- Need for continued funding for implementation of nutrient management planning
- Climate change/global warming
- Biofuels
- Concerns with farmers moving out of CRP program

Jeff said he would draft the section based on this discussion and include it to GCC members when he sent out sections for updating in mid-June.

7) Agency Updates

DOT – Bob Pearson reported that DOT has a lot of good information in older highway plans related to springs. The plans are now on microfiche and could be used to supplement other historical information on springs. Jamie Robertson said that WGNHS will find a way to utilize the information.

DNR - Mike Lemcke noted that Todd Ambs and had been very busy with the Great Lakes Compact which recently was passed by the Legislature. Several Drinking Water and Groundwater program staff had completed 60% of the inventory of high-capacity wells and were also beginning to collect pumping data. The methods for collecting the data range from measuring fuel usage to telemetry. It is not currently clear what will happen with non-complying well owners but the law requires DNR to have 50% reporting compliance by the end of 2009.

George Kraft and others underscored the importance of pumping data for a wide range of groundwater issues. Mike added that Cycle 9 of the groundwater standards was underway.

Governor's Representative – George Kraft noted that the UWSP Groundwater Center was working on a variety of projects including nitrate, the Little Plover River, and lake levels. High-capacity wells are clearly impacting both the Little Plover and some lakes.

DATCP – Lori Bowman handed out DATCP's April 2008 report, "Agricultural Chemicals in Wisconsin Groundwater" (http://www.datcp.state.wi.us/arm/agriculture/land-water/environ_quality/pdf/ARMPub180.pdf). The report summarizes results of a private well survey conducted in 2007. The purpose of the survey was to obtain a current picture of agricultural chemicals in groundwater and to compare the levels in the 2007 survey with levels found in surveys conducted in 1994, 1996 and 2001. Wells were selected using a stratified random sampling procedure and samples were analyzed for 32 compounds including herbicides, herbicide metabolites, one insecticide, and nitrate-nitrogen. Time trend analysis was performed to determine whether the proportion of wells that contained atrazine, TCR, nitrate-nitrogen, alachlor ESA and metolachlor ESA in private wells had changed since 2001. The results of this analysis did not show any statistically significant changes for these compounds over this time period. The estimate of the proportion of wells that exceeded the 10 mg/l enforcement standard for nitrate-nitrogen was 9.0%. Lori noted that given that newer wells have been drilled deeper, it's not clear if groundwater quality is getting worse. It's also difficult to identify land use causes at the scale (1 sq. mi.) that the land use data represents.

Lori reported that DATCP is giving grants to communities for prescription drug Clean Sweeps. They are working with the Department of Justice and the Federal Drug Enforcement Agency on liability issues.

DATCP is also working to make Cody Cook's well construction report GIS search tool available to staff in other agencies. Lori asked Jamie if there were any WGNHS concerns with making the WCRs available. Jamie said he had none.

WGNHS – Ken Bradbury reported that WGNHS was finishing a project in Iowa County and hopes to begin new projects in Columbia and Fond du Lac Counties next year. Concern about potential impacts from a recently-approved large expansion of an animal operation in Rosendale is the impetus for the Fond du Lac County project. Ken also reported that WGNHS was working with several local water suppliers, Madison, Middleton and Fitchburg on well siting questions.

Jamie Robertson reported that geologic mapping was being undertaken in Brown and Waupaca Counties. Jamie noted that there seemed to be more public acceptance of groundwater flow modeling and more desire for applying modeling results to groundwater problems. George Kraft agreed and noted that the modeling efforts under the Source Water Assessment Program in the Central Sands area had been used for several subsequent projects. Jamie also noted that WGNHS was documenting virus presence in sewage and drinking water systems. This highlights the need for investment in infrastructure improvements. Ken added that these projects show that deep wells are more vulnerable than had been thought.

DHFS – Henry Anderson reported that DHFS is splitting into two agencies; the Department of Health Services and the Department of Children and Families. The Division of Health Administrator was stepping down. The Health program will lose about 30% of its Information Technology support and social services programs will be migrating to the other agency. Current

activities include the 9th cycle of groundwater standards where there is lots of public interest in manganese.

8) Monitoring and Data Management Subcommittee report – Jeff Helmuth reported on the March 26th, 2008 Subcommittee meeting. The focus of the meeting was on monitoring needs in Groundwater Management Areas. Dave Hart talked about his experience characterizing and predicting groundwater levels and movement in both GMAs (Brown County and SE Wisconsin) and how significant long-term data needs in both GMAs were not being met. In Brown County six utilities' recently switched to surface water making predictions of groundwater level recovery important due to potential arsenic and other water quality issues. Local hydrostratigraphy and data scarcity make these predictions difficult. Recent loss of several wells used for long-term water level monitoring makes the need for new wells more acute.

In the Southeast WGNHS and USGS have done extensive hydrostratigraphic characterization and flow modeling. Problems with deep aquifer water quality and surface water declines have made this an area with serious long-term water supply issues. More deep sandstone water levels are needed to verify the flow modeling. More stream gaging data is needed to understand high-capacity well impacts on surface waters.

At the same meeting Jason Smith of USGS reported on the observation well network. There are very few wells in either GMA for long term deep aquifer water level monitoring. Due to flat funding, many wells were in need of repair or had been discontinued. Funding has been requested of DNR but almost all DNR funding for groundwater research and monitoring is used in the joint solicitation process and the joint solicitation is not really set up for this type of work. The 2003 Groundwater Quantity Act allocated funding for groundwater quantity-related monitoring but that funding had not currently been made available. However, other funding appropriated through the Act may eventually be available. The subcommittee did not recommend that DNR prioritize monitor network maintenance in the FY10 joint solicitation because of objections to using dwindling funds on network instead of research-oriented projects. The consensus was to pursue other sources of funding for the network.

9) Status of Wisconsin's statewide groundwater monitoring network - Ken Bradbury, with Chuck Dunning, described the network as being comprised of 102 wells around the state: 3 with continuous real-time recorders, 16 with continuous non-real time recorders, and 83 with periodic manual measurements. Of the 83 that are measured manually, 33 measured by USGS staff and 50 are measured by observers. The network is used 1) to establish a benchmark for trends related to pumping, land use change, climate change, industry, etc., 2) as a surrogate for site-specific water level trends needed for siting septic systems, landfills, highways, industries, etc., 3) to aid the development of water supply systems and to document the impact of pumping on water resources, 4) to provide calibration data for groundwater flow models and other predictive tools used in water supply and management, 5) to understand the impacts of droughts and floods on hydrologic systems, and 6) as baseline data for groundwater resource evaluation and research. A statewide map showing the location and aquifer monitored and a couple example hydrographs illustrated the breadth of information generated by the network.

The USGS and WGNHS have supported the network through a cooperative partnership since 1964. The current budget of $82,000 is split approximately 50:50 between the two agencies. No funds are available for well replacement, abandonment, upgrades, or major repairs.

Some of the problems facing the network include: maintaining an aging set of wells (some wells no longer meet code requirements), wells being "lost" due to development or land ownership

changes, wells being vandalized, wells becoming clogged or plugged, and some local observers are retiring. Flat or decreasing funding and increasing costs means wells are being dropped from the network (e.g. there is currently only one active well in the deep sandstone in SE Wisconsin).

The network badly needs more support. In the short-term an annual budget increase of about $20,000/yr cash is needed just to maintain the existing level of monitoring. In the longer term more funding is needed to add wells to the network to improve data collection, add wells in Groundwater Management Areas (GMAs) and to take advantage of other wells of opportunity. A prioritized list has been developed and submitted to DNR; total is >$500K.

Jamie thanked Ken and Chuck for their presentation and asked what the GCC could do to help. Ken said they could suggest funding sources, support requests to agencies (DNR), and help communicate the value of the network to state agencies and to the public.

10) Mechanisms of Groundwater Flow across Aquitards – Dave Hart explained the general hydrology of the Southeast Wisconsin study area with an emphasis on the role the Maquoketa Formation plays as a regional aquitard noting that it is largely responsible for the significant drawdown in the deep sandstone aquifer and the distance between the groundwater and surface water divides. Both are important effects due to water quality problems in the sandstone and the Great Lakes Compact use of the surface water divide to define the basin and potentially prohibit withdrawals from the Great Lakes Basin to thirsty communities outside the basin.

Despite the Maquoketa formation's important role as an aquitard, groundwater flow modeling work shows that approximately 12 million gallons per day move across the Maquoketa. Before this study it was unknown what the role of the rock, fractures, multi-aquifer wells, or erosional windows have in this movement.

Hydraulic conductivities measured in the laboratory, and by conducting slug tests, and using local and regional scale models, vary by almost 10 orders of magnitude and include flow rates higher than possible from just flow through rock. That coupled with a lack of evidence for erosional windows limits the possible explanations for the high flow through the Maquoketa to fractures and cross-connecting wells. Fractures known to be present in the formation include the Waukesha fault which is identified by outcrop in a quarry and offset in well logs as well as many other joints and fractures both large and small. Although without an offset it is nearly impossible to locate and identify these fractures it is expected that rock over 400 million years old would be extensively fractured.

By estimating the number of cross-connecting wells and the amount of water that could flow down those wells into the lower aquifer, Dave was able to estimate that the total well flow as about 30 % of total flow across Maquoketa shale. This leads to his recommendation that we continue to fill and seal multi-aquifer wells because they do not contribute enough water to the deep sandstone aquifer to offset the risk of contaminants entering the deep sandstone aquifer through these wells.

Dave also suggested that additional observation wells should be placed in the deep sandstone aquifer to improve our data and modeling predictions. Dave also advocated that DNR continue tracking the status and use data of high capacity wells. He found that only 69 of the 172 multi-aquifer wells in DNR's database (at the time of the study) had pumping records available.

The Council thanked Dave for his important research. Jeff Helmuth asked how many wells it would take to properly calibrate the regional groundwater flow model. Dave thought about 4 to 5

per county would be optimal. Mike Lemcke clarified that new well "abandonment" (now termed "filling and sealing" legislation made filling and sealing eligible for well compensation account funding. Also there is a new webpage for submission of required filling and sealing forms. Bob Pearson asked if plugging multi-aquifer wells would help groundwater rebound in the Silurian aquifer to which Dave replied that the effect would be very localized. Discussion of gamma and/or video-logging the deep Waukesha well followed ending with Mike Lemcke saying he would again check into funding opportunities. Bob Pearson opined that every State Park could be required to have a long-term observation well.

11) Adjourn and Next Meeting – The meeting was adjourned at 1:00. The next meeting will be held at 10:00 on August 22nd at the Wisconsin Department of Agriculture, Trade, and Consumer Protection.
Respectfully submitted,

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

Appendix C : Groundwater Research & Monitoring Projects 1985-2009

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	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	24
West Bend Area Road Salt Study	Marianna Sucht, DNR	1986-1991	DNR	8
Filtration Preservation Study of Groundwater Samples	David Sauer, John Schwalbe, DNR	1985	DNR	21a
Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin	Jack G. Saltes, Ed Kruel, DNR	1985	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	14a
Groundwater Monitoring Project for Pesticides	Jeffrey K. Postle, Kevin Brey, DATCP.	08/13/1985-06/30/1990	DNR	2
Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading	Thomas L. Portle, Carolyn Hunger, DNR	1985	DNR	19
Monitoring of Volatile Organic Compounds in Tomah, Wisconsin	Charles J. Krohn	1985	DNR	31a
Fate of Aldicarb Residues in a Groundwater Basin Near Plover, Wisconsin	George J. Kraft, WGNHS.	12/05/1985-06/30/1988	DNR	3
Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality	Phil Kammerer, USGS	1986	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	18
Evaluation Techniques for Groundwater Transport Models	John A. Hoopes, Howard Trussell, UW-Madison	09/25/1985-06/30/1986	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	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	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	17a
Barron County Nitrate Study	Dave Hanson, William McKinley, DNR	1985	DNR	37
Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills	Marci A. Friedman, DNR	1985-1987	DNR	4a
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	16

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	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	22
Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifer in Door County, Wisconsin	Kennth R. Bradbury, Maureen A. Muldoon, WGNHS. Margaret C. Blanchard, UW-Madison.	03/06/1986-06/30/1990	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	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	17b
Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations	William Boyle, Frederic J. Doran, UW-Madison	1985	DNR	23
Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin	Jim Anklam, William J. Evans, DNR	1985	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	13
Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision	John R. Tinker, UW-Eau Claire	1987-1990	DNR	11
Hydrogeologic Investigation and Groundwater Quality Assessment (Havenswood Landfill)	Pratap N. Singh, Miller Consulting Associates, Anthony R. Pawloski, Miller Consulting Engineers	1986	DNR	28
Investigation of Large Scale Subsurface Soil Absorption Systems	Daniel Peerenboom, DNR	11/13/1986-06/30/1987	DNR	42
Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System	Chris Norenberg, Jon Standridge, Wisconsin State Laboratory of Hygiene	1986	DNR	21b
Flambeau Paper Sulfite Lagoon Site Contamination Study	William Lantz, Dan Detroit, DNR	07/08/1986-08/15/1986	DNR	30
1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin	David Holman, Environmental Health Division, Rock County	1986	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	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	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	43
Plover Area Nitrate Study	Fred Bailey, DNR	1986	DNR	48

Project title	Investigators	Contract Period	Funding Agency	Project Number
Lead Contamination Study of Door County	Rick Stoll, DNR	1987	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	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	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	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	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	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	34
Radionuclides in Drinking Water of North central Wisconsin	Chuck Fitzgerald, Bill Dobbins, DNR	1987	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	52
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	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	49
VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications	Janet R. Battista, DNR	1988-1989	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	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	62
Effects of Volatile Organic Compounds on clay landfill liner performance	Edil, Berthouex, Park, Sandstrom		DNR	61
Grade A Dairy Farm Water Well Quality Survey	Gary LeMasters, DATCP. Douglas J. Doyle, WASS.	09/02/1988-06/30/1989	DNR	58

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	60
Designs for wellhead protection in Central Wisconsin	Osborne, Sorenson, Knaak, Mechenich		DNR	63
Pesticide Migration Study	Byron Shaw, UW - Stevens Point, and Mike Heitman, UW - Stevens Point	07/01/1989 – 06/30/1991	DNR	55
Optimum Manure Application Rate - Corn Shaw Fertility Management and Nitrate Leaching to Groundwater in Sandy Soils	Byron Shaw, Paul Trapp, UW - Stevens Point	07/01/1989 - 06/30/1991	DNR	71
Subdivision impacts on groundwater quality	Shaw, Ameson, VanRyswyk	07/01/1989 – 6/30/1991	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	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	75
Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN)	Bohn	07/01/1989 – 06/30/1990	DNR	68
Atrazine Contamination of Groundwater in Dane County, Wisconsin	Bradbury, McGrath	07/01/1989 – 06/30/1991	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
Follow Up to the Grade A Dairy Farm Well Water Quality Survey	Cowell, LeMasters	07/01/1989 – 06/30/1990	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	72
DNR and DATCP Rural Well Survey	LeMasters	01/1990 - 03/1991	DNR	69
Variation in Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology		01/1990 - 03/1992	DNR	74
Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells	Sonzogni, Eldan,, Lawrence, WSLH, UW-Madison	01/1990 - 03/1991	DNR	77
Nitrogen Isotope Monitoring at Unsewered Subdivisions		01/1990 - 03/1991	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	73
Integrated decision support for wellhead protection	Adams, Benson	07/01/1990– 06/30/1991	UWS	
Role of mobile colloids in the transport of chemical contaminants in groundwater	Armstrong, Shafer	07/01/1990-06/30/1992	UWS	
On-site nitrogen removal systems research demonstration project: Phase 1	Ayers and Associates	07/01/1990-06/30/1991	UWS	

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	
To Expand Groundwater Sampling in the Lower Wisconsin River Valley	Cates, Madison, Postle	07/01/1990–06/30/1991	DNR	78
Renovation of Pesticide Contaminated Rinse Water	Gordon Chesters, John Harkin	07/01/1990–06/30/1991	UWS	
In-situ Removal of Fe, Mn, and Ra from groundwater	Christensen, Cherkauer	07/01/1990–06/30/1991	UWS	
Reactions of Chlorohydrocarbons on Clay Surfaces	Fripiat	07/01/1990–06/30/1991	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	83
Chemical transport across a sediment-water interface	Green	07/01/1990–06/30/1992	UWS	
Adsorptive Behavior of Atrazine and Alachlor in Organic-Poor 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
Design of a small scale transportable mixing/loading system	Kammel	07/01/1990–06/30/1992	DATCP	
Municipal wastewater project	Kopecky	07/01/1990–06/30/1991	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	84
Using ground-penetrating 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	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	81
Facility plan amendment for wastewater collection for Green Lake Sanitary District, Green Lake, WI		07/01/1990–06/30/1991	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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	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	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	82
Waupaca County groundwater project: Towns of St. Lawrence and Little Wolf	Wilson, Blonde	7/01/1990-6/30/1992	DNR	79a
Waupaca County: Towns of Lebanon and Scandinavia	Wilson, Blonde	07/01/1991–06/30/1992	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	87
Evaluation of denitrification systems for improving groundwater from on-site waste disposal systems	Byron Shaw	07/01/1991–06/30/1993	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	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	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 biologic 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	88
Herbicide and nitrate movement in a sandy soil aquifer 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	07/01/1991–6/30/1993	DNR	96
Living mulch systems for nitrate trapping in vegetable production	Harrison	07/01/1991–06/30/1993	UWS	UWS

Project title	Investigators	Contract Period	Funding Agency	Project Number
Municipal wastewater absorption pond renovation for enhanced nitrogen removal	Gilbert	07/01/1991–06/30/1993	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	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	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	89
Evaluation of NURE hydrogeochemical groundwater data for use in Wisconsin groundwater studies	Bradbury, Mudrey, Shrawder	07/01/1991–06/30/1992	DNR	90
Distribution of radionuclides in Wisconsin groundwater	Bradbury, Mudrey	07/01/1991–06/30/1992	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	103
Ultrasonic verification technique for evaluating well seals	Tuncer Edil	07/01/1992–06/30/1994	UWS	UWS
A further study of organics at municipal solid waste landfills	Jack Connelly	07/01/1992–06/30/1994	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	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	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	102
The use of peat as an absorbtive medium	Jim Wiersma, Ron Stieglitz	07/01/1993–6/30/1994	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	112

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	110
Integrated computerized mapping of point source contaminants and physical environmental characteristics to protect and manage groundwater quality	Rick Stoll	07/01/1993–06/30/1994	DNR	105
Factors affecting the determination of radon in groundwater	William Sonzogni	07/01/1993–06/30/1994	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	95b
Investigation of potential groundwater impacts at yard waste sites	Pugh, Connelly	07/01/1993–06/30/1994	DNR	98b
Groundwater hydrogeology of an agricultural watershed	Ken Potter	07/01/1993–06/30/1995	DNR/DATCP	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 aquifers	William Hickey	07/01/1993–06/30/1995	UWS	94REM6 B2
Using "PREDICT" to reduce herbicide usage and improve groundwater quality	Harvey	07/01/1993–06/30/1995	UWS	94PES6B 2
Stratigraphy, sedimentology and porosity distribution of the Silurian rocks of Door County, Wisconsin	Mark Harris	07/01/1993–06/30/1995	UWS	94HGE2B 2
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	94PES1B 2
An investigation of field-filtering and low-field pumping when sampling for metals	Jack Connelly	07/01/1993–06/30/1994	DNR	106
Herbicide contamination of soil and groundwater at a mixing and loading site	Gordon Chesters	07/01/1993–06/30/1995	UWS & DATCP	94PES2B 2
Improved design of pump and treat systems for heterogeneous aquifers	Jean Bahr	07/01/1993–06/30/1995	UWS	94REM3 B2
Photocatalytic degradation of volatile organic carbon	Marc Anderson	07/01/1993–06/30/1995	UWS	94REM2 B2
Collection of hydraulic and geologic data to improve the quality of the Wisconsin Groundwater Monitoring Network	Zaporozec	07/01/1994–06/30/1996	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	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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	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 disrupters in drinking water	Warren Porter	07/01/1994–06/30/1996	UWS	UWS
Vertical and horizontal variability of hydrogeologic properties of glaciated landscapes	David Mickelson	07/01/1994–06/30/1995	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	116
Use of heavy nitrogen to study nitrate flux from septic systems	John Harkin	07/01/1994–06/30/1996	UWS & Comm	
A low-input crop management plan for Wisconsin fresh-market vegetable growers	Delahunt	07/01/1994–06/30/1995	DATCP	
A comparison of low flow pumping and bailing for VOC sampling	Jack Connelly	07/01/1994–06/30/1995	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	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	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 effectiveness 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 management and alleviate their public threat	Stoll	07/01/1995–06/30/1997	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-occurring arsenic 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	

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	123
Optimum management of groundwater resources in the Lower Fox River Valley	Jim Krohelski	07/01/1995–06/30/1997	DNR	122
Biostimulation 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	
Delineation of capture zones for municipal wells in Dane County, Wisconsin	Ken Bradbury	07/01/1995–06/30/1997	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	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	128
Stratigraphic controls on distribution of hydraulic conductivity in carbonate aquifers	Tony Simo	07/01/1996–06/30/1998	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	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	131
Molecular techniques for detection and identification of sewage-borne human pathogens in soils	William Hickey	07/01/1996–06/30/1998	Commerce	
Stratigraphy, sedimentology and porosity distribution of the Silurian Aquifer of Ozaukee County, Wisconsin	Mark Harris	07/01/1996–06/30/1997	UWS	
Experimental 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: sources of infectious diarrhea in central Wisconsin	Mark Borchardt	07/01/1996–06/30/1998	Comm	Comm
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	

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	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	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	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	136
Characterization of the hydrostratigraphy of the deep sandstone aquifer in southeastern Wisconsin	Timothy Eaton	07/01/1997–06/30/1999	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	138
Groundwater-surface water interactions in the Nine Springs watershed	Jean Bahr	07/01/1997–06/30/1999	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	

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	143
Sedimentology, stratigraphy, and porosity-conductivity relations of the Silurian aquifer 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	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	140
Mechanical controls on fracture development in carbonate aquifers: implications for groundwater flow systems	Cooke	07/01/1998–06/30/2000		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	07/01/1998-06/30/2000	UWS	
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	07/01/1999-06/30-2001	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	07/01/1999 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
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		

Project title	Investigators	Contract Period	Funding Agency	Project Number
Improvement of Wisconsin groundwater monitoring 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	156
Pesticide and nitrate leaching in soils receiving manure	Lowery, Arriaga, Stoltenberg	7/1/2000-6/30/2001	DATCP	
Public health impacts of arsenic contaminated drinking water	Knobeloch	7/1/2000-6/30/2002	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	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	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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
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	173
Development of a culture method for detection of Helicobacter pylori in groundwater	Sonzogni, Standridge, Degnan	7/1/2001-6/30/2002	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	173*
Importance of disinfection on arsenic release from wells	Sonzogni, Bowman Standridge, Clary	7/1/2001-6/30/2003	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	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	169
Susceptibility of La Crosse municipal wells to enteric virus contamination from surface water contributions	Hunt, Borchardt	7/1/2001-6/30/2002	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	170
Monitoring contaminant flux from a stormwater infiltration facility to groundwater	Dunning, Bannerman	7/1/2001-6/30/2003	DNR	168

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
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	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	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	181
Monitoring and predictive modeling of subdivision impacts on groundwater in Wisconsin	Bradbury, Bahr	7/1/2003-6/30/2005	DNR	178
Development of a groundwater flow model for the Mukwonago River watershed, southeastern Wisconsin	Bahr	7/1/2003-6/30/2005	DNR	180
Field and Laboratory Validation of Photoactivated Adsorption for Removal of Arsenic in Groundwaters	Anderson (Marc)	7/1/2003-6/30/2004	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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
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	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-Cancelled	DNR	188
Evaluating drinking-well vulnerability to viruses	Hunt, Borchardt	7/1/2006-6/30/2008	DNR	187
Identification and characterization of springs in west-central Wisconsin	Grote	7/1/2006-6/30/2007	DNR	184
Mapping and Characterization of Springs in Brown and Calumet Counties	Fermanich, Stieglitz, Zorn	7/1/2006-6/30/2007	DNR	183
Groundwater Mounding and Contaminant Transport Beneath Stormwater Infiltration Basins	Thompson	7/1/2006-6/30/2008	DNR	189
A Survey of Baseflow for Groundwater Protection Areas Western Fox-Wolf Watershed	Kraft	7/1/2006-6/30/2008	DNR	186
Centralizing Access to Groundwater Information for Use in Comprehensive Planning	Markham, Tang, Dunning	7/1/2006-6/30/2008	DNR	190
Mechanisms of Groundwater Flow across Aquitards	Hart, Bradbury, Feinstein and Yikoff	7/1/2006-6/30/2007	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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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	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	194
Use of Human and Bovine Adenovirus for Fecal Source Tracking	Pedersen UW- Mad	7/1/2006-6/30/2008	DNR	195
Knowledge Development for Groundwater Withdrawal Management around the Little Plover River	Clancy UW-SP	7/1/2006-6/30/2008	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	193
Transport and Survival of Pathogenic Bacteria Associated With Dairy Manure in Soil and Groundwater	Li , Yang	7/1/2007-6/30/2009	UWS	08-BEP-03
Is phosphorus-enriched groundwater entering Wisconsin streams?	Browne	7/1/2007-6/30/2009	UWS	08-CTP-01
Occurrence and generation of nitrite in ground and surface waters in an agricultural watershed	Stanley	7/1/2007-6/30/2009	UWS	08-CTP-03
Geochemical characterization of sulfide mineralization in eastern Wisconsin carbonate rocks	Luczaj and McIntire	7/1/2007-6/30/2008	UWS	08-GCP-01
Monitoring Septic Effluent Transport and Attenuation using Geophysical Methods	Fratta, Hart and Masarik	7/1/2007-6/30/2009	UWS	08-OSW-01
A thermal remote sensing tool for mapping spring and diffuse groundwater discharge to streams	Loheide	7/1/2007-6/30/2009	UWS	08-SAM-03
Influence of wetland hydrodynamics on subsurface microbial redox transformations of nitrate and iron	Bahr and Roden	7/1/2007-6/30/2009	UWS	08-WLA-02
Controls on methylation of groundwater Hg(II) in hyporheic zones of wetlands.	Shafer, Babiarz, Armstrong and Roden	7/1/2007-6/30/2009	UWS	08-WLA-03
Water Balance Modeling for Irrigated and Natural Landscapes in Central Wisconsin	Lowery and Bland	7/1/2007-6/30/2008	DNR	201
Assessment of virus presence and potential virus pathways in deep municipal wells	Bradbury , Gotkowitz, Borchardt and Hunt	7/1/2007-6/30/2008	DNR	197
Hydrostratigraphy and Groundwater Flow Model: Troy Valley Glacial Aquifer, Southern Waukesha Co., WI	Mickelson and Anderson	7/1/2007-6/30/2008	DNR	199
Understanding the Effects of Groundwater Pumping on Lake Levels	Kraft, Clancy and Mechenich	7/1/2007-6/30/2009	DNR	202
Assessing Seasonal Variations in Recharge and Water Quality in the Silurian Aquifer in Areas with Thicker Soil Cover	Muldoon and Bradbury	7/1/2007-6/30/2008	DNR	198
Investigating groundwater recharge to the Cambrian-Ordovician aquifer through fine-grained glacial deposits in the Fox River Valley, Wisconsin	Hooyer, Hart, Mickelson and Bradbury	7/1/2007-6/30/2008	DNR	200

Project title	Investigators	Contract Period	Funding Agency	Project Number
Assessing the Potential of Hormones from Agricultural Waste to Contaminate Groundwater	Hemming, Landreman and Hedman	7/1/2007-6/30/2009	DNR	203

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 2009
(July 1, 2008 – June 30, 2009)

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 12, 2007

Contact Christopher Babiarz, Water Resources Institute (*babiarz@aqua.wisc.edu*) or Jeff Helmuth, WDNR (*jeffrey.helmuth@wisconsin.gov*) 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

To: Interested Researchers
From: Todd Ambs, Groundwater Coordinating Council
Date: October 12, 2007
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 2009 (FY 09) beginning July 1, 2008.

The solicitation is a coordinated effort of the University of Wisconsin System (UWS), the Wisconsin Departments of Natural Resources (DNR), Agriculture, Trade and 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 $340,000 will be available for new monitoring and/or research to meet specific agency needs and objectives in FY 09.

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 12, 2007.** Investigators are required to submit proposals using *iPropose*, a web-based proposal submission system that will open for registration on Monday, October 15, 2007. Please visit the UW Water Resources Institute website (*http://wri.wisc.edu*) for more information.

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 09 Joint Solicitation for Groundwater Research and Monitoring Proposals

October 2007

The University of Wisconsin System (UWS) and the Wisconsin Departments of Natural Resources (DNR), Agriculture, Trade, and Consumer Protection (DATCP), and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems. Up to $340,000 will be available for groundwater-related monitoring and research in fiscal year 2009 (FY 09) for new projects. The four programs, which are collectively called the Wisconsin Groundwater Research and Monitoring Program (WGRMP), are summarized as follows:

1. UWS Groundwater Research - The UWS, through its UW-Madison Water Resources Institute (WRI), has received funding since FY 90 for groundwater research. Projects may be of a fundamental or applied nature on selected aspects of groundwater research in the natural sciences, engineering, social sciences, or law. Through FY 07, the UWS has invested $5.3 million on 148 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 (US Geological Survey). The UWS will have $90,000 to fund new projects in FY 09.

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 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. The DNR anticipates having up to $250,000 to support groundwater research and monitoring studies in FY09.

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 07, DATCP has 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 09. DATCP will, however, take part in the proposal review process.

Department of Commerce Private Onsite Wastewater Treatment System Research – The Division of Safety & Buildings (formerly in the Department of Industry, Labor, and Human Relations) received an annual appropriation of $50,000 from 1990 to 1993 to fund research on alternatives to current private sewage-system technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on private sewage systems. Through FY 07, Commerce has spent approximately $600,000 on eight projects. Two projects were co-funded with DNR and UWS. Due to budget shortfalls, Commerce will not have money to fund research projects in FY 09. Commerce will, however, take part in the proposal review process.

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 Monitor*ing" 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 the 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.

Christopher Babiarz, UW Water Resources Institute: (608) 265-5085; *babiarz@aqua.wisc.edu*
Jeff Helmuth, Dept. of Natural Resources: (608) 266-5234; *jeffrey.helmuth@wisconsin.gov*
Jeff Postle, Dept. of Agriculture, Trade and Consumer Protection: (608) 224-4503;
jeff.postle@wisconsin.gov
Harold Stanlick, Department of Commerce: (262) 521-5065; *hstanlick@commerce.state.wi.us*

Eligibility

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

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

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

Principal investigators that are significantly overdue with completed final reports to this program will not be eligible for new funding. In the case of UWS, reports are considered significantly overdue six months after the initially specified or understood completion dates. The GCC may consider extenuating circumstances on a case-by-case basis.

Submission of Proposals

Proposals for the Wisconsin Groundwater Research and Monitoring Program (WGRMP) will be submitted via the University of Wisconsin Water Resources Institute's (WRI) website at *http://wri.wisc.edu*. Complete directions for submission of proposals will be posted on the WRI website by October 15, 2007. **The deadline for submittal of proposals is 5:00 pm Monday, November 12, 2005.**

Investigators will be required to provide the following information when submitting 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 template for the proposal narrative will be available for download from the WRI website in both Microsoft Word and WordPerfect formats
3. A budget spreadsheet in Microsoft Excel format. A template for the budget spreadsheet will be available for download from the WRI website in Microsoft Excel format.
4. A transmittal form with signatures of individuals authorized to sign off of proposal submissions. Details will be provided on the WRI website.

To create a PDF file, investigators may use the online or the desktop version of Adobe Acrobat software. Adobe online offers a monthly subscription service for creating PDF files and a free trial subscription to create 5 PDF files. Visit *https://createpdf.adobe.com* for more information.

Proposals should be no longer than 18 pages. All pages should be 8.5" x 11". The project summary, narrative, curriculum vitae, and support pages should start on a new page, 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. *Guidelines for Proposal Submission* begin on page 8 and a checklist is available for download on the WRI website.

All proposals must be submitted using the instructions that will be available on the WRI website after October 15, 2007. No facsimiles of proposals and no hand-written proposals will be accepted. Special attachments (maps, brochures, etc.) will be accepted, noted, and kept on file, but will not be included in the package of materials submitted to reviewers.

Review of Proposals

All proposals received through the 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 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 2008. Proposals that are not chosen for funding through this solicitation may be referred to other funding sources for their consideration with permission of the investigators. Likewise, other funding organizations may refer proposals to the funding agencies involved in this solicitation.

Administration of Projects

Proposals that are funded become the property of the granting Wisconsin state agency. Please note that each agency has separate mechanisms for administering funds, and separate requirements for reporting. However, all investigators will be asked to submit a 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 Christopher Babiarz.

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. Reports from projects funded by DNR, DATCP, and Commerce are kept on file with the respective agencies. Many of these reports are also provided to the WRI Library for public distribution. All of the two-page Project Summaries submitted by project investigators upon completion of their project are made available on the WRI website (*http://wri.wisc.edu*).

Previously, only summaries of the funded projects were available online. In 2006, the WRI Library partnered with the UW Digital Collections Center to digitize and post most WRI and selected DNR final project reports online. The WRI Web site now links to the full-text reports, which are included in the University of Wisconsin Ecology and Natural Resources Digital Collection at *http://uwdc.library.wisc.edu/collections.html*.

Guidelines for Proposal Submission

Investigators are required to submit proposals using *iPropose* (a web-based proposal submission system developed by the UW Aquatic Sciences Center). **The deadline for submission is 5:00 p.m. (Central Standard Time) on Monday, November 12, 2007.** The submission system will open on October 15, 2007 and is located on the UW Water Resources Institute website (*http://wri.wisc.edu*).

The steps for entering information and uploading a proposal are relatively simple. The overall proposal format is identical to previous years, and a checklist is available for download on the WRI website. There are eight steps in the process, and we recommend that investigators concentrate on step one and step two prior to using the online system:

STEP 1: Prepare full proposal. Please use the Microsoft Word or Corel WordPerfect templates that can be downloaded using the online version of these guidelines (located on the UW Water Resources Institute website *http://wri.wisc.edu*). The proposal will consist of the following items:

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

B. Project Summary (begin on same page; **not to exceed 2 double-spaced pages**)
    1. Specific groundwater or related problem addressed by research/monitoring proposal.
    2. What will findings contribute to problem solution or understanding?
    3. Project objectives.
    4. Project approach to achieve objectives, including methods and procedures.
    5. Potential users of project findings.

C. Proposal Narrative (begin on new page; **not to exceed 10 double-spaced pages**)
    1. Objectives
    2. Background information describing prior research/monitoring relevant to objectives and, if applicable, relationships to other projects funded through the Wisconsin Groundwater Research & Monitoring Program (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.

D. Curriculum Vitae of Principal Investigators (begin on new page; **not to exceed 4 pages total**). Provide curriculum vitae (including recent publications) for each investigator and state the percentage of time that each will spend on the project (whether funding is requested for that individual or not).

E. Current or Pending Support (begin on new page; **not to exceed 2 pages**).

After the full proposal is prepared, convert it to Adobe PDF format and save it on your local computer or network. When you submit your proposal package online you will be uploading this PDF file. The system requires that the proposal be in Adobe Acrobat PDF format (.pdf).

STEP 2: Prepare budget information. Please use the Microsoft Excel budget spreadsheet that can be downloaded using the online version of these guidelines (located on the UW Water Resources Institute website *http://wri.wisc.edu*). The budget will consist of the following items:

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 for meetings is excluded due to limited funding).

F. Other Costs (e.g., equipment maintenance and fabrication, subcontracts, rentals, etc.).

Please note: At the point of submission, the funding source should be considered State of Wisconsin GPR funds. *Facilities and Administration costs (F&A), formerly called indirect costs, do not apply.* In the event a proposal is selected for funding by the Department of Natural Resources (DNR), Department of Commerce, or Department of Agriculture, Trade & Consumer Protection (DATCP), the budget may need to be revised to include F&A costs, depending on the source of the funding they use.

Save the Excel budget file on your local computer or network as you work on it. When you submit your proposal package online you will be uploading this Excel file. The system requires that the budget be in Excel format (.xls).

STEP 3: Create an *iPropose* account. Developed by the UW Aquatic Sciences Center, *iPropose* is a user-friendly web tool for submitting your proposal. Investigators must register online (*https://aqua.wisc.edu/iPropose*) before submitting proposals. **Note:** *iPropose* will open for registration and submission on October 15, 2007. Instructions on the site will assist you in entering your proposal package.

Steps Four through Six (below) may be completed separately. *You do NOT need to upload your entire proposal package in a single session.* Your account will remain active through the submission deadline (5 p.m. November 12th), and you may edit each section until your proposal is officially submitted (see Step 7). **Note:** Your proposal is not officially submitted until you click on the "Submit Proposal" button.

STEP 4: Enter information about your proposal into the online system:

A. Title

B. Abstract (condensed version of project summary (300 words maximum). It is recommended that the abstract is prepared in a word processing program, saved locally and then copied and pasted into the online form. This suggestion is for your protection in case there were problems with your submission.

C. Location of field research.

D. Principal and associate investigators.

E. Ranking of agencies in order of preference or relevance for funding: University of Wisconsin System, DNR, DATCP and Commerce. (Note that this ranking does not exclude consideration of a proposal by any of the agencies, but it does assist the reviewers in evaluating the proposal.)

F. The name of at least one financial contact and the department/entity where project will be administered if approved for funding.

G. Names and email addresses of three qualified reviewers, including their areas of expertise (two of the reviewers must be from outside Wisconsin).

STEP 5: Upload the proposal PDF file into the online system. This is the file that you prepared in Step One.

STEP 6: Upload the budget information Excel file into the online system. This is the file that you prepared in Step Two.

STEP 7: Submit your proposal. Please review the accuracy of the information provided before submitting your proposal. To formally submit your proposal package, select the "Submit Proposal" button at the bottom of your screen. **This step MUST be done by 5:00 p.m. CST Monday, November 12, 2007.**

STEP 8: Provide proof of administrative approval. Your submission is not complete until you provide official administrative approval to the Water Resources Institute. Authorization forms are due by 5:00 p.m. Monday, November 12, 2007. Your proposal will not be considered for funding without an appropriate authorization form on file:

UW-Madison applicants must provide a completed UW-Madison transmittal form (also known as a T-Form). An interactive PDF version of the T-Form can be downloaded using the online version of these guidelines (located on the UW Water Resources Institute website *http://wri.wisc.edu*). Although the T-Form is normally used for extramural funding, we use it here to ensure your proposal has administrative approval through the appropriate intramural channels (your department and your dean/director's office). As a result, the T-Form is NOT processed through the Office of Research and Sponsored Programs (RSP) at the time of proposal submission. If your proposal is selected for funding by DNR, DATCP, or Commerce, its status would change to extramural and a revised T-form will be routed through RSP.

Non-Madison applicants need to provide a completed WRI Proposal Transmittal/ Authorization form (or equivalent) to demonstrate administrative approval. An interactive PDF version of this form can be downloaded using the online version of these guidelines (located on the UW Water Resources Institute website *http://wri.wisc.edu*).

The authorization forms need to be delivered, scanned and emailed, or faxed to Dan Marklein, (address 264 Goodnight Hall, 1975 Willow Drive, Madison, WI 53706; email *marklein@aqua.wisc.edu*; fax (608) 890-1125) no later than 5:00 p.m. Monday, November 12, 2007.

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 $90,000 available in FY 09 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.

- 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.

- Impact of contaminated groundwater on Wisconsin families, including human health effects on reproduction, development, and chronic disease; or on economic losses attributable to groundwater contamination.

- Impact of land-use practices on groundwater quantity and quality, including the effects of agricultural, industrial, municipal, residential, or waste management activities that either contaminate or recharge groundwater.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
FY 09 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 $250,000 to fund new monitoring and research projects in FY 09 (July 1, 2008, through June 30, 2009). 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 or 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 thorough documentation of methods, all the data collected, and a 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.

Monitoring and Research Priorities

The DNR has identified the following priorities for groundwater monitoring and research for FY 09. 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 in Northeast Wisconsin have been 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:
    - Mechanisms, pathways and timing of movement into groundwater and private drinking water wells in Northeast Wisconsin
    - Methods for evaluating sites in Northeast Wisconsin for suitability for livestock waste application
    - Influence of landscape settings
    - New analytical tools (microbial source tracking, isotopic methods, etc.)
    - Methods of assessing the vulnerability of private water supply wells
    - Associated contaminants (bacteria, nitrate, pharmaceuticals, viruses, other pathogens, etc.)
    - Best management practices
    - Influence of climatic effects (droughts, floods, climate change)

2. **Information to Support Implementation of 2003 Wisconsin Act 310.** In May 2004, state statutes were modified, setting new standards and conditions for protection of surface waters as part of the process in evaluating applications for high-capacity wells (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:

- *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 [cfs] at least 80 percent of the time." While historic records pertaining to springs have recently been compiled into a single database, current information is generally lacking throughout the state. Updated spring inventories, using uniform methods, are needed in many parts of the state, along with maps and characterization of these springs. Given that the existing statutory definition of spring specifies a flow criterion of 1 cfs, verification of the location and flow characteristics of springs with reported flows of approximately 1 cfs would have the most immediate value. Also, better information about spring hydrology is needed to assess the impacts of high capacity wells on spring flow rates and characterize the susceptibility of certain spring types or size categories to impacts as a result of groundwater drawdown.
- *Impacts of high capacity wells on surface waters* - 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 methods for estimating stream flow rates in areas where stream gaging data is sparse, how a reduction in baseflow affects water quality, temperature, fish and other biota, habitat, and how to best evaluate these impacts. There is a need for the development of advanced screening and assessment tools useful in areas where there are significant numbers of both agricultural high-capacity wells and high-quality surface water resources. There is also a need for more surface water/groundwater interaction research (e.g. streambed conductance, recharge area identification, assessment of irrigation practices and consumptive use coefficients for agricultural applications, characterization of wetland and lake hydrology).
- *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, quantity and surface waters is needed. Examples include estimates of current and projected water use rates; basin-scale groundwater budgets; and quantification of environmental, social and economic impacts of groundwater withdrawals.

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

- Reduced water demand through conservation, reuse and irrigation efficiencies
- Identification of water-dependent environmentally sensitive resources (e.g. calcareous fens)
- Efficient and accurate water use reporting
- Enhancement of natural recharge
- Identification and evaluation 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.** A GCC-facilitated statewide groundwater monitoring strategy has been incorporated into the DNR Water Division's Monitoring Strategy (*http://dnr.wi.gov/org/water/monitoring/strategy.htm*). Its purpose is to provide a common state and federal agency framework to coordinate groundwater monitoring programs. A major component of the strategy is updating and refining the State Observation Well Network. Data from the existing network needs to be examined to help prioritize locations and depths of new wells to be added to the network. As natural groundwater contaminants cause some water users to shift towards shallower aquifers, other groundwater users in other areas are shifting towards deeper aquifers where there may be a greater quantity available. The network needs to track the groundwater resource in three dimensions. Another 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 evaluated 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 the following areas:

   - *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. The information is needed to 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.
   - *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 (e.g. stormwater) on groundwater quality and quantity. Simple tools should be developed for communities evaluating how land use decisions impact groundwater.
   - *Identifying abandoned wells in wellhead protection areas for filling and sealing* – Open wells can be a conduit for groundwater contamination. There is a need to assess the extent of the problem (e.g., an area-wide pilot project).

Ongoing Needs

The following topics are the result of input 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.

Viruses and Other Microbial Contaminants – Well water monitoring has shown the presence of viruses in public and private groundwater supplies. US EPA's Groundwater Rule will be requiring small public systems to install treatment for microbial control. Private wells in many parts of the state are also at risk. Areas where work is needed most include: 1) evaluation of existing treatment systems effectiveness; 2) development of new treatment system technology that would be effective, feasible for smaller systems, with minimal owner maintenance and

chemical use, and easy to install; and 3) adenovirus research - genotypes, affects, routes of exposure, what people are impacted, and drinking water implications.

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 09

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 09. DATCP will, however, take part in the proposal review process and recommend funding for projects that meet their research objectives. Contact Jeff Postle (608-224-4503) for more information about DATCP research priorities if you intend to submit a pesticide-related proposal to another funding agency. Investigators should note that the focus of the DATCP program is on pesticide and nutrient research, which includes but is not limited to groundwater issues.

DATCP Research Priorities for FY 09

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

- Directed toward protecting public health, groundwater and surface water quality;
- Result in onsite sewage treatment that is consistent with the provisions of the Groundwater Protection Law;
- Be affordable by the average owner of an onsite sewage system; and
- Be practical for the climate and soils of Wisconsin.

The department also intends to monitor, on an ongoing basis, the performance of various 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.

Due to budget constraints, the Department of Commerce will not have money available to fund projects in FY 09. 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.

Department of Commerce Research Priorities for FY 09

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.