Wisconsin Groundwater Coordinating Council

REPORT TO THE LEGISLATURE

August, 2009

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Department of Health Services - **Henry Anderson, MD**
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State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

Jim Doyle, Governor

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August, 2009

To: The Citizens of Wisconsin
The Honorable Governor Jim Doyle
Senate Committee on Environment and Natural Resources
Assembly Committee on Natural Resources
Secretary Frank Busalacchi - Department of Transportation
Secretary Dick Leinenkugel - 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 2009 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 25 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 09 (July 1, 2008 to June 30, 2009) 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*.

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

- Passage of the Great Lakes Compact and Implementing Legislation – 2008 Wisconsin Act 227.
- Implementation of 2003 Wisconsin Act 310 – the Groundwater Quantity Law - resulted in major improvements in the collection of high-capacity well pumpage data, with 2008 data setting a baseline for groundwater usage.
- GCC-facilitated research on virus-contamination of groundwater-supplied public drinking water supplies showed virus occurrence is more widespread than expected. New techniques for detecting and tracing viruses have been developed through this work.
- Key groundwater information and education efforts including Water Resources Institute publications of fact sheets on nitrate and arsenic in groundwater, groundwater teacher workshops, and a new outreach program created at the Wisconsin Geological and Natural History Survey.

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 2009 (FY 09). 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 09. Examples include:

The UW Water Resources Institute (WRI) funded and continued to work closely with the GCC Education Subcommittee on a comprehensive groundwater education/outreach project that resulted in fact sheets on nitrate and arsenic in groundwater (*http://aqua.wisc.edu/publications/productslist.aspx?CategoryID=38&sel=6*), and activities for Groundwater Awareness Week (March 9-15, 2009). The latter included groundwater-related press releases prepared by UW-Stevens Point and WRI, and a public radio talk show with DHS and DNR representatives discussing groundwater issues.

Members of the GCC's Education Subcommittees helped guide the Wisconsin Well Water: Planning Web-Based Resources project (http://www.uwsp.edu/cnr/watersheds/programs_outreach/hwpp.htm). The project's focus is on developing web-based tools to systematically provide information to Wisconsin's domestic water well users that will aid in individual determinations of drinking water safety. The subcommittee also provided content for the DNR's web page entitled "What's Wrong with My Water?"

Three groundwater workshops for teachers were held in January of 2009 in Mount Horeb, Eau Claire, and West Bend. Staff from the DNR, WGNHS and the Central Wisconsin Groundwater Center at UW - Stevens Point instructed teachers on using a groundwater sand tank model and

provided other groundwater teaching aids. Teachers from 24 different schools attended the workshops and received a free model for their school.

The DATCP geographic information system-based well construction report search tool was made available to staff in other state agencies. This innovative tool offers user-friendly access to reports fundamentally important to our understanding of groundwater.

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 10 solicitation for groundwater research and monitoring proposals was released in October 2008 (see *Appendix D*). A total of 18 project proposals were received. A comprehensive review process resulted in the selection of 5 new projects for funding for FY 10, all by UWS. The GCC approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The FY 10 groundwater monitoring and research projects are listed by funding agency in Table 2, including projects that were carried over from FY 09.

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 09. Several highlights are below.

The Great Lakes Compact - Signed by Governor Doyle in 2008, the Compact requires Wisconsin to have water conservation goals within the Great Lakes Basin. Implementing legislation – 2007 Wisconsin Act 227 – is currently being implemented. In FY 09 the DNR has issued interim approvals to persons who were withdrawing water in the Great Lakes Basin above the threshold permitting level of 100,000 gallons per day as of December 8, 2008. The DNR is also planning to promulgate administrative rules related to the following Compact-related topics: Registration & Reporting; Water Use Permitting; Consumptive Use/Water Loss; Public Participation; Water Conservation & Efficiency; and Water Supply Service Area Planning; and Water Withdrawal Fees.

*Nutrient Management Plan*ning - 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 calendar year 2008, $2,900,000 was allocated to provide cost-sharing to farmers for the development and implementation of nutrient management plans (NMP) for their cropland. In 2008, Wisconsin attained a record number of cropland acres under NMPs, achieving 1,600,000 acres, a 60% increase over acres reported in 2007.

The Groundwater Protection Act (2003 Act 310) - Chapter NR 820, Wis. Adm. Code, Groundwater Quantity Protection (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. In FY 09 DNR staff made progress updating a high-capacity well inventory and collecting annual pumpage reports. In May 2009 data on this groundwater usage was first compiled and made widely available. These data are establishing important baseline information regarding water use in the state and will be used for a variety of resource management concerns.

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 about 60 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. Related chemical compounds that form when the parent pesticide compounds break down in the soil and groundwater are called pesticide metabolites. The most commonly detected pesticide compounds in Wisconsin groundwater are: metabolites of alachlor (Lasso) and metolachlor (Dual), and atrazine and its metabolites. 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 and 2007, 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, included 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. The DNR has recently begun tracking total coliform detects in the raw water samples through its Drinking Water System database.

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 viruses found in the municipal wells and wastewater system in Madison (Bradbury, 2007).

Leaking sanitary sewers were shown to be a source of infectious viruses to drinking water wells in subsequent work funded by WDNR and the USGS (Hunt and others, in review). Marshfield Clinic and USGS researchers sampled over 30 unconfined municipal wells in 14 Wisconsin communities. From this survey 8 wells had surface water contributions, 4 had unambiguous waste-water tracers, and 5 were positive for viruses. Follow-up investigation of the shallow groundwater system between 3 of these wells and suspected sanitary sewer sources showed that sampling at any one time may not show concurrent virus and trace presence due to analytical precision and seasonality of the sources in the waste stream. However, given sufficient sampling over time, a good relation between unambiguous waste-water tracers and virus occurrence was identified - locations that were characterized by recurring unambiguous tracer occurrence also were found to have enteric viruses present. Moreover, it was demonstrate that high-capacity pumping can induce viruses to move into a well before they are inactivated during their time in the subsurface.

Microbial contamination of groundwater is not restricted to vulnerable or shallow aquifers. Researchers recently discovered human viruses in the confined aquifer supplying Madison's drinking water. This finding was completely unexpected because it was believed a shale confining layer protected the aquifer from microbial contamination. Additional research on the Madison wells has shown virus transport from leaking sanitary sewers to the wells is very rapid, on the order of weeks to months instead of years. The virus transport and contamination levels were particularly high after extreme rainfall events or rapid snowmelt. From a public health perspective, the lesson learned is that all aquifers are potentially vulnerable to microbial contamination and require a similar level of disinfection for drinking water purposes.

Public and private water samples are not regularly analyzed for viruses due to the high cost of the tests. The presence of coliform bacteria has historically been used to indicate the water supply is not safe for human consumption. However, recent findings show that coliform bacteria do not always correlate with the presence of enteric viruses.

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). 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 federal drinking water standard of 10 µg/L. Although arsenic has been detected in well water samples in every county in Wisconsin, 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 use was estimated to be 983 Mgal/d in 2005, but much of the increase between

2000 and 2005 was due to a shift in how irrigation water use was estimated. 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. Implementing legislation – 2007 Wisconsin Act 227 – is currently being implemented.

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 $15.2 million has been spent by DNR, UWS, DATCP, and Commerce through FY 09 on 369 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

DIRECTIONS FOR FUTURE GROUNDWATER PROTECTION

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

- Evaluate acute and chronic impacts to groundwater from manure management practices.
- Understand and better predict impacts from groundwater withdrawals
- Continue to evaluate and catalog Wisconsin's groundwater resources
- Investigate extent and origins of naturally occurring substances in groundwater
- Evaluate occurrence of recently discovered groundwater contaminants
- Understand the links between land use and groundwater quantity and quality
- Evaluate potential impacts of climate change on Wisconsin's groundwater
- Address groundwater quantity management issues at both statewide and regional levels
- Find solutions to groundwater nonpoint pollution problems
- Meet funding needs for nutrient management practice research to evaluate resource protection effectiveness

- Develop methods to assess and protect against health hazards posed by exposure to 'orphan' contaminants as well as multiple contaminants in a water supply
- Continue to fund groundwater monitoring and research
- 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

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Chapter 1 – INTRODUCTION

PURPOSE OF THE REPORT

The Groundwater Coordinating Council (GCC) is required by s. 15.347, Wis. Stats., to prepare a report which "summarizes the operations and activities of the council…, describes the state of the groundwater resource and its management and sets forth the recommendations of the council. The annual report shall include a description of the current groundwater quality of the state, an assessment of groundwater management programs, information on the implementation of ch. 160, Wis. Stats., and a list and description of current and anticipated groundwater problems." This report is due each August. The purpose of this report is to fulfill this requirement for fiscal year 2009 (FY 09).

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 09. *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 (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. 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.

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. 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. The rule, Ch. NR 820, formally defines the extent of Groundwater Management Areas as required by Act 310 and also 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.

Major components of 2003 Wisconsin Act 310 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. A municipal water supply 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. 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. Pursuant to Act 310, the GAC was terminated at the end of 2007.

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.

Great Lakes Compact and 2007 Wisconsin Act 227

In May 2008, Wisconsin ratified the Great Lakes – Saint Lawrence River Basin Water Resources Compact (Compact) and enacted legislation to implement the Compact in the state. By July 8, 2008, all eight Great Lakes states had ratified the Compact through state legislation. On September 23, 2008 the U.S. Congress consented to the states' ratification, and the President signed Congress' Consent resolution on October 3, 2008. As a result, the Compact took effect on December 8, 2008 – significantly sooner than expected.

The Compact is the legally binding implementation for the Great Lakes states of the Great Lakes – Saint Lawrence River Basin Water Resources Agreement (Agreement), also signed in December 2005 by the Great Lake states, Ontario and Quebec. The Agreement, a good faith pact among the states and provinces, parallels the Compact, but lacks enforceability because states cannot enter into legally binding treaties with foreign governments.

The Compact addresses water quantity management in the Great Lakes – Saint Lawrence River Basin (Basin). It sets out requirements for Basin water uses in the areas of registration, reporting, management, and water conservation and efficiency. It also prohibits diversions of Basin water with limited exceptions for straddling communities, communities in straddling counties and intrabasin transfers (transfers of water from one Great Lake basin to another).

Under the Compact, states are required to develop a program for management of Basin withdrawals, including both groundwater and surface water withdrawals that relies on a decision making standard for new or increased withdrawals. States are also required to develop and implement a Basin water conservation and efficiency program. These programs will be reviewed by the Regional Body (a Body comprising the governors of the Great Lakes states and the premiers of the Canadian provinces of Quebec and Ontario) on a regular basis. The Compact also calls for the submission of initial withdrawal amounts (or baselines) for water users, annual reports on Basin water use, and periodic assessments of cumulative impacts to the Regional Body.

Wisconsin's legislation implementing the Compact—2007 Wisconsin Act 227—is extensive.

Registration - Act 227 calls for statewide registration of existing and new water withdrawals with the capacity to withdraw more than 100,000 gallons per day averaged over 30 days.

Reporting – Withdrawals over 100,000 gallons per day averaged over 30 days must be reported annually. Existing state statutes already require this reporting for groundwater withdrawals; however, most surface water withdrawals, other than municipal, are not currently being reported. This requirement applies statewide.

Baseline – An initial withdrawal amount must be determined for all withdrawals existing as of December 8, 2008—the Compact's effective date. This amount will be the basis for determining if a proposed increase in a withdrawal exceeds the threshold for applying a decision making standard.

Management of Basin Withdrawals (Water Use Permits) –Act 227 directs that Great Lakes Basin withdrawals over 100,000 gallons per day averaged over 30 days require a permit. General permits will be issued for withdrawals of 100,000 gallons per day or more averaged over 30 days. Individual permits will be issued for withdrawals exceeding 1 million gallons per day for 30 consecutive days. Water use permits (both general and individual) establish the authorized withdrawal amount, as well as requirements for reporting and water conservation. General permits have a 25-year term; individual permits have a 10-year term.

Water Conservation and Efficiency –Act 227 requires that the Department develop and implement a water conservation and efficiency program with voluntary measures to apply across the state, additional mandatory elements that apply in the Great Lakes Basin, and the most stringent requirements for communities applying for diversions or water uses with high rates of water loss.

Public Participation –Act 227 requires that a public notice, comment and hearing process be developed as part of the review of all new water use permits and applications for diversions.

Water Supply Service Area Plans – An additional element of the new legislation is the requirement for water supply service area plans. Act 227 requires all municipalities with water supply systems that supply more than 10,000 people to have an approved water supply plan by 2026. This planning process is modeled after the wastewater planning process and uses a cost-effectiveness analysis that assesses the environmental and economic impacts of alternatives in the plan to determine the approach that maximizes environmental benefits and minimizes total resource costs over the planning period.

State Water Use Report –Act 227 also requires the department to develop a statewide water resources inventory and publish a state water use report every five years.

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 09. 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 09, 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.* The recommendations from the summit continue to guide the GCC's activities.

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

To complement the 2008 publication, Protecting Wisconsin's Buried Treasure booklet, the UW-Madison Water Resources Institute (WRI) completed two of a series of four fact sheets on Wisconsin's most important groundwater resource issues: nitrate, arsenic, groundwater quantity, and pathogens. The booklet, and fact sheets on nitrate and arsenic in groundwater are available at: http://aqua.wisc.edu/publications/productslist.aspx?CategoryID=38&sel=6. These publications are being completed in collaboration with the GCC Education Subcommittee.

The WRI is also continuing to update its website (www.wri.wisc.edu) providing access to summaries of GCC-facilitated groundwater research and cataloging all WRI research reports into WorldCat and MadCat, two library indexing tools that provide both worldwide and statewide access to this research.

Climate change continued to be the focus of outreach and education efforts sponsored by the UW-Madison WRI during FY 09. The WRI cosponsored "Water Matters: A Lecture Series" as part of the October 2008–January 2009 "Mami Wata: Arts for Water Spirits in Africa and its Diasporas" exhibit at the UW-Madison Chazen Museum of Art. Designed to enhance public awareness and understanding of water resources issues in the context of a changing climate, the series attracted 295 attendees, of whom 71 percent reported that they gained new insights as a result of the lecture they attended.

The WRI also helped support "Climate Change in the Great Lakes Region: Starting a Public Discussion," a seminar series featuring eight climate-effects experts who discussed what is known, what is predicted and what can be done to adapt to a changing climate. An 80-page summary report and DVD featuring video and the PowerPoint® presentations from all eight seminars were published (available at: http://aqua.wisc.edu/publications/productslist.aspx?CategoryID=33&sel=2. To date, 760 copies of the printed summary report and 50 copies of the DVD have been distributed, and the online PDF of the report has been downloaded 2,129 times.

Climate change in the form of "Wisconsin's Changing Water Resources" was the theme of the American Water Resources Association-Wisconsin Section's annual conference March 5-6, 2009, in Stevens Point. Sponsored by the WRI, UW-Stevens Point Center for Watershed Science and Education (CWSE), WDNR, WGNHS, and the USGS Wisconsin Water Science Center, the conference's plenary session topics included global effects of climate change, effects of climate change on Wisconsin lakes and future implications of climate change to Wisconsin. About 170 water managers and scientists from throughout Wisconsin attended the conference, which featured more than 60 oral and poster presentations on a wide range of related water resources topics.

For the ninth 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 attended the workshops and received a free model for their school. With funding from a U.S. Environmental Protection Agency (EPA) grant, over 200 groundwater models have been given to schools or nature centers since 2001 and nearly 400 educators have received hands-on training in using the model effectively.

UW-Extension staff continue to offer drinking water education programs that provide communities across Wisconsin the opportunity to have their private wells tested. In FY 2009, nearly 1,200 private well owners in 10 different counties took part in this educational opportunity.

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 at the UW-Extension Drinking Water Quality display. The DNR and Dept. of Commerce had additional displays focused on well water issues, well construction, water treatment devices and backflow prevention.

A series of press releases was distributed to local media outlets to promote Groundwater Awareness Week March 8-14, 2009. The issues covered in those releases included groundwater quality, quantity and water conservation. In addition, the WRI arranged for Stephen Ales and Kevin Masarik to discuss groundwater and drinking water concerns on Wisconsin Public Radio's Larry Meiller show.

The Department of Natural Resources recently launched a web page entitled "What's Wrong with My Water?" The resource provides information for well users to find information to help diagnose water quality problems. It also assists well users in finding information concerning water testing and treatment.

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 10 Joint Solicitation for Proposals in August of 2008 (see *Appendix D*). In January 2009, members of 2 GCC Subcommittees reviewed the research and monitoring proposals and made their recommendations to the agencies and the GRAC. In March 2009 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 2 completed fact sheets on nitrate and arsenic in groundwater and work on two more facts sheets on

groundwater quantity and pathogens in groundwater.

- UWS and agency activities for Groundwater Awareness Week (March 8-14) including an appearance by GCC member Dr. Henry Anderson and DNR Hydrogeologist Steve Ales on the Larry Meiler radio show to discuss groundwater issues.
- FY 10 joint solicitation for groundwater proposals
- UWS FY 10 groundwater research plan
- The creation of a new WGNHS outreach program focused on developing more digital information available on an interactive website.
- Research on rapid movement of water and contaminants through soil cracks.
- New, streamlined meeting format for GCC meetings.
- Research on virus presence and pathways into deep municipal wells in Madison
- DNR's Water Use Program and the Great Lakes Compact
- Research on causes of low flow in the Little Plover River
- Impacts of State budget cuts on groundwater programs
- Research on thermal remote sensing of stream temperature and groundwater discharge and its applications to groundwater policy

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 10. The subcommittee also met with the Monitoring and Data Management Subcommittee in January 2009 to review proposals that were submitted in response to the FY 10 solicitation. Subcommittee members made recommendations that were used by the UWS and DNR in deciding which groundwater-related proposals to fund for FY 10. The projects to be funded in FY 10 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 18 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 10.

The subcommittee also identified and prioritized ongoing efforts, contextual items, and near-term projects to focus future activities.

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 09. 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 into a few new issue-related fact sheets, revisions to existing groundwater brochures and content for the DNRs web page entitled "What's Wrong with My Water?". The subcommittee also participated in a one-day discussion centered on technology-based solutions to enhance well water quality outreach education. Lastly, the subcommittee made an effort to promote Groundwater Awareness Day in Wisconsin by providing a series of press releases to local media outlets and participating in a discussion of well water and groundwater on the Larry Meiller Radio Show. 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 FY 09 but several members began exploring webcam technology to facilitate virtual meetings to minimize travel time for future meetings.

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 $15.2 million has been spent through FY 09 on approximately 369 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 09, the DNR has spent approximately $7 million on 206 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 09, the UWS has spent $5.9 million on 160 groundwater research projects. Several projects have been co-funded with DNR, Commerce and/or DATCP and 13 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 09, 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 09, 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 09 Proposal Solicitation. The Solicitation for Proposals (SFP) for FY 09 was distributed in September 2007. A total of 15 project proposals were submitted in response to the SFP. To assist in the review process, a joint meeting of the Monitoring & Data Management and Research Subcommittees of the GCC was held in January 2008 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, nine new projects were selected for funding; three by DNR and six by UWS. Eight ongoing projects were carried over into FY 09. A total of 17 projects were funded through the joint solicitation at a cost of approximately $560,000 (see Table 1). DATCP and Commerce did not fund projects in FY 09.

FY 10 Proposal Solicitation. The SFP for FY 10 was distributed in October 2008 for funding in FY 10. 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 17, 2008.

As was done in the FY 09 solicitation, the entire submission and review process was conducted online through a secure Web site administered by the WRI. A total of 18 proposals were submitted, requesting a total of $1,061,076 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 2009 to rank the proposals. In addition, the GRAC met in February 2009 to select projects to recommend to the GCC for UWS funding.

A total of five new projects were selected for funding by UWS. Including continuing projects the UWS will fund eight projects during FY10 for a total of $286,356. DATCP, DNR and Commerce will not be funding projects in FY 10. With the assistance of Federal (USGS) dollars leveraged through the Water Resources Institute, all of the continuing UWS projects that began in FY 09 will be funded through FY 10. The projects to be funded in FY 10 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 again in FY 05 and by 4.5% in FY10. DNR's state groundwater funding for projects has been cut significantly starting in 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 to 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. DNR selected no projects for FY10 due to State budget shortfalls but plans to renew its commitment to groundwater research and monitoring when funds are again available.

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, U.S. 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 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. In FY 09 work has continued to digitize and post more project summaries and final reports on the WRI website.

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 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 (Kraft)	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 and Hart	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-03	Controls on methylation of groundwater Hg(II) in hyporheic zones of wetlands.	Shafer and Babiarz	UW-Madison	$44,400
UWS*	08-WLA-02	Influence of wetland hydrodynamics on subsurface microbial redox transformations of nitrate and iron	Bahr and Roden	UW-Madison	$39,869
UWS	09-SOS-01	Use of the 2009 Behavioral Risk Factor Surveillance Survey to Assess the Safety of Private Drinking Water Supplies	Knobeloch	UW-Madison and DHS	$23,250
UWS	09-REM-01	Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water	Li	UW - Parkside	$9,960
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

The total cost of all projects funded through the UWS (including fringe benefits and USGS contribution) through the FY09 Joint Solicitation for proposals was $343,591 ($275,500 without USGS -- including 6% administration)

*	Continuing project
**	UWS continuing project funded with USGS 104 B funds

Table 1 (Continued): Groundwater Research and Monitoring Projects Funded in FY 09

Agency	Code	Title	Investigators	University	Cost
DNR *	08-HDG-05	Water Balance Modeling for Irrigated and Natural Landscapes in Central Wisconsin	Lowery and Bland	UW-Madison	$44,426
DNR *	08-HDG-01	Understanding the Effects of Groundwater Pumping on Lake Levels	Kraft, Clancy and Mechenich	UW-Stevens Point	$34,853
DNR *	08-BEP-01	Assessing the Potential of Hormones from Agricultural Waste to Contaminate Groundwater	Hemming, Landreman and Hedman	UW-Madison	$25,461
DNR	09-HDG-01	Drawdown in the Northeast Groundwater Management Area (Brown, Outagamie, and Calument Counties, Wisconsin)	Luczaj	UW – Green Bay	$40,863
DNR	09-CTP-04	Human viruses as tracers of wastewater pathways into deep municipal wells	Bradbury, Borchardt and Gotkowitz	UW - Extension	$52,037
DNR	09-SAM-02	Development and Validation of a PCR-based Quanification Method for *Rhodococcus coprophilus*	Long	UW -SLH	$35,560
The total cost of all projects funded through the DNR in FY 09 through the Joint Solicitation for proposals was $233,200					
*	Continuing project				

Table 2: Groundwater Research and Monitoring Projects Funded in FY 10

Agency	Code	Title	Investigators	University	Cost
UWS*	09-SOS-01	Use of the 2009 Behavioral Risk Factor Surveillance Survey to Assess the Safety of Private Drinking Water Supplies	Knobeloch	UW-Madison and DHS	$26,750
UWS**	09-REM-01	Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water	Li	UW - Parkside	$10,954
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	$15,649
UWS	10-BEP-02	Fecal Source Tracking Using Human and Bovine Adenovirus and Polyomaviruses	Pedersen, McMahon, Long	UW-Madison	$ 49,907
UWS	10-GCP-01	Predicting Mercury Methylation: Testing the Neutral Sulfide Speciation Model in a Groundwater-Dominated Wetland	Shafer	UW-Madison	$ 42,717
UWS	10-WSP-01	Assessing the Effect of Pleistocene Glaciation on the Water Supply of Eastern Wisconsin	Grundl	UW-Milwaukee	$ 50,000
UWS	10-HDG-02	Forecasting Impacts of Extreme Precipitation Events on Wisconsin's Groundwater Levels	Gotkowitz	UW-Extension	$ 39,582
UWS	10-SAM-01	DTS as a Hydrostratigraphic Characterization Tool	Bahr and Hart	UW-Madison	$ 36,094

The total cost of all FY 10 UWS –funded projects selected through the joint solicitation (including fringe benefits and USGS contribution) proposals is $286,356 ($259,753 without USGS, and incl. 6% administration)

Table 3: Groundwater Research and Monitoring Projects FY99 - FY09

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
2009	9	306,771	3	128,460	6	178,311	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
2009	8	254,426	3	104,740	5	149,686	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	667,372	10	389,739	10	277,633	0	0	0	0
2009	17	561,197	6	233,200	11	327,997	0	0	0	0
Total	251	6,552,027	92	2,893,411	137	3,137,551	21	463,065	1	58,000

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

2001-09 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 and much of the Great Lakes Compact 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 last 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 Wisconsin Dept. of Health Services (DHS) is currently evaluating a list of substances, submitted to it by the DNR, for possible new groundwater quality standards development. If adequate toxicological information is available DHS will develop recommendations for possible new (or revised) groundwater quality standards for the substances on the list.

The Drinking Water and Groundwater Program (DG) maintains a table listing NR 140 health and welfare 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 to resource web sites listed in the table allow users to obtain additional toxicological and health related information on many of the table substances.

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 (see Chapter 1 for more information on the Act). 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. Since then these staff have handled work 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 administrative rule authorized by Act 310 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. Since late 2007, when Ch. NR 820 went into effect, the DNR has approved fewer than 10 wells in groundwater protection areas. In most cases, the application involved a proposed well with a pumping capacity that was very small relative to the size of the potentially affected water body. For each well that was approved within a groundwater protection area the DNR determined that the well would not result in significant adverse environmental impact and in some cases imposed conditions on the operation of the well to ensure that significant impacts did not occur.

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 2008, 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 pumpage report forms were mailed to owners of high capacity wells to report their 2007 and 2008 pumping. Pumpage data was collected for 2008 and was substantially more complete. The level of compliance, in terms of percentage of wells for which pumping was reported, increased in the second year of reporting to approximately 67%, and is expected to continue to increase in subsequent years. High capacity well pumpage data is available on the DNR's website. 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 groundwater use in the state.

Great Lakes Compact and Implementation of 2007 Act 227 - Congress' unexpectedly swift consent to the Great Lakes Compact in 2008 greatly accelerated the timetable for implementing the Compact in Wisconsin.

In FY 09 the DNR has issued interim approvals to persons who were withdrawing water in the Great Lakes Basin above the threshold permitting level of 100,000 gallons per day as of December 8, 2008. The DNR is also planning to promulgate administrative rules related to the following Compact-related topics: Registration & Reporting; Water Use Permitting; Consumptive Use/Water Loss; Public Participation; Water Conservation & Efficiency; and Water Supply Service Area Planning; and Water Withdrawal Fees.

The DNR's post rule development workload will include implementing the following programs: Registration & Reporting; Permitting in the Great Lakes Basin (DNR's Northern, Northeast, and Southeast Regions); Water Supply Service Area Planning; Statewide Water Conservation & Efficiency; and Public Participation.

The Governor's proposed 2009-11 biennial budget includes position authority and funding for 2 FTE in FY 2010; and an additional 2 FTE in FY 2011, along with funding for water quantity monitoring and database and GIS development. To fund the program in FY 2011 and beyond, the Governor's budget also includes a statewide water withdrawal base fee of $125 on all water supply systems with the capacity to withdraw 100,000 gallons per day, and an additional fee to be imposed in the Great Lakes Basin only on persons who withdraw more than 50 million gallons per year. The DNR is directed to promulgate a rule to implement the latter fee.

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.

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.

The Private Water Section also responds to numerous complaints regarding the contamination of private wells. Contamination by manure has been an increasing problem in recent years. Using the results of newly developed analytical tools for tracking the source of microbial contamination, staff are able to determine whether fecal contamination is from grazing animal manure or human sources (see the "Microbial Agents" section in Chapter 4, and the "Detection and Monitoring of Microbiological Contaminants" section of Chapter 5 of this report for more information on the development and use of microbial source tracking methods). These new tools have proven useful in granting Well Compensation awards to private well owners with well contamination from manure. Since 2006 when the Well Compensation statute was revised to allow use of funds for replacement of water supplies due to manure contamination, about 40 well compensation grants totaling over $500,000 have been awarded for that purpose. Additional costs have been incurred by well owners to cover related expenses not covered by the grants.

Private water staff developed a web page titled "What's Wrong with My Water?" The website answers some commonly asked questions about private well water quantity, helps well owners diagnose their aesthetic water quality problems and captures and preserves DNR water supply institutional knowledge.

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 with well construction reports and many other related files.

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.

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 promoted as a solution to problems that water utilities may face in managing peak seasonal water demands. 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 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.

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 both federal regulatory requirements and Wisconsin's Groundwater Law.

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 the required ASR demonstration test and received a conditional approval to operate its ASR well; however, after performing two additional ASR cycles, the concentrations of manganese and iron in groundwater were observed to have increased to levels that are above their respective enforcement standards. As a result of the exceedances, the utility is required to make changes to its ASR operations plan. If ASR operations cannot be modified in a manner that will return the ASR facility to compliance with Wisconsin's groundwater protection regulations, the DNR is required to rescind its approval for Oak Creek Water and Sewer Utility to operate an ASR system. ASR activities have been temporarily suspended while the water utility considers its options. A final decision on future ASR operations will be made in 2010.

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 goal of Wisconsin's Wellhead Protection (WHP) program is to reduce the risk of groundwater contamination in areas contributing groundwater recharge to public water supply wells, 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 WHP planning. A video and several publications are available to assist communities in their WHP efforts. The DNR also maintains a web page (dnr.wi.gov/org/water/dwg/gw/wellhead.htm) with a variety of relevant information.

In addition, the DNR has developed a tracking system for wellhead protection activities in the DNR's Drinking Water System database. The DNR uses this information to report annually to U.S. EPA on WHP progress.

In FY 09, 18 communities submitted wellhead protection plans to the DNR. There are now 342 communities who have a WHP plan for at least one of their wells.

For the ninth 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. Educators from 24 schools centers took part in the workshops held at Mount Horeb, Eau Claire, and West Bend and were able to take a free groundwater model back to their school. Besides learning how to use the groundwater model, the educators received groundwater resources to incorporate groundwater concepts into their classroom. The intent of the workshops is to provide information for teachers to educate students – and their parents – on the importance of protecting groundwater in their own communities. With funding from an EPA grant, groundwater models have been given to over 200 schools or nature centers since 2001.

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.

The DNR provided WHP information to Wisconsin communities, 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.

The DNR continued to work with the federal Farm Service Agency to identify cropland in WHP areas. Farmers that own cropland in WHP 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 worked with U.S. EPA Region V and the other Region V states to increase the acreage eligible for CRP in WHP areas. The new CRP Rule (7 CFR part 1410) defines WHP areas as including land located within a 10-year time of travel surrounding a public well. The proposed rule published on April 7, 2009 and is currently undergoing interagency review.

Groundwater Information and Education. As noted in the WHP 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.

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 three 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 09, six projects were supported at a total cost of $233,200. Due to the State budget shortfall, no new projects were selected for funding in FY 10. 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://www.wri.wisc.edu*

In FY 09, DG staff continued to work with representatives from the DATCP, USGS, WGNHS, and UW Stevens Point on implementing the statewide groundwater monitoring strategy. 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 online. 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 09. 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.

DG staff assisted in making the DATCP well construction report search tool available to agency staff outside of DATCP. This new geographic information system-based tool offers expanded features over previously available applications.

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 was completed by February 2009.

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), and 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. In FY 2009, the program spent $1.76 million in Environmental Fund dollars to initiate or continue environmental cleanup actions at over 73 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 09, DNR awarded 42 Site Assessment Grants totaling approximately $1.7 million to 29 communities across the state. Small grants up to $30,000 make up 30 of the awards, while 12 are large grants between $30,000 and $100,000. Local governments have also pledged more than $607,000 in additional funds for the projects, well beyond the 20 percent match required through the application process.

The grants will provide funds for environmental activities on 162 acres of land. Activities include 61 site assessments and investigations, the demolition of 61 buildings or structures and the removal of 17 tanks, drums and other abandoned containers. Since site assessment grants began 10 years ago, the state has awarded more than $15 million to 199 communities to begin investigation and cleanup on more than 1,500 acres.

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 09, the RR program awarded $118,950 in grants for two brownfields projects; a $19,000 grant for one, and a $99,950 for another. The RR Program was unable to award additional funds this fiscal year due to a forced lapse of funds as a result of the Wisconsin state budget shortfall.

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 U.S. EPA Brownfields Site Assessment Grant, the partners have begun site investigation activities on more than 30 sites in the Corridor since 2004.

In FY 09 the partnership continued with significant progress by:
- completing Phase I environmental site assessments at 23 properties;
- completing or continuing Phase II work at 16 properties; and
- identifying additional sites for Phase I or II assessment work.

Completion of the first grant occurred 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.

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 70 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 09.

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 09, DNR issued a Certificate of Completion at 6 properties for completed cleanups and 10 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. As of June, 2009, there are 230 sites in the program, with 182 at various stages of investigation and cleanup and 48 sites closed. The program is implemented through ch. NR 169, Wis. Adm. Code. The DERF program closed to new applicants in August of 2008.

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.

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 Program

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 occasionally assists or participates in local planning efforts for existing developed areas (served by onsite wastewater treatment systems) that are investigating the possibility of providing a public sewerage system.

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 U.S. 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 continues to implement revisions to NR 243 that became effective on July 1, 2007.

There are currently 185 WPDES permits issued for livestock operations (87% dairy; 5% poultry; 4% swine; 4% 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.

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: Sections NR 151.07 and ATCP 50.04(3) require all crop and livestock producers to develop and implement nutrient management plans. Technical Standard NRCS 590 contains planning and implementation requirements that must be met. 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) and 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 technical resources and expertise to implement NRCS Standard 590, including development and dissemination in cooperation with the University of Wisconsin of the field-based Soil Nutrient Application (computer) Program. Implementation of this performance standard can not be required without cost sharing in certain situations. A multi-partner conservation consortium was effective in securing cost share resources from the legislature to help farmers meet the requirements. The DATCP administers these funds

through its Soil and Water Resource Management Program. In addition, the NRCS provides cost sharing for development and implementation of comprehensive nutrient management plans including 590 compliant planning and implementation. In other situations, cost sharing does not have to be provided to require compliance. This includes compliance for farms operating under a WPDES Animal Feeding Operation Permit, farms receiving state Farmland Preservation tax credits, livestock operations obtaining local permits under the state Livestock Siting Law and livestock operations that voluntarily apply for new or altered manure storage facilities when the local regulation requires development and implementation of a nutrient management plan.

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 with the latest revision being effective on April 1, 2009. A set of maps for 101 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 assists in the protection of water resources through nutrient management. The DNR rules on runoff management to protect both groundwater and surface water, NR 151, Wisconsin Administrative

Code, lay out the procedures for implementing and enforcing compliance with agricultural performance standards including nutrient management. The nutrient management rules apply to all crop and livestock producers that apply manure or other nutrients directly or through contract to agricultural fields. DATCP has adopted the USDA NRCS 590 nutrient management standard via administrative rule, ATCP50, to meet DNR's performance standards. Under Wisconsin Statutes, cost-share funds must be made available to producers to compel compliance. However, as many as half of Wisconsin farms may be compelled to comply with nutrient management standards and other performance standards without cost-sharing because they are either: Concentrated Animal Feeding Operations (operations with 1,000 animal units or greater); or, farms regulated by local manure storage or Livestock Siting ordinances; or, participants in the Farmland Preservation Program or Working Lands Initiative Program;.

DATCP's nutrient management standard includes a number of practices to protect groundwater from the impacts of nutrient applications including:

- nutrient and manure application setbacks from karst features and other conduits to groundwater.
- combinations of reduced nutrient application rate, timing, and nutrient sources to mitigate movement of nutrients and manure when applying to highly permeable or thin soils.
- nitrogen applications must meet University of Wisconsin recommendations for crop production.

Like other agricultural performance standards, the nutrient management standard is "designed to achieve water quality standards by limiting nonpoint source water pollution" (Chapter 281.16 (3) 'Nonpoint sources that are agricultural'). Requiring applications of nitrogen to meet University of Wisconsin recommendations for crop production, in conjunction with the other practices listed above, is meant to "limit" non-point pollution of groundwater. Recent statewide estimates by DATCP indicate that in 2007, over 200 million pounds of nitrogen (from all sources) were applied *in excess* of UW recommendations. Clearly, if Wisconsin's agricultural lands were to meet University recommendations for crop production, and comply with the other required nutrient management practices, significant reductions in nitrogen loading to groundwater would be realized.

Research conducted by John Norman on silt loam soils at Arlington indicates that applications of nitrogen to UW recommendations on continuous corn would, on average, roughly comply with the nitrate water quality standard of 10 parts per million. Other research cited later in this report, on other soils and cropping systems, indicate that UW recommendations for nitrogen would result in leaching of nitrogen to groundwater that would exceed the nitrate standard. Additional research, and importantly, monitoring of actual in-field practices are needed to illuminate the effectiveness of the nutrient management standard to protect groundwater under various conditions. DATCP has advocated that approach through its priority recommendations to the GCC.

Currently, less than 20% of agricultural land in Wisconsin follows an approved nutrient management plan. DATCP contends that the current nutrient management standard, while not 100% protective under all conditions, would dramatically improve water quality if it were implemented widely throughout the state.

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 from $520,000 to $6.5 million in the second year of 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. DATCP elected to phase in nutrient management cost-sharing over two years, allocating about $3.0 million in 2008. Due to budget shortfalls, cost-share funding was reduced to about $740,000 for 2009. Despite budget cuts, DATCP continued to maintain funding for implementation support, ensuring access to farmer training and other support activities.

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.

Through these combined efforts, DATCP increased the number of acres covered by NM plans statewide in 2008 to over 1.6 million acres, an increase of about 600,000 acres from 2007.

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. Thirteen 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.

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 900 acute spills of agrichemicals. The ACCP staff have

received 997 reimbursement applications and provided over $ 33.3 million in reimbursement payments.

The Pollution Prevention for Agrichemical Dealerships program began in 2000 and has evolved and been renamed the Environmental Partners program. Its purpose is to reduce the amount of agrichemicals that escape into the environment during routine transfer and handling of agricultural chemicals and fertilizers at agrichemical storage and dealership sites. The program helps protect soil and groundwater by encouraging better management practices. 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 can be shared so that everyone can learn and benefit from the program. To date, about 45 agrichemical dealerships have volunteered for assessments at their dealership sites. More information about this program can be obtained at ***http://www.datcp.state.wi.us*** (keyword search "Environmental Partners").

In 2007, DATCP received authority to manage a pollution prevention grant program. DATCP began preparing rules to govern how this grant program would be implemented, but with budget reductions and hiring limitations, has had to place a hold on further rule development.

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 56,000 wells and nearly 361,000 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 Stan Senger, DATCP, 2811 Agriculture Drive, PO Box 8911, Madison,

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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. Currently in Wisconsin there are over 50 approved stormwater use or wastewater reuse plumbing systems.

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

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.

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 U.S. 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, was recently revised with an effective date of February 1, 2009. Another revision covering the Federal Energy Policy Act of 2005 operator training requirements is in the final stages of rule revision with anticipated implementation in the last quarter of 2009.

Since 1991 the database inventory of petroleum product and CERCLA hazardous substance underground storage tanks regulated under Chapter Comm 10, Wis. Admin. Code has increased from 143,681 to 181,353, along with 33,311 registered aboveground tanks, 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 May 20 23, 2009, the database reflects 81,444 federally regulated tanks with only 12,345 tanks in use and 313 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 90% 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.

Addressing "abandoned" tanks continues to be a challenge due to the difficulty in locating the site or the tank to determine if the tank exists and take the respective regulatory action. There currently are 6,746 abandon USTs on the tank database.

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 past year the department partnered with trade associations working with the regulated community to provide training related to the revised Comm 10 and the pending operator training.

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 for FY09 and in 2010 is $10 million. In FY08, the PECFA program reimbursed $14.9 million to 796 claimants. The Program currently reimburses claimants within two 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 100 sites per year.

Blight Elimination and Brownfield Redevelopment (BEBR) Grants
The BEBR program typically receives $7 million/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 $66,415,000 in grants since the inception of the initiative in 1998. Funds have been used to remediate 171 properties with soil or groundwater contamination. Program staff has reviewed 323 applications requesting a total of over $165 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 is working with county code administrators and POWTS industry members to upgrade the reporting and recording of inspection, maintenance and servicing events for onsite sewage systems. The department promulgated a rule revision in late 2008 that implements POWTS program related provisions contained in 2005 Wisconsin Act 347. The revised rule requires that counties conduct an inventory to identify all POWTS within their jurisdictional areas. Counties must also initiate new or enhance existing reporting programs related to inspection, maintenance and servicing events. This is expected to be a multi-year effort with code specified deadlines

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 30 rest areas and 60 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 1,271 salt storage sites listed in the database and 2,459 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@wisconsin.gov.

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 provides interim drinking water advisories for substances that do not have a current enforcement standard. DHS staff serves 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 09

In June of 2008, twenty-nine counties in southern Wisconsin were affected by severe flooding. In many of these areas, a larger portion of the population relies on private wells as the main source of drinking water. 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. DHS encouraged homeowners with impacted wells to test their drinking water for coliform and E. coli. Between June 8th and June 30th, 885 samples were tested at the SLH. Of these, 250 (28.2%) were found to be unsafe. E. coli was found in 54 (6.1%) of the June samples. Well testing and well disinfection continued for many months after the event. Between June 8th and December 31st a total of 3016 well water samples were sent to the SLH. Of these, 912 (30.2%) were unsafe. E. coli was found in 126 (4.2%) of all samples. DHS will continue to work with flooded communities and provide sampling into the next fiscal year.

In response to the demand for environmental specialists to assist impacted homeowners with testing and well disinfection, DHS requested two Applied Public Health Teams from the United States Public Health Service. The teams arrived August 22nd and assisted homeowners in the hardest hit counties until September 18th. During that time, the teams visited 1,047 homes, took 196 samples, and conducted 118 well disinfections.

Revisions to NR 140 groundwater quality standards were last 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. DHS is currently evaluating a list of substances, submitted to it by the DNR, for possible new groundwater quality standards development. DHS will develop recommendations for possible new (or revised) groundwater quality standards for the substances on the list if adequate toxicologic information is available.

DHS has developed environmental public health tracking (EPHT) modules to create data systems that link health outcome information with relevant information on hazards and exposures. 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.

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.

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 include bacteria, nitrates, fluoride, and arsenic.

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.

Figure 1 shows the locations of WGNHS projects that were active in FY 2009. Highlights of the WGNHS groundwater activities for FY 09 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 09, the Survey initiated or carried out geologic and/or groundwater studies in the following counties: Brown, Dane, Calumet, Columbia, Fond du Lac, Iowa, Marquette, Outagamie, Sheboygan, 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 09 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 and analyses in the SEWRPC (Southeastern Wisconsin Regional Planning Commission) region, spanning seven counties in SE Wisconsin. During FY 09 this work included development of groundwater recharge maps for the entire Region and an analysis of the sustainability of shallow groundwater using a series of demonstration models. The WGNHS also participated in the development of new groundwater flow models for the Troy Valley area in southern Waukesha and northern Walworth Counties.

b. Geologic mapping and groundwater investigations. With funding from the federal STATEMAP program and additional funding from the UW Groundwater Research Advisory Council, 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 FY09 included 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. During 2009 the WGNHS completed a research study of groundwater movement through clayey sediment of the glacial Lake Oshkosh basin. This study, funded in part through the Wisconsin Joint Solicitation Program, is evaluating the aquitard characteristics of the lake clays and implications for recharge and groundwater management.

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 FY09 the WGNHS completed the first of two follow-up studies to sample additional wells in the Madison area and to evaluate the pathways and mechanisms of virus transport to the deep wells; this work shows that viruses are present in many wells and that transport times from the surface to the wells can be rapid (see Http://www.uwex.edu/wgnhs/news.htm). Municipal sewers are a likely virus source. This work will continue in FY 10.

c. *Flooding*. Severe flooding occurred across a large portion of southern Wisconsin following intense rainfalls in June, 2008. In several areas, long-lasting flooding occurred far from streams and rivers. At these locations, the water table rose above the land surface. The WHNHS provided technical assistance and education programs to several communities affected by high water table elevations, including Spring Green (Sauk County), Brooklyn (Dane County), and Clear Lake (Rock County).(see http://www.uwex.edu/wgnhs/news.htm) . In 2010 the WGNHS will begin a new the examine links between flooding and climate change.

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. 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 2009 this method was applied to the SEWRPC area in SE Wisconsin and to Dane County 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 09 the WGNHS participated in a study of

recharge in shallow-bedrock areas of Calumet, Kewaunee, Brown, and Manitowoc 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..

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.

g. *Water-level recovery in the Lower Fox Valley*. In late 2007, suburban communities in the Lower Fox Valley reduced consumption of groundwater 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 Survey 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. Also, in 2008, the Survey initiated new county-wide bedrock mapping and stratigraphic interpretation of Brown County with support from the USGS STATEMAP program, and this bedrock mapping should be completed in 2010. In early 2009 the Survey conducted borehole geophysics and packer testing in several boreholes. These boreholes have improved the understanding of hydrostratigraphy in the region. Survey staff also provided oversight to a graduate student who compiled pumpage and water level data for the region. These efforts will continue in FY2010.

Groundwater Data Management

During FY 09 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 2008 the WGNHS updated this database to include hydrogeologic properties of materials. The data are available 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 early 2009 the Survey hired a new Outreach Manager, who has the responsibility to manage and direct the Survey's education and outreach programs.

In FY 10 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, flooding, karst and shallow bedrock, 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 10. 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 10. We also provide a collection of representative Wisconsin rocks for teachers to use, which include samples of our major aquifers.

Recent WGNHS Publications Relevant to Wisconsin's Groundwater Resources

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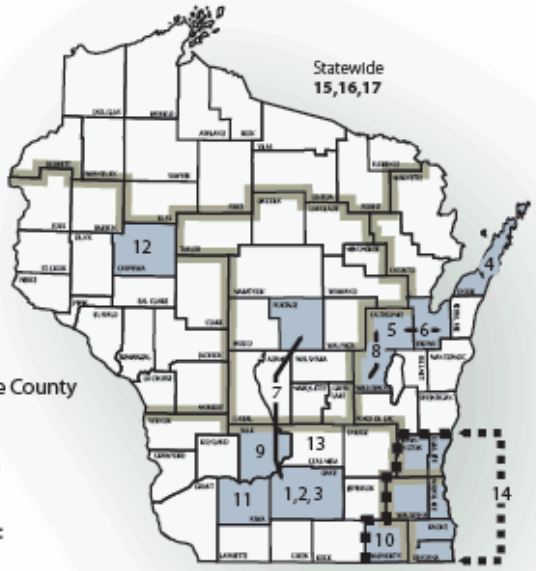
UW Extension
Cooperative Extension

Wisconsin Geological and Natural History Survey

Current projects—2009



Water resources

County

1. Occurrence and pathways of human viruses in deep municipal wells: Dane County
2. Hydrogeology of Dane County
3. Effects of unsewered subdivisions on groundwater: Dane County
4. Groundwater budget for Dunes Lake: Door County
5. Investigation of groundwater movement through thick clayey lake sediment: Outagamie County
6. Monitoring water-level recovery of deep wells following construction of a water-supply pipeline to Lake Michigan: Brown and Outagamie Counties
7. Geophysical methods for detection of septic effluent: Portage and Dane Counties
8. Fox River Valley arsenic project: Winnebago and Outagamie Counties
9. Response to groundwater flooding and evaluation of climate change on water table elevation in Spring Green: Iowa County
10. Development of a groundwater flow model in the vicinity of Geneva Lake: Walworth County
11. Groundwater resources of Iowa County
12. Groundwater quality inventory: Chippewa County
13. Groundwater resources of Columbia County

Regional

14. Hydrogeology of southeastern Wisconsin: Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Waukesha, and Washington Counties

Statewide

15. Groundwater level observation network
16. Techniques of aquitard evaluation
17. Hydrogeology of fractured rocks and karst in Wisconsin

water resources

Wisconsin Geological and Natural History Survey
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State Geologist: James M. Robertson

Figure 3.1 Current WGNHS water resources projects

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 FY 09 included research focused on various groundwater contaminants, including pathogenic bacteria, endocrine disrupting chemicals, phosphorus, nitrate/nitrite, methylmercury and arsenic.

During FY 09, the WRI directed a wide-ranging program of priority groundwater research consisting of 11 projects (see Table 1). 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:

- Occurrence and Generation of Nitrite in Ground and Surface Waters in an Agricultural Watershed
- A Thermal Remote Sensing Tool for Mapping Spring and Diffuse Groundwater Discharge to Streams
- Transport and Survival of Pathogenic Bacteria Associated With Dairy Manure in Soil and Groundwater
- Is Phosphorus-Enriched Groundwater Entering Wisconsin Streams?
- Monitoring Septic Effluent Transport and Attenuation using Geophysical Methods
- Influence of Wetland Hydrodynamics on Subsurface Microbial Redox Transformations of Nitrate and Iron
- Controls on Methylation of Groundwater Hg(II) in Hyporheic Zones of Wetlands
- Use of the 2009 Behavioral Risk Factor Surveillance Survey to Assess the Safety of Private Drinking Water Supplies
- Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water

- "The Lethal and Sublethal Effects of Elevated Groundwater Nitrate Concentrations on Infaunal Invertebrates in the Central Sand Plains"
- Assessing Levels and Potential Health Effects of Endocrine Disrupting Chemicals in Groundwater Associated with Karst Areas in Northeast Wisconsin

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, UW-Green Bay, UW-Parkside and UW-Oshkosh.

The UWS selected five new groundwater research projects from this year's Solicitation for Proposals for support during FY 10 (July 1, 2009–June 30, 2010), and three projects, selected from the previous year's solicitation, will receive continuation support during FY 10 (see Table 2). The new projects are based at UW-Madison and UW-Milwaukee.

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 UW-Madison Water Resources Library maintains an extensive curriculum collection of guides with innovative approaches and other educational materials for 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. iPROPOSE received several administrative enhancements during FY 09 to simplify and streamline the reviewer assignment process. New tools allow easier tracking of assigned reviewers and global management of their reviews. New features also allow fast and easy database record comparisons and merging.

Information and Outreach Activities

In 2007, 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 to date it has logged 19,080 page views and 3,289 unique visitors. The month of March was the most active month of the period was March, when 4,622 page views and 680 visitors were logged.

Water Resources Publications

In 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*, documents the accomplishments, impacts and benefits of the Groundwater Research & Monitoring Program. Drawing on some of the most important issues identified in the pamphlet, two fact sheets were published in 2009: *Nitrate in Groundwat*er and *Arsenic in Groundwater*. Two more fact sheets are in preparation on *Water Quantity and Groundwater Drawdown* and *Pathogens in Groundwater*. These publications will 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 to date, and a free electronic copy of the pamphlet in the ASC's online Publications Store has been downloaded 1,048 times between the date it was posted (11/1/07) and the end of May 2009.

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 the ASC Publications Store. Since its publication, a total of 490 print copies have been distributed and 21,321 downloads of the online PDF have been logged.

"Water Matters" Lecture Series

The WRI cosponsored "Water Matters: A Lecture Series" as part of the public programming accompanying the October 2008–January 2009 "Mami Wata: Arts for Water Spirits in Africa and its Diasporas" exhibition at the UW-Madison Chazen Museum of Art. Besides the Chazen and WRI, other major partners in this project were the UW Sea Grant Institute and the UW-Madison Department of Art History. Designed to enhance public awareness and understanding of water resources issues in the context of a changing climate, the series of five lectures featured presentations by the WRI director (Anders Andren) and faculty members from the UW-Madison American Indian Studies Program, Center for Limnology, Zoology Department and Life Sciences Communications; Northland College Department of Biology, and UC-Berkeley.

The series attracted a total of 295 attendees, and evaluations were submitted by 116 (39%). Evaluation data indicate 52% of the lecture attendees were adult campus visitors (the primary target audience), 48% were students (the secondary target audience), and 48% had no prior awareness of the WRI. Seventy one percent reported that they gained new insights as a result of the lecture they attended, and on a scale of 1 to 5 (5 = excellent), 89% gave the presentations a rating of 4 or 5. In addition, the "Water Matters" Web site, which featured audio of the American Indian "MadTown Singers" group, attracted 514 visits and 827 page views over a one-month period. One of the presenters, UW-Madison Center for Limnology Director James Kitchell, was a featured on the October 19, 2008, "University of the Air," a Wisconsin Public Radio program that typically attracts more than 300,000 listeners.

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. To continue and expand public discussion of what climate change means for the Great Lakes region, an 80-page summary report and a DVD featuring video and the PowerPoint® presentations from all eight seminars were published in 2008, either of which may be purchased or downloaded free of charge from the UW Aquatic Science Center's online Publications Store (*aqua.wisc.edu/publications*). To date, 760 copies of the printed summary report and 50 copies of the DVD have been distributed, and the online PDF of the report has been downloaded 2,129 times. A written summary and video of each seminar PowerPoint® presentation are also available for free download from the "The Seminars" section of the project Web site (*www.seagrant.wisc.edu/ ClimateChange*), which has logged 1,471 page views in 762 visits by 657 unique visitors.

Groundwater Awareness Week

The WRI again contributed to a series of seven news releases for the annual "Groundwater Awareness Week" in March 2009 that 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 Kevin Masarik, outreach specialist for the UW-Stevens Point Center for Watershed Science and Education, to be guests on the March 25 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 have said the number of calls show strong enough statewide interest in the topic to merit additional programs on groundwater topics in the future. This was reinforced by the strong follow-up interest in this topic as evidenced by more than 27 WPR member downloads of the MP3 video file of the program and 76 "plays" of the RealMedia streaming audio archive of the program on the WPR Web site.

AWRA Annual Conference

The WRI once again cosponsored the American Water Resources Association-Wisconsin Section's annual conference, "Wisconsin's Changing Water Resources," held March 5-6, 2009, in Stevens Point, Wis. Other sponsors included the UW-Stevens Point Center for Watershed Science and Education, Wisconsin Department of Natural Resources, Wisconsin Geological and Natural History Survey, and the U.S. Geological Survey's Wisconsin Water Science Center. About 170 water managers and scientists from throughout Wisconsin attended the conference, which featured more than 60 oral and poster presentations on a wide range of water resources topics. Plenary session topics included global effects of climate change, effects of climate change on Wisconsin lakes and future implications of climate change to Wisconsin. During the conference, the AWRA Wisconsin Section presented its Distinguished Service Award to WRI Assistant Director for Research and Outreach James Hurley in recognition of his exceptional contributions to water resources education, significant scientific contributions towards improving the water resources of Wisconsin and dedicated service to the AWRA organization.

Wisconsin's Water Library Outreach Activities

During the past year, Wisconsin's Water Library 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. The library provided outreach by providing in depth reference

assistance on a wide range of water-related topics. Some examples of reference queries answered included the history of dredging of the Baraboo River; research on statistics relating to Lake Michigan weather and water conditions; thorough inventory of periodical literature on water since the beginning of the 20th century; locating references on the safety of eating fish caught in Lake Mendota; research on temperature tolerance and preference and dissolved oxygen tolerance and preference for certain fish species; and a literature search on climate change effects (or varying water level change effects) on port, harbor or marina operations.

During the reporting period, in partnership with the Wisconsin Department of Natural Resources and the Wisconsin Wastewater Operator's Association (WWOA), the library continued its outreach to current and future wastewater operators of Wisconsin. The library cataloged the essential technical manuals into the library catalog and provided loans to WWOA members around the state in support of their required state license examinations as well as in support of 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 where 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. During FY 09, the story hour was expanded to serve second and third graders in addition to first graders and kindergarteners.

Library Web Sites

The main outreach tool for the library is the newly redesigned and launched library Web site (*aqua.wisc.edu/waterlibrary*). During FY 09, the library combined the three previous sites into one, seamless resource. For UWS faculty, staff and students, the Web site introduces services and resources tailored to them. An important part of this redesign was the update of the research tool, the Water Research Guide (*http://researchguides.library.wisc.edu/waterresearchguide*). The research guide contains books, journals, databases and other resources on water, science and the Great Lakes.

For Wisconsin residents, the library Web site is an outreach site for those who want to learn 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.

During FY 09, the library initiated a new Web 2.0 service, AquaLog (*aqualog2.blogspot.com*), using Blog technology to provide daily, up-to-date, water-related news, publications and resources about Wisconsin and the Great Lakes region. AquaLog's posts are searchable by topic and a monthly archive is available. A researcher or a member of the public can receive notices of updates to the blog using an RSS feed.

The popularity of the all the library Web sites continues to grow. From July 1, 2008 through June 30, 2009, the WRI Library received 20,614 visits by 18,997 unique visitors who logged 39,382 page views.

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. The project listing, project reports, groundwater research database, funding opportunities and conference information sections of the Web site are updated annually.

The ASC Publications Store (*www.aqua.wisc.edu/publications*) features publications from both the Water Resources and Sea Grant Institutes. WRI fact sheets on arsenic in groundwater (197 downloads), groundwater drawdown (716 downloads) and Wisconsin's groundwater resources (155 downloads) continue to be popular. Forty two print publications and 3,480 downloads of online publications were logged by the Publications Store from 7/1/08 through 6/18/09.

UWS FY 09 Publications Resulting from Groundwater Research & Monitoring Program Projects

WRI Reports

Edil, Tunder B. and Craig H. Benson, 2007. Validation of Transport of VOCs from Composite Liners. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 113 p.

Kraft, George J., 2007. Nitrate and Pesticide Penetration into a Northern Mississippi Valley Loess Hills Aquifer. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 10 p.

Geissinger, Peter, 2008. Multi-Parameter, Remote Groundwater Monitoring with Referencing Using Crossed Optical Fiber Fluorescent Sensor Arrays. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 21 p., + app.

Gotkowitz, Madeline B., David J. Hart and Charles Dunning, 2008. Groundwater Sustainability in a Humid Climate: Groundwater Pumping, Groundwater Consumption, and Land-Use Change. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 19 p., + app.

Hickey, William J., 2008. Enhanced Reductive Dechlorination of Chorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 16 p.

Luczaj, John and Michael McIntire, 2008. Geochemical Characterization of Sulfide Mineralization in Eastern Wisconsin Carbonate Rocks. Water Resources Institute, University of Wisconsin, Madison, Wisconsin. 15 p.

Theses

Jablonski, M. 2009. Comparison of the Role of Ionic Strength and Surface Charge Heterogeneity on the Initial Adhesion, Distribution, and Detachment of Two Escherichia coli Strains. Master's thesis, Department of Civil Engineering and Mechanics, University of Wisconsin-Milwaukee.

Rigo, M.V. 2009. Plasmonic Optical Fiber Sensor for Oxygen Measurement. Ph.D. thesis, Department of Chemistry & Biochemistry, University of Wisconsin-Milwaukee.

Other Publications

Gao, J., and J.A. Pedersen. 2009. Sorption of sulfonamide antimicrobial agents to humic-clay complexes. J. Environ. Qual. (in press)

Lepore, B.J., and P. Barak. 2009. A Colorimetric Microplate Method for Determining Bromide Concentrations. Soil Sci Soc Am J, 73: 1130-1136.

Lepore, B.J.; C.L.S. Morgan, J.M. Norman and C.C. Molling. 2009. A Mesopore and Matrix Infiltration Model Based on Soil Structure. Geoderma. (accepted).

Li, Z., and H. Hong. 2009. Retardation of Chromate through Packed Columns of Surfactant-Modified Zeolite. J. Hazard. Mater, **162**, 1487-1493. *http://dx.doi.org/10.1016/j.jhazmat.2008.06.061*

Liu, Z.; Y. Li and Z. Li. 2009. Relationship between land use and surface water quality in Wisconsin - a GIS approach. J. Integr. Environ. Sci., **6**, 69-89.

Luczaj, J.A.; M.J. McIntire, A.M. Steffel and A.L. Duca. 2009. Geochemical Characterization of Sulfide Mineralization in Eastern Wisconsin Carbonate Rocks. 33rd American Association of Water Resources Wisconsin Section Meeting, Stevens Point, Wisconsin, March 5-6, 2009. Program and Abstracts, p. 38.

Pedersen, J.A.; K.G. Karthikeyan and H.M. Bialk. 2009. Sorption of human and veterinary antibiotics to soils. Natural Organic Matter and Its Significance in the Environment. Wu, F.; Xing, B. (eds); Science Press: Beijing, China, pp. 276-299.

Summitt, A.; D.J. Hart, K. Masarik and D. Fratta. 2009. Imaging the Fate of Septic Tank Effluent using Multiple Geophysical Techniques. Journal of Environmental and Engineering Geophysics (in preparation for publication - draft completed).

Wilcox, J.D.; J.M. Bahr, C.J. Hedman, J. D. C. Hemming, M.A.E.Barman and K.R. Bradbury. 2009. Removal of organic wastewater contaminants in septic systems using advanced treatment technologies. J. Env. Quality 38:149-156.

Zhang, X.; H. Hong, Z. Li and J. Guan. 2009. Removal of Azobenzene from Water by Kaolinite. J. Hazard. Mater. (in press) *http://dx.doi.org/10.1016/j.jhazmat.2009.05.073*

For More Information

Visit the WRI Web site (*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) 262-0591, 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 groundwater protection, describing the extent and causes of groundwater pollution, assessing drinking water quality, and working on groundwater policy. Recent policy work focuses on groundwater pumping and impacts on surface waters. 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 at *http://www.uwsp.edu/cnr/watersheds/*.

Drinking Water Programs. In 2008, the Center assisted over 3,335households in having their water tested in conjunction with county Extension offices and the Watershed Center's Water and Environmental Analysis Laboratory. Of these, 13% exceeded drinking water standards for nitrate-nitrogen. Seventeen percent of samples were unsafe because of coliform bacteria. Twelve Drinking Water Education Programs helped nearly 1,200 well users in 11 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 536,183 individual test results for approximately 69,185 samples covering the state; including 20 counties with 100 to 500 samples and 32 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.

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

- Understanding the effects of groundwater pumping on lake levels and streamflows in central Wisconsin

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.

Clancy, K., G.J. Kraft, and D.M. Mechenich. 2008. Knowledge development for groundwater withdrawal management around the Little Plover River, Portage County Wisconsin. Report to the Wisconsin Department of Natural Resources, Project NMG00000253. University of Wisconsin – Stevens Point.

Kraft, G.J., K. Clancy, and D.M. Mechenich. 2008. A survey of baseflow discharges in the western Fox-Wolf watershed. University of Wisconsin – Stevens Point.

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) hosts UWEX state specialists addressing water resources, land and water conservation, and forestry. ERC also coordinates a number of regional and national programs addressing water resources and national youth water education initiatives related to groundwater.

ERC Regional Water Programs and Conservation Professional Development: Through a federal partnership with USDA Cooperative States Research Education and Extension Service (CSREES), ERC hosts the Great Lakes Regional Water Program, a 6-state program involving collaboration among Land Grant Universities, state agencies, and federal agencies across the region (*http://www.uwex.edu/ces/regionalwaterquality/*). One of the programs emerging from this collaboration is a partnership providing multi-state professional development to conservation professionals. In 2008, Wisconsin programs included issues of manure management and fractured bedrock geology including:

- Presentation and tour to the WI Land and Water Conservation Board
- 60 manure applicators received 1.5 hrs continuing education on manure application in Karst areas
- Half day workshop on Karst incorporated into the Conservation Planning Training session in NE WI
- Karst manure and fertilizer management incorporated into farmer training in 3 counties.

ERC Youth Education: 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.

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 170 nutrient management education projects since its inception in 1997. These projects have resulted in awards of over $2.5 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 USDA-CSREES; 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 1,600 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 to support state, county and local efforts to protect and improve surface and ground water quality and quantity across the state's 22 major river basins. Fifteen locally situated Basin Educators develop and conduct programs throughout each basin, accessing state-level support for educational material development and program evaluation. 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, water conservation and efficiency, 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

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 (Norovirus), parasites (Cryptosporidium, Giardia, and microsporidia), radioactivity, inorganic compounds (mercury, nitrate, arsenic) and organic compounds (atrazine, PCBs, PBDEs).

In addition to routine testing of fecal indicators and emerging contaminants, the WSLH now employs a "toolbox" of microbial source tracking assays. Microbial source tracking is used to determine sources of fecal contamination in water, whether from human or animal sources, using multiple microbial and chemical agents. The data is then used for making management decisions regarding fecal pollution control of groundwater.

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 09:

- Assessing occurrence, persistence and biological effects of hormones released from livestock waste. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene. (Funded by the U.S. EPA, project ongoing).
- 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, project completed).
- Assessment of the potential of hormones from agricultural waste to contaminate groundwater. Jocelyn Hemming, PhD, Wisconsin State Laboratory of Hygiene. (Funded by the DNR through the GCC's joint solicitation, project ongoing).
- 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 DNR through the GCC's joint solicitation, project completed).
- Assessment of the Efficacy of the First Water System for Emergency Hospital Use. Sharon C. Long, PhD, Jeremy Olstadt ,Wisconsin State Laboratory of Hygiene and Dennis Tomcyzk, Hospital Emergency Preparedness, Wisconsin Division of Public Health. (Funded by the Wisconsin Division of Health, publication pending with the Journal of Disaster Medicine and Public Health Preparedness).
- Madison Metropolitan Sewerage District: Biosolids Research 2009-2010 and Madison Metropolitan Sewerage District: PFRP Equivalency Project**,** Sharon C. Long, PhD and Jamie R. Stietz, Wisconsin State Lab of Hygiene. (Project ongoing).
- Evaluation of PCR-based methods for *Rhodococcus coprophilus*. Sharon C. Long, PhD and Jamie R. Stietz, Wisconsin State Laboratory of Hygiene. (Funded by the DNR through the GCC's joint solicitation, publication pending).

For more information, visit the following website (http://www.slh.wisc.edu/) or contact William Sonzogni, Wisconsin State Laboratory of Hygiene, 2601 Agriculture Drive, Madison, WI 53718, phone (608) 224-6200, or email sonzogni@facstaff.wisc.edu.

FEDERAL AGENCY PARTNERS

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

The mission of the U.S. Geological Survey - Water Resources Discipline is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. The

Wisconsin Water Science Center accomplishes this mission 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 Wisconsin's water resources.
- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface water and groundwater.
- 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 in order to quantitatively predict their response to stress.
- Disseminating 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 Wisconsin Department of Natural Resources (WDNR), UW Systems, UW-Extension (Wisconsin Geological and Natural History Survey [WGNHS] and Center for Land Use Education [CLUE]), Southeast Wisconsin Regional Planning Commission (SEWRPC), the Menominee and Stockbridge-Munsee Tribes of Wisconsin, the Rock River Coalition, and numerous county and city governments. The federal funds that support these projects come from the Cooperative Water Program, an ongoing partnership between the USGS and non-Federal agencies (http://water.usgs.gov/coop/). In addition the Wisconsin Water Science Center conducts projects that are funded entirely by USGS Federal programs. Recent and current projects that have a significant groundwater component are listed below.

Projects funded cooperatively with state and local agencies:

1. Operation and maintenance of the Wisconsin Observation Well Network; data collection, processing, archiving, and presentation (with WGNHS).
2. Development of the Water Use in Wisconsin summary report (produced at a 5-year interval); data collection and estimation, development of water-use coefficients and default values; evaluation compiled by aquifer, geographic, and political criteria (with WDNR). Simulation of groundwater/surface-water systems in the vicinity of Chenequa, Wisconsin using Local Grid Refinement of the SEWRPC southeast Wisconsin groundwater-flow model (with Village of Chenequa and SEWRPC).
3. Evaluating land use and climate change effects on a southern Wisconsin trout stream - results of the Black Earth Creek modeling study (with WDNR and local communities).
4. Assess the breeding range contraction of Great Lakes area Common Loons resulting from the alteration of habitat characteristics sensitive to climate change (with WDNR).
5. Simulation of groundwater/surface-water systems in the Rock River Basin of Wisconsin (with the Rock River Coalition and 40 contributors in the Rock River Basin).
6. Simulation of the effects of water diversion from Shell Lake, Washburn County, on the shallow groundwater – lake system (with the City of Shell Lake and the WDNR).

Wisconsin projects funded entirely by USGS:

1. Availability and use of fresh water in the United States: Lake Michigan Pilot Study *http://water.usgs.gov/ogw/gwrp/activities/wateravail_pilot.html*.

2. Relation between groundwater flow and beach health (water quality) at Horseshoe Bay in Door County
3. Hydrologic and biogeochemical budgets in temperate lakes and their watersheds, northern Wisconsin Long Term Ecological Research site, http://infotrek.er.usgs.gov/doc/webb/index.html.
4. Western Lake Michigan Drainages National Water-Quality Assessment http://wi.water.usgs.gov/nawqa/index.html.
5. Spatial and temporal shallow groundwater recharge rates in Wisconsin

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 compiled 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 to support 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 2007, there were seven investigations of the USGS Wisconsin Water Science Center that incorporated a water-use component. The majority of these investigations integrate water-use data into hydrologic models that evaluate the impact of water use on water budgets, groundwater-flow paths, and baseflow contribution to surface-water features. These data and the periodic report are becoming increasingly critical in understanding water use, supporting Groundwater Management Areas around the state, and supporting implementation of the Great Lakes Compact.

The USGS Wisconsin Water Use 2005 report (Buchwald, 2009) has been released and can be accessed through the USGS Publication Warehouse at *http://pubs.er.usgs.gov/* . 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/data/wateruse.html*.

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 groundwater system; urbanization can result in less groundwater being discharged as base flow to streams. By understanding the interactions between surface water and groundwater systems, the effectiveness of water management alternatives used to mitigate the effects of urbanization can be evaluated. A coupled groundwater/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 groundwater 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 (Westenbroek, 2009).

Rock River Basin Groundwater-Flow model

A study of the shallow groundwater-flow system in the Rock River Basin was undertaken from 2007 to 2009 by the U.S. Geological Survey in cooperation with the Rock River Coalition (RRC). The primary objectives of the study are to improve understanding of the hydrogeology of the Rock River Basin, evaluate groundwater/surface-water interaction and base flow contribution to the Rock River and its tributaries, estimate amounts and rates of groundwater flow, and highlight areas that would benefit from additional data collection. These objectives have been achieved through the development of a numerical screening model to simulate the groundwater-flow system of the basin. The screening model describes the regional characteristics of the groundwater-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. Two public meetings have been held to present the results of the study, and work continues with the RRC and WGNHS to encourage the use of the model by communities and consultants in the basin to address water management problems.

Great Lakes Basin Pilot study to improve fundamental knowledge of the water balance of the basin, including the flows, storage, and water use by humans. At the request of Congress, the USGS is assessing the availability and use of the Nation's water resources to gain a clearer understanding of the status of our water resources and the land-use, water-use, and natural climatic trends that affect them. The goal of the National Assessment of Water Availability and Use Program is to characterize how much water we have now, how water availability is changing, and how much water we can expect to have in the future.

Water availability is a function of many factors, including the quantity and quality of water and the laws, regulations, economics, and environmental factors that control its use. The focus of the Great Lakes Basin Pilot study is on improving fundamental knowledge of the water balance of the basin, including the flows, storage, and water use by humans. An improved quantitative understanding of the basin's water balance not only provides key information about water quantity but also is a fundamental basis for many analyses of water quality and ecosystem health.

For Wisconsin this Pilot study is providing important hydrologic data sets, an assessment of historical water use (Buchwald and others, in preparation), detailed recharge maps developed with the Soil Water Balance model (Dripps 2003; Westenbroek and others, 2009), and a calibrated groundwater-flow model (Feinstein and others, in preparation) providing information critical to water management and implementation of the Great Lakes Compact.

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

Simulations of climate-change effects on groundwater systems have often been simplified, using estimates to characterize changes in the hydrologic cycle. The recently developed USGS groundwater/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 groundwater 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.

Web Site – Protecting Wisconsin's Groundwater 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 groundwater information and data accessible and usable, thereby encouraging government officials and planners to incorporate groundwater 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 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 groundwater information into comprehensive plans, and presents case studies of municipalities that have worked hard to understand their groundwater resources and develop groundwater goals, objectives, and policies.

From January 1 through May 18, 2009 the website is averaging over 600 successful requests for information per day, and nearly 100 successful requests for pages per day. 1,700 distinct files have been requested and more than 1,200 different individuals or organizations from dozens of countries have visited the site over that period. The complete Web Server Statistics are available at: *http://wi.water.usgs.gov/server_stats/2009/usgs/wi.water_gwcomp_i.html#req*

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 this web site is undetermined; other than correcting identified errors this site is currently static. Funding for development of this web site came from the Wisconsin Department of Natural Resources through the GCC's Joint Solicitation for Groundwater Research & Monitoring. Additional funds were provided by the US Geological Survey Cooperative Water Program.

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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 2008 (Oct. 1, 2007 to Sept. 30, 2008), NRCS, in cooperation with county Land Conservation Departments, planned over 385,000 acres of conservation systems and implemented conservation practices to improve water quality on over 572,000 acres in Wisconsin.

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 2008, 1221 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 208 farms and plans developed for 93.
- *Animal waste storage*: Proper waste storage siting and design is imperative to protect groundwater from contamination by animal waste. Last year 74 animal manure storage structures were planned and 49 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 83 farms, and 260 implemented.
- *Managed grazing:* Pastureland is divided into small paddocks and intensively grazed for 1 or 2 days and then rested for 25-35 days. About 329 prescribed grazing plans were implemented covering 20,000 acres. Prescribed grazing was applied to 11,367 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. The Wetlands Reserve Program in 2008 recorded 22 easements covering 1,343 new acres.
- *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 2008, 1,144 contracts were completed for $21.2 million in financial assistance for farmers..
- *Well decommissioning*: Proper decommissioning is essential to prevent contaminants from entering groundwater through abandoned wells, which are direct conduits to the groundwater. NRCS decommissioned 35 wells last year.

<u>2008 Accomplishments through Conservation Technical Assistance Program</u>

- Conservation Plans Written on 385,639 acres
- Wetlands Created, Restored or Enhanced = 2,735 acres
- Comprehensive Nutrient Management Plans Written = 274
- Comprehensive Nutrient Management Plans Applied = 219
- Watershed or Area-wide Conservation Plans Developed = 13
- Land with Conservation Applied to Improve Water Quality = 572,293 acres
- Cropland with Conservation Applied to Improve Soil Quality = 490,272 acres
- Land with Conservation Applied to Improve Irrigation Efficiencies = 5,866 acres
- Grazing and Forest Land with Conservation Applied to Improve the Resource Base = 43,941 acres

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 Standards for Feed

Storage Leachate and Runoff Control, and for Milking Center Wastewater Treatment System are being finalized in 2008-9.

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.

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 7,600 reported releases at a variety of 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. The DNR also tracks approximately 20,000 spills, some of which were also sources of VOCs.

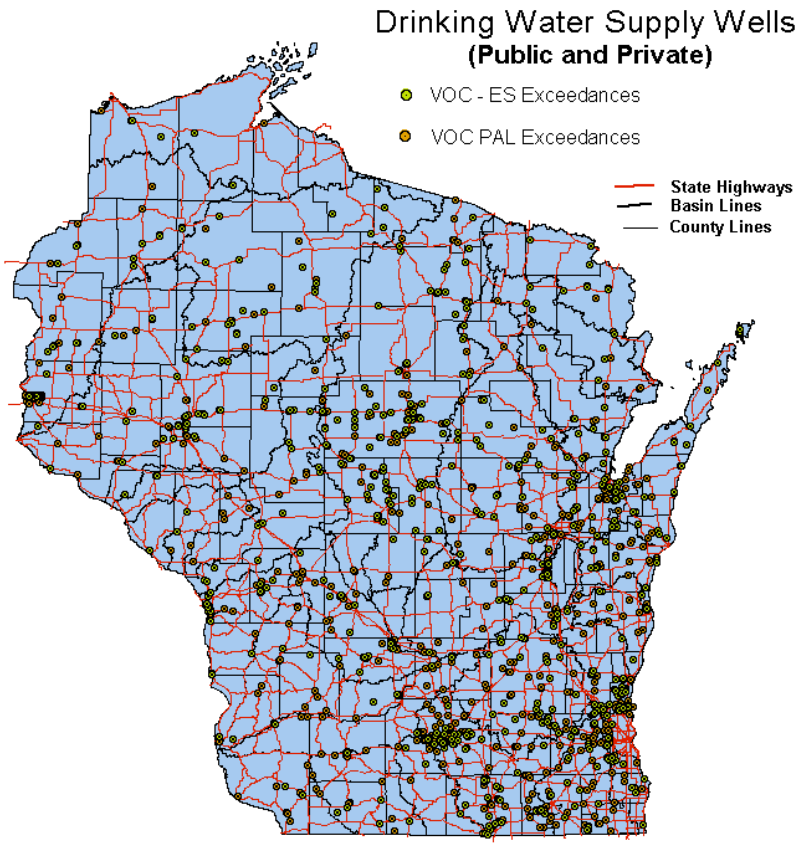

Figure 4.1 Volatile Organic Compounds (VOCs) past enforcement standard (ES) and preventive action limit (PAL) exceedances for public and private drinking water supply wells. Source DNR

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.

Increasing numbers of residential developments are 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 closed landfills with 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. The DNR evaluated all of the landfills where the private wells had detects to determine whether more sampling or further action was required and has taken follow-up measures at all of the landfills where levels exceeded drinking water standards.

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 81,421 are federally regulated. About 12300 federally regulated tanks are in use, with a total of nearly 53,000 USTs in use total (federally regulated and state regulated). 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. In 2008, approximately 1,300 hazardous substance discharges were reported to the DNR. Approximately 900 were spills, and 400 more required greater follow up. Of the 400 sites, 130 were from USTs, and 11 were agrichemical discharges transferred to DATCP.

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

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Pesticides

Pesticide contamination in groundwater results from field applications, pesticide spills, misuse, or improper storage and disposal. The health effects of pesticide exposure vary by pesticide. For example, atrazine, a common corn herbicide, has been linked to weight loss, cardiovascular damage, retinal and some muscle degeneration, and cancer when consumed at levels over the drinking water limit for long periods of time (http://www.epa.gov/safewater/contaminants/basicinformation/atrazine.html). Long-term exposure to alachlor, another herbicide, is associated with damage to the liver, kidney, spleen, and the lining of the nose and eyelids, and cancer (http://www.epa.gov/safewater/pdfs/ factsheets/soc/alachlor.pdf). Only about 30 pesticides currently have health-based drinking water limits and groundwater standards in ch. NR 140, Wis. Adm. Code. in Wisconsin, so occasionally, pesticides are detected in drinking water, but their harmful levels or health effects are unknown. Also unknown are the health effects of a combination of pesticides in drinking water.

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. In 1983 the DNR and DATCP expanded their sampling programs to include analysis of pesticides commonly used in Wisconsin. These programs now include sampling for chemical compounds that form when pesticides break down in the soil and groundwater into what are known as pesticide metabolites. The most commonly detected pesticides in Wisconsin groundwater are metabolites of alachlor (Lasso), metolachlor (Dual) and Atrazine and its metabolites.

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 was the most widely used herbicide in Wisconsin for more than 30 years because it is effective and inexpensive (glyphosate use has now passed atrazine use in Wisconsin due to Roundup-ready soy beans and corn)
- 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 more readily than many other herbicides

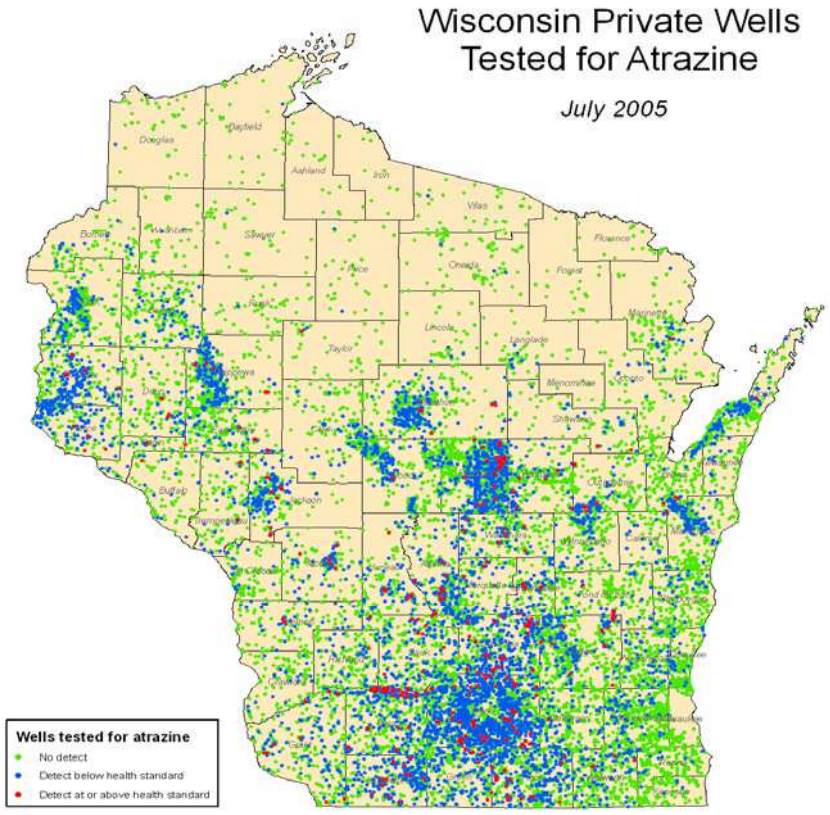

Figure 4.2 Private wells tested for atrazine in Wisconsin as of July 2005. Source: DATCP

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

recorded. Forty-two percent of the samples had a detection for a triazine compound; 13% exceeded the PAL for atrazine of 0.3 µg/L; and 1.6% exceeded the ES for atrazine of 3.0 µg/L.

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

Chloroacetanilide herbicide metabolites - 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 2008, with samples collected from 150 different wells at least once during this time period. As of

2008, atrazine levels had gone down in over 80% of the wells. Five 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. 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. Three hundred and ninety-eight private drinking water wells were sampled as part of this survey. Each well sample was analyzed for 32 compounds including 17 pesticide parent compounds, 14 pesticide metabolites and nitrate-nitrogen.. Health standards have been established for 11 of the parent compounds and 4 of the metabolites. 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%. The average number of pesticide or pesticide metabolite detects for wells with detects was 2.3. 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%.

The health effects of multiple pesticides in drinking water are not well understood. Some studies have found that pesticide mixtures at equal or less than the EPA drinking water standard can produce effects that are not found upon exposure to a single pesticide at the same concentrations. Tests of mixtures of the insecticide aldicarb, the herbicide atrazine, and nitrate in rats show endocrine, immune and behavioral effects including decrease in speed of learning, change in aggression intensity and frequency, change and reduction in memory and motor coordination in the brain, change in growth hormone, and reduction in antibodies formation capability (Porter, 1999). Frogs exposed to pesticide mixtures used on a corn field (with each pesticide at 0.1 ppb) had retarded larval growth and development and induced damage to the thymus, resulting in immunosuppression (Hayes, 2006).

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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*

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Nitrate

Based on data collected by the DNR, DATCP 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) is a water-soluble molecule 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 per cent 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 (ES) 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.

DHS obtained research funding from the WRI to add a module to the 2008 and 2009 Behavioral Risk Factor Surveys on the testing of private drinking water supplies. Based on responses from the 2008 survey, 36 percent of Wisconsin's families obtain their water from a privately-owned well and one-third of well owners have never had their water tested for nitrate. The most common reasons cited by well owners who had not tested their water was that their water "tasted

and looked fine." Some owners indicated that they didn't know how to find a lab or didn't know what tests to request.

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).

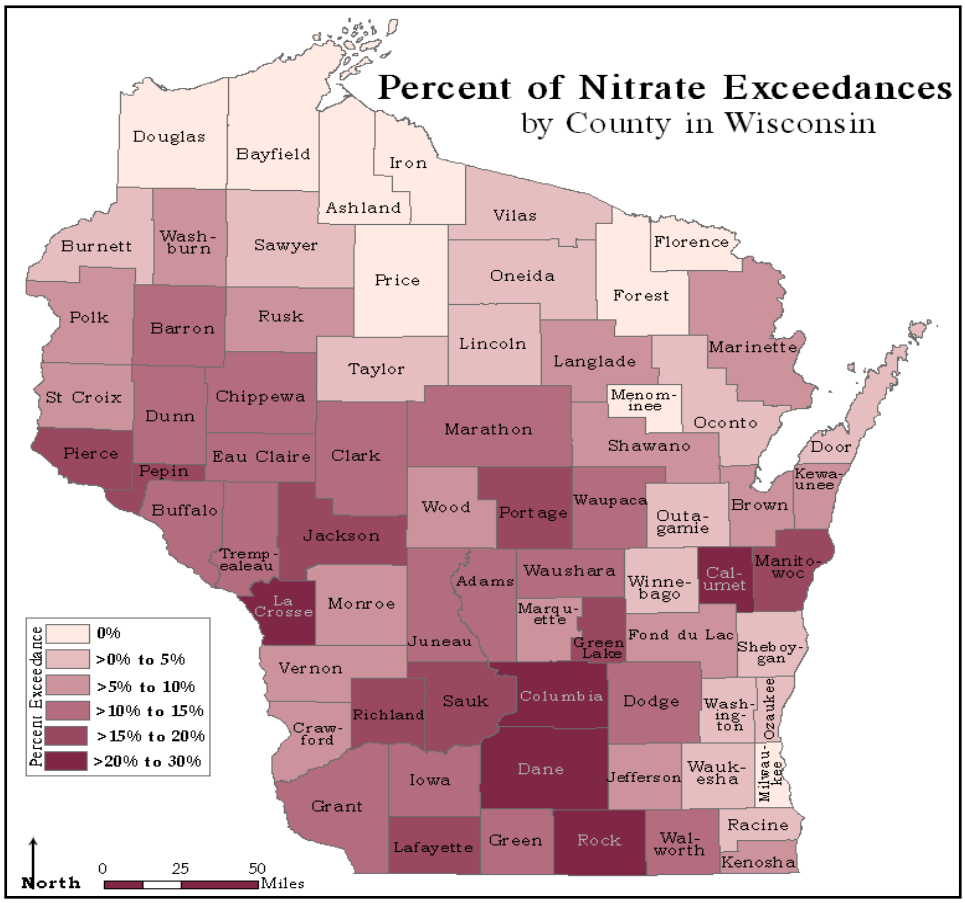

Figure 4.3 – Percentage of nitrate samples from private wells exceeding 10 mg/L by county. Data sources: DNR, Center for Watershed Science and Education, and DATCP groundwater databases.

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 DHS recommend that new private wells be tested for nitrate 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.

A modeling study on contaminant transport in Central Sands wellhead protection areas (Mechenich and Kraft, 1997) predicted eventual nitrate-N concentrations of 38 mg/L for the Whiting municipal wells recharge area, and 26 mg/L for Plover municipal wells. Full farmer adoption of University of Wisconsin recommendations would decrease the predictions to 26 mg/L for Whiting and 19 mg/L for Plover. These concentrations are about 1.5-2 times higher than present values. In this study area agriculture was responsible for 89% of the nitrate inputs to groundwater whereas septic systems contributed about 7%. The investigators concluded that in some hydrogeologic settings current recommended fertilizer application practices are not capable of keeping groundwater nitrate concentrations below the enforcement standard.

A study on nitrate inputs to a Central Wisconsin groundwater aquifer (Kraft, 2003) concluded that nitrate concentrations will continue to increase if current nitrogen input rates continue. Nitrate-N concentrations under potato and vegetable fields averaged about 20 mg/L when grower inputs of nitrogen fertilizer were made according to University recommendations, but some applications are made at higher than recommended rates.

A later similar study (Kraft 2004) investigated nitrate penetration into the sandstone aquifer in south central Wisconsin. The sandstone lies beneath 30 meters of glacial till deposits so the transport time from the ground surface to the sandstone is about 18 years. In this study, Kraft found a steady increase in nitrate concentrations . Modeling suggests that under modern land use practices, in 20-40 years the groundwater in this aquifer will reach a state where the average concentration will be over 10 ppm.

Another paper (Saad, 2008) describes the analysis of data from the USGS National Water-Quality Assessment (NAWQA) Program study area in the Western Lake Michigan Basin in Central Wisconsin. Samples from 1994 were compared to 2002 for one set of wells. Median nitrate values increased by 4.5 mg/l from 1994 to 2002. Of the 26 wells re-sampled, 13 showed an increase in concentration, 7 remained virtually the same and 6 showed a decrease. Age-dating of

the water allowed for a comparison of nitrate concentrations over time with historic agricultural chemical use. Here a clear trend of increasing nitrate with increasing fertilizer use was seen.

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Microbial agents

The United States produces some of the cleanest drinking water in the world and yet there are still reports of waterborne disease outbreaks. These outbreaks are produced by microbial agents including bacteria, viruses and parasites. These agents can cause acute and chronic illnesses and result in life-threatening conditions for individuals with weakened immune systems. Of the

approximately 20 outbreaks reported nationally per year, more than half are related to groundwater consumption (Lee, and others 2002; Yoder and others 2008). Many waterborne outbreaks are not reported or detected.

In Wisconsin, a statewide assessment showed approximately 23% of private well water samples tested positive for total coliform bacteria, an indicator species of other biological agents (Warzecha, and others 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.

The DNR recommends that private well owners test their water for coliform bacteria 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.

-Manure spreading can contaminate groundwater with bacteria and/or viruses in karst areas and/or where soils are thin. Contamination is more likely when landspreading of manure occurs prior to, or during runoff events. Runoff events occur when precipitation exceeds soil infiltration rates, or snow pack melts during the spring thaw. Runoff risks can be substantially reduced if manure spreading is done according to an approved nutrient management plan which includes a number of restrictions on manure applications to thin soils and locally identified karst features. Currently, however, less than 20% of state farmland is covered by a state-approved nutrient management plan. Scores of private wells have had to be replaced due to manure contamination.

DNR private water staff respond to homeowner complaints regarding private well contamination events, many of which correspond to manure spreading. Until 2007 there were no readily available methods for testing for manure in these wells. Standard methods for testing for bacteria do not show whether the bacteria are derived from human or animal sources. Recently developed laboratory techniques have made it possible to discern whether bacteria are from human, animal or other sources. These microbial source tracking (MST) tools include tests for *Rhodococcus coprophilus* (indicative of grazing animal manure), *Bifidobacteria* (indicative of human waste) and *Bacteriodes* (indicative of recent fecal contamination by either humans and/or grazing animals). The DNR has been using these tools since 2007 to determine the source of fecal contamination in private wells. Since 2007, in response to private well water quality complaints 49 groundwater samples have been analyzed. Results indicate 28 samples with bacteria associated with grazing animals, 3 samples with bacteria exclusive to humans, and 10 samples with recent non-differentiated fecal contamination. Nine samples had no indication of fecal contamination. DNR's Drinking Water & Groundwater and Runoff Management programs are working with the DATCP nutrient management program to find ways of controlling this significant threat to health.

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. Many other parts of Wisconsin contain areas of shallow, fractured bedrock or minor karst features making them very vulnerable to microbial contamination from the land surface.

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, one in December 2004 and another in May 2007. The cause of the May 2007 outbreak was a genogroup 1 norovirus, quantified in the restaurant's well water at more than 50 viruses per liter, well above the infectious dose necessary for a widespread outbreak. More than 250 people became ill and 6 people were hospitalized. The nucleic acid sequences of the viruses from the well and stool specimens from ill patrons were identical, providing definitive evidence for the waterborne transmission route. Moreover, a state-of-the-art dye tracer study conducted by the University of Minnesota demonstrated unequivocally a rapid transport route from the restaurant's new septic system to its well. Transport was from both: 1) untreated effluent discovered leaking from a broken pipe fitting near a septic tank; and 2) dischange from the septic drainfield. Groundwater and public health experts believe another outbreak in Door County may be imminent due to the widespread shallow soils and karst bedrock found in the couty which make it difficult to find an appropriate place for locating septic systems. There is overwhelming evidence in the state of Wisconsin and nationwide that karst areas have highly vulnerable groundwater requiring special consideration and protection.

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, and others 2003b). In general, infectious diarrhea did not correlate with drinking from private wells or drinking from wells that had positive analytical results for total coliform. However, wells which tested positive for enterococci were associated with children having diarrhea of unknown etiology likely caused by noroviruses. A subsequent study of 50 private wells throughout the state indicates that 8% of private wells may be subject to virus contamination (Borchardt and others 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 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 norovirus (Borchardt and others 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 and others 2004, Hunt and others 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.

Leaking sanitary sewers were shown to be a source of infectious viruses to drinking water wells in subsequent work funded by WDNR and the USGS (Hunt and others, in review). Marshfield Clinic and USGS researchers performed a synoptic sampling of over 30 unconfined municipal wells in 14 Wisconsin communities. Groundwater collected was evaluated for surface water contributions and presence of waste-water tracers and human enteric viruses. From this survey 8 wells had surface water contributions, 4 had unambiguous waste-water tracers, and 5 were positive for viruses. These analyses were used to identify 3 well sites used for intensive instrumentation of the shallow groundwater system between the wellhead and suspected sanitary sewer sources. Viruses and waste-water tracers were found in the groundwater at all three instrumented sites. The work showed that sampling at any one time may not show concurrent virus and trace presence due to differences in analytical precision and seasonality of the sources

in the waste stream. However, given sufficient sampling over time, a good relation between unambiguous waste-water tracers and virus occurrence was identified such that locations that were characterized by recurring unambiguous tracer occurrence also were found to have enteric viruses present. Moreover, nearby groundwater velocities and presence of infectious viruses at the wellhead demonstrate that high-capacity pumping can induce travel times that are sufficiently short such that viruses are not inactivated during their time in the subsurface. Because sanitary sewers are commonly located near municipal wells and can carry very high numbers of infectious viruses, and very small numbers of infectious viruses in water can constitute a health risk, drinking water wells can be considered vulnerable to fast groundwater flowpaths that only contribute a very small amount of virus-laden water to a well. Thus, these results suggest that evaluations of drinking well vulnerability should include low yield-fast transport pathways in addition to traditional high yield-slower transport plume contaminants currently included in wellhead protection. Such evaluations are thought to be important in communities such as the 14 included in the study, as they were chosen because they did not routinely employ chlorination or other disinfection procedures at the time of the study.

Microbial contamination of groundwater is not restricted to vulnerable or shallow aquifers. In a novel study, researchers at the Marshfield Clinic, Wisconsin Geological and Natural History Survey, and the University of Waterloo, discovered human viruses in the confined aquifer supply Madison's drinking water (Borchardt et al 2007). This finding was completely unexpected because it was believed the 3 to 9 meter shale confining layer protected the aquifer from microbial contamination. Additional research by Marshfield Clinic, WGNHS, and USGS, on the Madison wells has shown virus transport from leaking sanitary sewers to the wells is very rapid, on the order of weeks to months instead of years (Bradbury and others, 2008). The virus transport and contamination levels were particularly high after extreme rainfall events or rapid snowmelt. From a public health perspective, the lesson learned is that all aquifers are potentially vulnerable to microbial contamination and require a similar level of disinfection for drinking water purposes.

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 other indicators as well) do not always correlate with the presence of enteric viruses. For example, municipal water sampled by Borchardt and others (2004) showed that, even though 50% of the samples were positive for viruses, none of the same samples tested positive for coliform or other indicators. Recently, water samples from private residences in Door County found low levels of some viruses but water samples did not contain coliform (Wisconsin DNR). Indicators have a high positive predictive value but a low negative predictive value for pathogen occurrence. In other words, when an indicator is present in drinking water there is a high probability that particular water source will be contaminated with a pathogen at some point in time. However, if an indicator is absent, no inferences can be made about pathogen occurrence. Additional study is needed to determine what virus results mean to human health.

Data from the U.S. EPA shows that the highest percentage of microbial unsafe water is found in small water systems, like transient non-community (TN) systems such as restaurants and convenience stores (Peterson, 2001). There are approximately 9,500 active TN systems in Wisconsin. The mobility of 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 tracks and identifies 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 U.S. 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 first strategy of the Groundwater Rule includes sanitary surveys of public systems to identify deficiencies. The second strategy is an improvement on Safe Drinking Water Act requirements which have focused on sampling for microbial indicators in the distribution system. The Groundwater Rule will require source water monitoring when total coliform is detected in the distribution system. Third, the Rule 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 Rule is monitoring requirements to ensure that treatment equipment is maintained. The Groundwater Rule includes preventative strategies that prior EPA drinking water legislation did not adequately address. Implementation of the deficiency and monitoring requirements of Groundwater Rule will begin on December 1, 2009.

Wisconsin conducts inspections and requires correction of non-complying features. Therefore, the major changes resulting from the Rule 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.

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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.

Prior to implementation of a new, lower federal standard for arsenic in 2006, 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 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). Recently completed research focused on release mechanisms, triggers and reaction kinetics that affect well construction, disinfection, and rehabilitation. A second focus of recent work is identifying other areas of the state with impacted groundwater.

A DHS Health Consultation study on arsenic in private wells in the Wind Lake, Racine County area showed arsenic is present in both the deep glacial and Silurian bedrock aquifers (*http://www.atsdr.cdc.gov/HAC/pha/WindLakePrivateWells/WindLakeHC04-28-2009.pdf*) Of 25 wells tested, 12 contained arsenic levels above the ES of 10 µg/L. Free test kits were made available to any interested resident in the area and resulted in 92 samples from 70 different private wells. The results showed 22 of 70 (31%) wells with arsenic levels at or above the ES. Test results ranged from 10 to 27 µg/L. In addition to arsenic, water from 10 wells had lead at levels above the ES of 15 µg/L.

The DNR, DHS, Commerce and others continue to work on arsenic problems around the state. Arsenic has been found at levels above the ES in every county. DHS has conducted two separate studies on the health effects of arsenic on Wisconsin citizens. DHS researchers have observed higher rates of skin cancer, heart disease and depression among consumers of water that contains traces of arsenic (Knobeloch et al, 2002; Zierold et al, 2004). In addition, two Wisconsin residents were diagnosed with peripheral neuropathy after consuming well water that had arsenic levels of 190 and 900 µg/L (DNR).

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. One point-of-use treatment system was recently approved.
- 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.

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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.

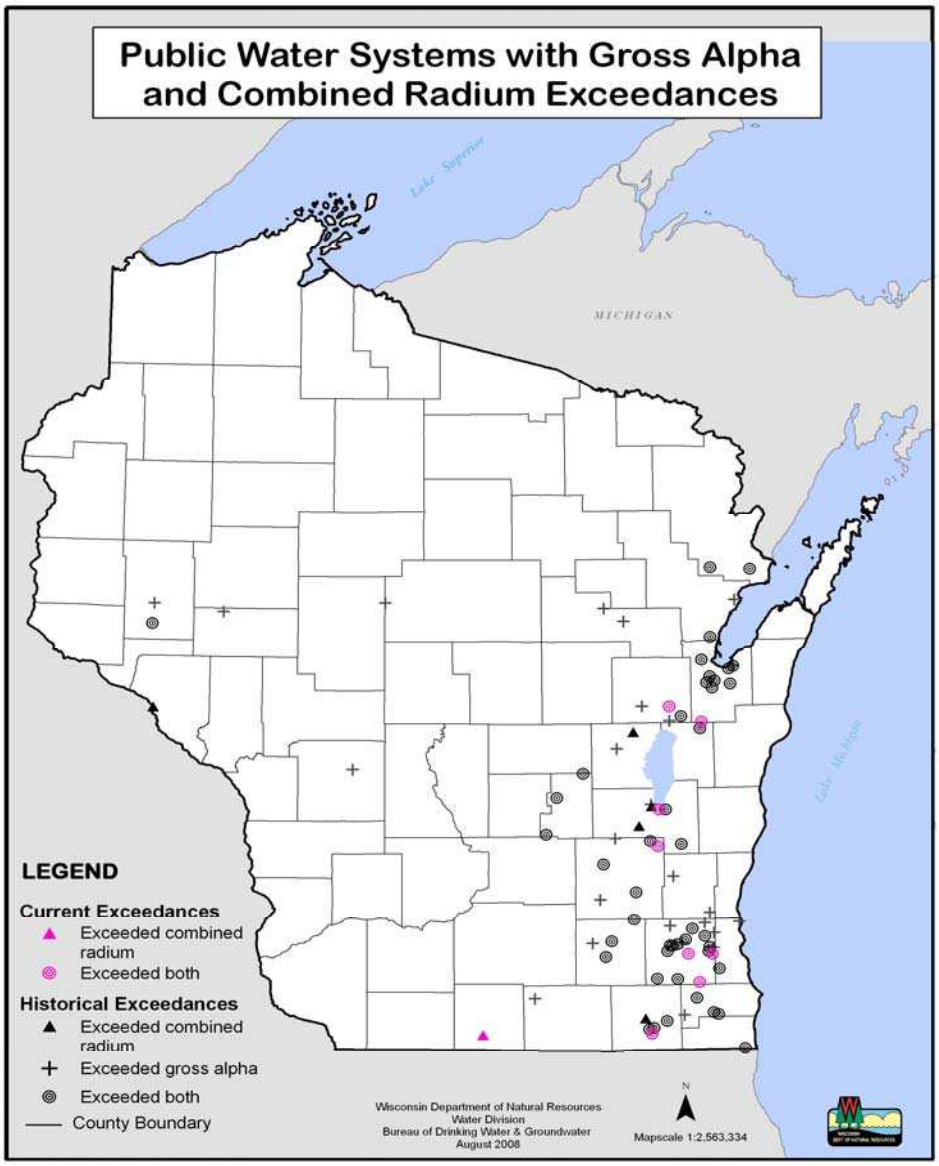

Figure 4.4 Public water systems that exceed radionuclide standards as of August 2008 or have exceeded radionuclide standards in the past. Source: DNR

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.

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

GROUNDWATER QUANTITY

Adequate groundwater is present throughout most of Wisconsin to support municipal, industrial, agricultural, and domestic demands, yet important challenges have been identified. In some areas of the State adequate groundwater does not exist to support unlimited users or simply future use from an increasing population; whereas, in other areas, groundwater pumping diverts too much baseflow from lakes, streams, and wetlands. The GCC has long supported stronger management of groundwater pumping in Wisconsin (DNR, 1997). 2003 Wisconsin Act 310 took some first steps. The Groundwater Advisory Committee and its technical advisory committees expended

significant effort attempting to develop new public policy related to groundwater quantity during 2007, but relatively little progress was made as there were deep splits between water using groups and those who sought stricter pumping controls. Significant issues relating to the impacts of high-capacity wells on surface waters still remain unaddressed as of present.

Water Use

As part of the National Water-Use Information Program, the U.S. Geological Survey (USGS) collects, compiles, and disseminates information about water use. Every 5 years, since 1950, data about water use were aggregated for Wisconsin and published in a National circular. Since 1978, these data were aggregated every 5 years at the county level, and sometimes by watershed and aquifer, to be published in a State summary. Currently (2009) there are six reports that summarize water use in Wisconsin.

Total groundwater use estimated by the USGS during 2005 was estimated to be 986 million gallons per day (Mgal/d) (Buchwald, 2009). This estimate is 380 Mgal/d greater than withdrawals estimated for 1979, and 146 Mgal/d greater than those estimated for 2000 (Ellefson and others, 2002; Lawrence and Ellefson, 1982). Total groundwater use in 2005 can be divided into public-supply water use, as in water for various community uses delivered by a water-supply system (305 Mgal/d) and self-supplied water use, as in water withdrawn by a user and not obtained from a public supply (681 Mgal/d). Irrigation water use was the largest category of self-supplied use (387 Mgal/d), although the reported 2005 estimate was believed to be at the higher end of the range of possible irrigation water use.

Also, as a result of 2003 Act 310, groundwater pumping reports are required of high capacity well users. As of the end of April 2009, pumpage data collected by DNR and the Public Service Commission for the 2008 calendar year includes data for a total of 7,321 high capacity wells. Approximately 200 billion gallons were pumped from these wells

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Statewide Groundwater Level Network

Understanding groundwater quantity issues depends on data collected by Wisconsin's statewide groundwater level monitoring network, jointly operated by the University of Wisconsin Extension - Wisconsin Geological and Natural History Survey and the U.S. Geological Survey. 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; data are compromised and wells go out of service due to age, equipment failure, or ownership issues. (See Chapter 6—DIRECTIONS FOR FUTURE GROUNDWATER PROTECTION - PRIORITY RESEARCH & MONITORING NEEDS/ISSUES, Groundwater Monitoring Network)

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 were substantial declines in groundwater levels in these three areas. 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. The WGNHS determined that so far, water levels have risen more than 100 feet in certain place. Although the water levels are approaching a new stable level, a smaller additional rise is expected.

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. High-capacity well pumping in the Lower Fox River Valley has lowered water levels in the bedrock aquifer. In some locations, this has exposed the mineralized zone to the atmosphere which oxidizes and subsequently, releases arsenic to the groundwater. In 2006 a new (lower) standard of 10 µg/L for arsenic in drinking water took effect, resulting in many wells in violation of this standard.

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.

In Green Bay it was determined that ASR, as pilot tested, would 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.

Pilot testing of ASR at Oak Creek demonstrated that the technique is possible; however, concentrations of manganese and iron were 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. However, groundwater quality data submitted to the DNR in 2007 indicated that the concentrations of manganese and iron in the groundwater around the ASR well continued to be above state groundwater quality standards. As a result of the exceedances, the utility is required to make changes to its ASR operations plan. If ASR operations cannot be modified in a manner that will return the ASR facility to compliance with Wisconsin's groundwater protection regulations, the DNR is required to rescind its approval for Oak Creek Water and Sewer Utility to

operate an ASR system. ASR activities have been temporarily suspended while the water utility considers its options. A final decision on future ASR operations will be made in 2010.

Great Lakes Compact

In May 2008, Wisconsin ratified the Great Lakes – Saint Lawrence River Basin Water Resources Compact (Compact) and enacted legislation to implement the Compact in the state. By July 8, 2008, all eight Great Lakes states had ratified the Compact through state legislation. On September 23, 2008 the U.S. Congress consented to the states' ratification, and the President signed Congress' Consent resolution on October 3, 2008. As a result, the Compact took effect on December 8, 2008 – significantly sooner than expected.

The Compact is the legally binding implementation for the Great Lakes states of the Great Lakes – Saint Lawrence River Basin Water Resources Agreement (Agreement), also signed in December 2005 by the Great Lake states, Ontario and Quebec. The Agreement, a good faith pact among the states and provinces, parallels the Compact, but lacks enforceability because states cannot enter into legally binding treaties with foreign governments.

The Compact addresses water quantity management in the Great Lakes – Saint Lawrence River Basin (Basin). It sets out requirements for Basin water uses in the areas of registration, reporting, management, and water conservation and efficiency. It also prohibits diversions of Basin water with limited exceptions for straddling communities, communities in straddling counties and intrabasin transfers (transfers of water from one Great Lake basin to another).

Under the Compact, states are required to develop a program for management of Basin withdrawals, including groundwater and surface water, that relies on a decision making standard for new or increased withdrawals. States are also required to develop and implement a Basin water conservation and efficiency program. These programs will be reviewed by the Regional Body (a Body comprising the governors of the Great Lakes states and the premiers of the Canadian provinces of Quebec and Ontario) on a regular basis. The Compact also calls for the submission of initial withdrawal amounts (or baselines) for water users, annual reports on Basin water use, and periodic assessments of cumulative impacts to the Regional Body.

Wisconsin's legislation implementing the Compact—2007 Wisconsin Act 227—is extensive.

Registration –Act 227 calls for statewide registration of existing and new water withdrawals with the capacity to withdraw more than 100,000 gallons per day averaged over 30 days.

Reporting – Withdrawals over 100,000 gallons per day averaged over 30 days must be reported annually. Existing state statutes already require this reporting for groundwater withdrawals; however, most surface water withdrawals, other than municipal, are not currently being reported. This requirement applies statewide.

Baseline – An initial withdrawal amount must be determined for all withdrawals existing as of December 8, 2008—the Compact's effective date. This amount will be the basis for determining if a proposed increase in a withdrawal exceeds the threshold for applying a decision making standard.

Management of Basin Withdrawals (Water Use Permits) –Act 227 directs that Great Lakes Basin withdrawals over 100,000 gallons per day averaged over 30 days require a permit. General permits will be issued for withdrawals of 100,000 gallons per day or more averaged over 30 days. Individual permits will be issued for withdrawals exceeding 1 million gallons per day for 30 consecutive days. Water use permits (both general and individual) establish the authorized

withdrawal amount, as well as requirements for reporting and water conservation. General permits have a 25-year term; individual permits have a 10-year term.

Water Conservation and Efficiency –Act 227 requires that the Department develop and implement a water conservation and efficiency program with voluntary measures to apply across the state, additional mandatory elements that apply in the Great Lakes Basin, and the most stringent requirements for communities applying for diversions or water uses with high rates of water loss.

Public Participation –Act 227 requires that a public notice, comment and hearing process be developed as part of the review of all new water use permits and applications for diversions.

Water Supply Service Area Plans – An additional element of the new legislation is the requirement for water supply service area plans. Act 227 requires all municipalities with water supply systems that supply more than 10,000 people to have an approved water supply plan by 2026. This planning process is modeled after the wastewater planning process and uses a cost-effectiveness analysis that assesses the environmental and economic impacts of alternatives in the plan to determine the approach that maximizes environmental benefits and minimizes total resource costs over the planning period.

State Water Use Report –Act 227 also requires the department to develop a statewide water resources inventory and publish a state water use report every five years.

Congress' unexpectedly swift consent to the Compact has greatly accelerated the timetable for implementing the Compact in Wisconsin.

The DNR continues working to issue interim approvals to persons who were withdrawing water in the Great Lakes Basin above the threshold permitting level of 100,000 gallons per day as of December 8, 2008. The DNR is also planning to promulgate administrative rules related to the following Compact-related topics: Registration & Reporting; Water Use Permitting; Consumptive Use/Water Loss; Public Participation; Water Conservation & Efficiency; and Water Supply Service Area Planning; and Water Withdrawal Fees.

The DNR's post rule development workload will include implementing the following programs: Registration & Reporting; Permitting in the Great Lakes Basin (DNR's Northern, Northeast, and Southeast Regions); Water Supply Service Area Planning; Statewide Water Conservation & Efficiency; and Public Participation.

The Governor's proposed 2009-11 biennial budget includes position authority and funding for 2 FTE in FY 2010; and an additional 2 FTE in FY 2011, along with funding for water quantity monitoring and database and GIS development. To fund the program in FY 2011 and beyond, the Governor's budget also includes a statewide water withdrawal base fee of $125 on all water supply systems with the capacity to withdraw 100,000 gallons per day, and an additional fee to be imposed in the Great Lakes Basin only on persons who withdraw more than 50 million gallons per year. The DNR is directed to promulgate a rule to implement the latter fee.

Surface Water Impacts

Some local and regional effects from groundwater withdrawals are not as well documented as those in the northeast and southeast. Cases exist where wells, springs, and wetlands have gone dry; lake levels have dropped; and streamflow has been reduced, apparently in response to groundwater pumping.

In the central sands region, streamflows and lake levels appear to be depressed in a way not attributable to recent climate. The central sands is the most highly developed part of the state for groundwater pumping. The connection between pumping and surface water impacts is virtually conclusive in the case of the Little Plover River, a Class I trout stream and Exceptional Resource Water in Portage County. The Little Plover has experienced dramatically reduced flows in the last few years to the point of drying in stretches every year since 2005. Statistical approaches and groundwater flow modeling indicate that Little Plover flow would be robust in the absence of pumping. Its situation may be indicative of conditions on other headwaters streams in the central sands and may explain depressed lake levels to the point of dryups in the region (Clancy and Kraft, 2008)

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.

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 an 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. 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.

Excess Groundwater

In contrast to the groundwater issues above that relate to lack of sufficient quantity of groundwater, too much groundwater can also be a problem. Southern Wisconsin experienced record amounts of precipitation from August 2007 through July 2008. Severe flooding occurred across this region, resulting in significant property loss, human displacement, and disruption of transportation. While most of the initial flooding occurred as surface water overflow, longer-term groundwater flooding remained for many weeks or months following the rain events. Groundwater flooding occurs when the water table rises above the land surface, and can be long-lasting because water-table decline requires drainage of an entire aquifer. Seepage lakes may also experience flooding of shoreline beaches and developments due to rise in the water table elevation and the related long-term increase in lake stage.

Several communities are affected by elevated groundwater levels. Examples include Clear Lake, in Rock County, where the lake stage has increased by about 7 feet over the past year. In Spring Green, 4,378 acres outside of areas currently designated as floodplain by the Federal Emergency Management Agency were flooded for over five months. Modeling and field investigation indicate this flooding was caused by water table rise above ground surface. Although the hydrogeologic setting varies among affected areas in southern Wisconsin, the widespread occurrences of groundwater flooding and the regional nature of intense precipitation events in 2007 and 2008 show that it is a regional issue. Researchers at the WGNHS and the UW Madison will begin a study of these affected hydrologic systems and climate change, funded by the UW System.

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Chapter 5 -- BENEFITS FROM MONITORING AND RESEARCH PROJECTS

The State of Wisconsin has funded approximately 369 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. These substances are often classified, along with other chemicals, as contaminants of emerging concern (CECs), emerging contaminants (ECs) or trace organic contaminants (TOrCs).

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 emerging contaminants such as pharmaceuticals, PCPs and EDCs in the environment.

Discharges of treated wastewater through land (soil) 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.

A study titled, *Assessing Levels and Potential Health Effects of Endocrine Disrupting Chemicals in Groundwater Associated with Karst Areas in Northeast Wisconsin* (Project No. 09-CTP-02), is currently underway. This research project assesses groundwater movement and contaminant transport through carbonate bedrock areas in four counties in northeastern Wisconsin. The carbonate bedrock areas chosen for study have shallow soil depths and karst features, and are considered to be very vulnerable to contamination leaching from the ground surface. The research specifically evaluates the fate and transport of endocrine disrupting chemicals in groundwater associated with the land application of dairy waste on soils above the vulnerable bedrock aquifer.

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 confirming that these sites are performing as WMM program staff had hoped. The results of the three VOC studies were used to establish requirements for VOC sampling at new and existing landfills. These studies also indicated that inorganic compounds could be useful in predicting VOC contamination at landfills. Therefore, until EPA rules began requiring VOC monitoring in 1996, 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 was useful in meetings held to convince municipalities that they had not been singled out for further evaluation of groundwater contamination and to demonstrate that the process used for selecting landfills for monitoring was 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 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 decide not to require liners and 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 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. Eleven sites were sampled in the spring and summer of 2003 and the findings summarized 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 have not become available to do the follow-up study.

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 well disinfection and release of trace metals to groundwater was recently completed (Gotkowitz, 2007). On-going efforts include compilation of private well sampling results. The goal of this effort is to continue identification of areas in Wisconsin with relatively high numbers of wells impacted by naturally occurring arsenic.

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 (see *http://www.fws.gov/Midwest/endangered/insects/hed/DoorCtyHEDgrndwtrRptMay2008.html*).

The techniques developed in the Door County research are being applied to carbonate rocks in other parts of Wisconsin to help address the question "how much soil is enough?" when making management decisions in carbonate rock areas. In 2008, researchers (Muldoon and Bradbury, 2009) completed a project monitoring shallow groundwater adjacent to agricultural fields in areas of moderately thick soil (10-20 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. All four wells showed rapid rises in water levels within 24 to 48 hours of significant recharge events. Electrical conductivity data indicate that the water-level rise is due to dilute recharge water entering the saturated zone rather than the drainage of vadose zone water. All wells exhibit elevated nitrate and chloride values and periodically exceeded the nitrate standard of 10 mg/l NO3-N.. This work shows that even in areas of moderately thick soil in the areas studied wells respond rapidly to recharge events following snowmelt or heavy thunderstorms.

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.

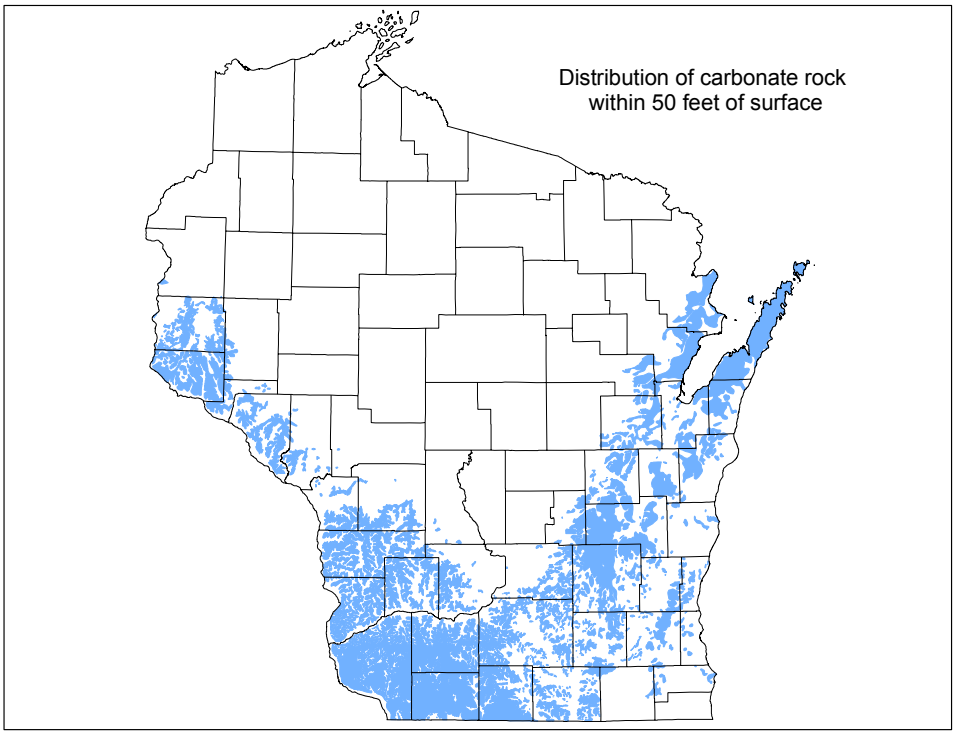

Figure 5.1 Location of shallow carbonate bedrock in Wisconsin

A third recent study complementing the Door County work occurred on the Platteville Pioneer farm, located a few miles southeast of Platteville in Lafayette County (Kraft, 2008). Work at this has shown that groundwater movement in the southwest has some similarities and dissimilarities to those in the northeast part of the state. In common with northeastern Wisconsin, recharge reaches the shallow aquifer quickly and penetrates the upper part of the aquifer in a karst-like fashion. However, it appears that transmission to the deeper part of the aquifer is not as strongly dominated by conduit-type flow as in the northeast.

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DEVELOPING NEW TOOLS FOR GROUNDWATER PROTECTION

Continuing cooperation between state and federal agencies and the University System, with funding provided through the Joint Solicitation Program, has fostered development of several new tools and methods for groundwater protection that are now becoming commonly used in Wisconsin. One such success story is the development of a rapid method for estimating groundwater recharge based on a soil-water balance method. Information on groundwater recharge rates is critical for building reliable groundwater flow models, but recharge rates are notoriously difficult to measure. Through a series of projects (Dripps and Bradbury, 2007; Hart and others, 2008, 2009; Westenbroek and others, 2009) Wisconsin investigators have developed, tested, and applied a computerized technique for rapid estimation of recharge rates using widely-available data on land use, topography, soils, and climate. Application of this model has become almost routine for new groundwater studies in Wisconsin, and the technique has seen use in other states, notably Minnesota.

In addition to improvements in site and county scale characterization of groundwater recharge, a recent estimate of the larger-scale distribution of statewide recharge (Figure 5.2) was developed using 1970-1999 stream baseflow data and GIS watershed delineation (Gebert and others, 2009a, 2009b). This type of tool was intended to help develop more realistic initial estimates of groundwater recharge, which in turn facilitate better and more efficient groundwater model development, resource and water availability evaluations, and protection plans. The statewide map also has value in that it encompasses areas where groundwater system is not the dominant component to hydrologic flows, thus are areas that likely have not yet had extensive hydrogeologic study. Groundwater resources may still be important in such areas, especially given potential future land use and climate change. Therefore, initial estimates of groundwater recharge will likely have value in future hydrogeological studies in these understudied portions of the state.

Groundwater models are one of the primary tools for groundwater protection, but be expected to be only as good as their representation of real world characteristics important for groundwater flow. Recent work has shown how including processes in the unsaturated zone can influence groundwater recharge estimates and groundwater-surface water interaction in northern Wisconsin (Hunt and others, 2008). This work is one of the first to use and show the utility of this new modeling tool for humid climates like Wisconsin, and is expected to be able to inform other similar work as the tool is available as part of the widely used USGS MODFLOW computer code. In addition to including relevant processes important to groundwater flow, groundwater modeling is improved by evaluating the degree to which a model represents the real world. This is assessed by comparing how well simulated results compared to data measured in the field. Collection of field data to constrain and calibrate models is expensive, however, thus recent work has focused on methods to extract the most information from existing field data (e.g., Hunt and others, 2007; Fienen and others 2009, Fienen and others, in press). Such tools have additional utility for groundwater protection because they are designed to quantitatively evaluate the efficacy of current and future monitoring network designs. Such information is critical for 7evaluating the “bang for the buck” of alternative networks, and ensures that decision makers are maximizing the funding resources available for monitoring.

Other innovative work done at UW Madison includes use of Unmanned Aerial Vehicles (UAVs) to collect thermal remote sensing data for mapping of groundwater discharge. Thermal imagery was collected at the stream reach scale (several kms), at four times during the day – dawn, noon, 4pm, and dusk. Groundwater discharge, visible in this imagery is intended to allow 1) a better understanding of stream-aquifer interactions; 2) insight into the underlying groundwater flow system; 3) identification of reaches where groundwater discharge may threaten surface water

quality through discharge of contaminated groundwater; 4) developing a water quality monitoring program that can account for areas of known discharge; and 5) targeting reaches for conservation or restoration where stream-aquifer interactions are favorable for supporting aquatic ecosystems (Deitchman, 2009).

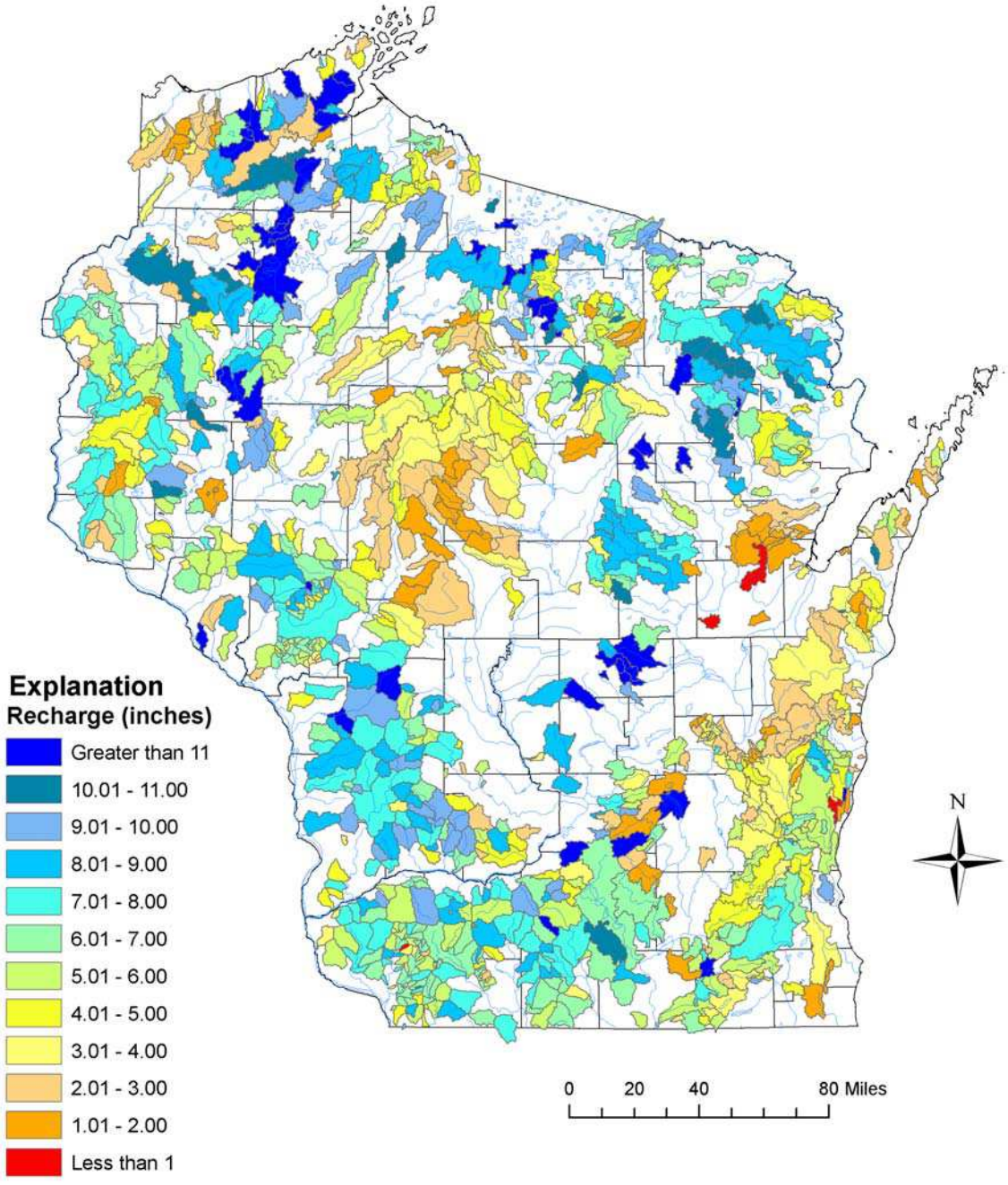

Figure 5.2 Spatial distribution of average annual recharge at partial record stations in Wisconsin (from Gebert and others, 2009b).

Modern borehole logging and imaging represent additional new tools coming into wider use in Wisconsin. Borehole geophysical logging refers to a series of field techniques in which various electronic sensors are lowered down wells or boreholes to record physical properties of the subsurface rocks and water. Typical sensors include temperature, electrical conductivity, natural radiation, borehole diameter, fluid flow, and borehole imaging. While these techniques are by no means new, and have long been used in the petroleum industry, they have only recently been applied routinely to shallow environmental and water-supply problems. Modern computers and electronics make these instruments portable and much less expensive and easier to use than in the past. The Wisconsin Geological and Natural History Survey (WGNHS) routinely uses such instruments to collect subsurface data from wells across the State, and this information is invaluable for understanding Wisconsin's hydrogeology.

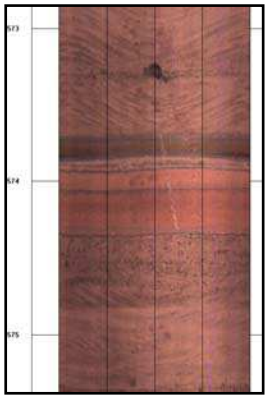

Figure 5.3 Optical borehole image from a WGNHS test well drilled in Pierce County. This image shows the borehole wall between 573 and 575 feet below the surface.

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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 (projects can be found in Appendix C):

- 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), (Metz & Benson, 2004-06), (Anderson, 2003), (Park, 2002-03), (McGinley, 2002-03)
- Improvements in the predictability of pump-and-treat or excavate-and-treat remediation applications to contaminated aquifers (Bahr, 1994-95),. (Evans & Li, 2002-03);
- 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);
- Multi-parameter sensors for monitoring groundwater quality (Geissinger, 2006-08), (Anderson & Glanchandani, 2002-03).

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.

Bacteria

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 study conducted at the WSLH (Long and others, 2008), and funded by the Groundwater Coordinationg Council, developed a Real-Time PCR assay for the molecular detection of *Rhodococcus coprophilus.* Detection of *Rhodococcus coprophilus* is an indicator of fecal pollution from grazing animals. This data is useful as part of the WSLH's "toolbox" of microbial source tracking methods to determine the source of fecal contamination of groundwater. Other assays performed as part of the microbial source tracking (MST) toolbox are; genotyping of male-specific coliphages, detection of sorbitol-fermenting *Bifidobacteria* and detection of *Bacteroides* using different primer and probe sets to distinguish between human and animal sources of fecal pollution. In the last 2 years there have been 49 groundwater samples collected for analysis. One sample was from a drain tile and the others were from 40 different private wells (with 8 wells sampled twice). Results indicate 28 of the 49 samples were positive for contamination from grazing animals, 3 samples tested positive for bacteria associated with human waste, 10 samples tested positive for recent but inconclusive fecal contamination, and 9 samples tested clean. The use of these analyses has proven valuable to DNR in granting Well Compensation awards for replacement wells for wells contaminated with livestock waste (manure)

A UW Water Resources Institute project examined the strengths and weaknesses of 10 enzyme-based tests approved by the U.S. EPA 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.

Viruses

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, 2003, 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.

After several years of development and validation, researchers at the Marshfield Clinic Research Foundation now possess the capacity for high-throughput testing of waterborne viruses. Virus tests include six common human enteric virus groups and six common bovine viruses. The number of tests that used to take three months to complete can now be accomplished in an afternoon. Recently, these researchers completed a study involving more than 20,000 virus analyses of the groundwater supplying drinking water in 14 Wisconsin communities. This level of laboratory capacity relies on three major advances: 1) Inexpensive and effective concentration of waterborne viruses using glass wool filtration, a method developed and fully validated at Marshfield Clinic (Lambertini et al. 2008); 2) Virus detection by real-time quantitative

polymerase chain reaction (qPCR) using recently developed high-throughput platforms and highly specific fluorescent probes; and 3) Development at Marshfield Clinic of a unique Laboratory Information Management System (LIMS) for quality assurance, quality control, and data management of analyses for waterborne pathogens. Contingent on several more advances, the researchers believe it will be possible to screen a water sample for all common waterborne pathogens using an approach that is inexpensive, efficient, and reliable.

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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 wells 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.

In late 2007, suburban communities in the Lower Fox Valley reduced consumption of groundwater 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. Since 2007, as part of a regional study, water levels have been monitored and collected into a database. As of Spring 2009, water levels had risen by 100 feet in much of the region and, in some wells, by more than 150 feet. The rate of recovery has significantly slowed showing that nearly all of the recovery has occurred. In addition to water levels, the pumping rates of current groundwater users in the region have also been collected. We expect that the results of the study will provide guidance to the region on how much drawdown to expect as pumping rates change in the future.

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 groundwater protection strategies. The website is available at *http://wi.water.usgs.gov/gwcomp/index.html*. From January 1 through May 18, 2009 the website is averaging over 600 successful requests for information per day, and nearly 100 successful requests for pages per day. 1,700 distinct files have been requested and more than 1,200 different individuals or organizations from dozens of countries have visited the site over that period.

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; other than correcting identified errors this site is currently static. Funding for development of this web site came from the Wisconsin Department of Natural Resources through the Joint Solicitation for Groundwater Research & Monitoring of Wisconsin's Groundwater Coordinating Council. Additional funds were provided by the US Geological Survey Cooperative Water Program.

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. In FY 09, over 490 printed copies and 21,321 downloads were recorded.

METHYLMERCURY FORMED IN GROUNDWATER

Methyl mercury (MeHg) is one of the most toxic and persistent substances in the environment. Current research has focused on how MeHg forms from inorganic mercury deposited from atmospheric sources such as coal combustion. A UW study conducted at the Allequash Creek watershed in northern Wisconsin determined that anoxic zones in shallow groundwater are an important site of MeHg formation. Recent results show that MeHg concentrations in these hyporeic (shallow zone) pore waters co vary with the mercury methylation rate at depth. This suggests that the measured MeHg concentrations are likely produced in situ, and are not from legacy sources. Methylation rates in the hyporeic zone of the peat bog are generally higher than those of the headwater springs – which is consistent with previous observations of increased wetland export of MeHg. Current results also show that methylation rates are not controlled by the total mercury concentration in pore waters. Instead, high concentrations of strong mercury-binding ligands have been observed and are believed to influence methylation rates by one of several possible mechanisms. This information advances our understanding of mercury transport and methylation in groundwater, and will help us interpret the watershed response to changing conditions in the hyporeic zone. For example, due to the lack of correlation between total mercury and methylation rate in pore water, the mitigation of atmospheric mercury inputs to the watershed, may not immediately affect MeHg export. In addition, any impact on groundwater levels, whether due to climate change or conjunctive use of groundwater and surface waters, will likely influence MeHg production in both natural and engineered wetlands.

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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

- **Evaluate acute and chronic impacts to groundwater from manure management practices.:** Groundwater contamination associated with manure handling and disposal is an ongoing problem in many parts of Wisconsin Rural home owners sometimes report brown, discolored, or smelly well water, and some of these cases have been directly linked to manure contamination. Concern about this problem is increasing as Wisconsin farming methods have evolved toward larger farms with thousands of animal units and proportionally higher waste loads. Manure handling has also evolved toward producing material with higher liquid content, which is easier to transport and store but has a higher probability of moving to groundwater than the higher-solid manure produced by traditional Wisconsin farms. A statewide assessment of manure-groundwater issues 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 better understood. 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.

- **Understand and better predict impacts from groundwater withdrawals:** Recent headlines about lakes streams and springs drying up in various parts of the state, 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 hydrologic relationships between surface water 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 address this issue.

- **Continue to evaluate and catalog Wisconsin's groundwater resources.** Water supply problems are typically not statewide problems but rather local supply problems. That is, the flow of water in the natural system cannot always 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 have ample amounts of water in our state, we can still experience water shortages locally. The groundwater resource needs to be further defined in terms of its quality, quantity, and availability.

- **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 and some such wells is difficult to use. In some other existing deep wells as far south as Milwaukee, the TDS have been steadily increasing over the years. These radium, 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 byproducts 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 evaluate the threats these substances pose a threat to Wisconsin's groundwater resource, and also to human health.

- **Understand the links between land use and groundwater quantity and quality:** Intelligent decision-making requires an understanding of how land use change (such as a change from rural to urban land use) impacts groundwater.. 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. Another example is the impact of storm water infiltration on groundwater. 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. Research is needed to determine the impact of infiltration devices on local groundwater, and to assess the need for signage or abandonment criteria to protect the groundwater resource.

- **Evaluate potential impacts of climate change on Wisconsin's groundwater:** Climate change will likely increase the frequency and severity of weather patterns that may produce unprecedented flooding or drought conditions. As a result, land and water 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, the relative contribution of groundwater to lakes , 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.

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 indicated 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 if Wisconsin groundwater will continue to 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 practice research to evaluate resource protection effectiveness.** 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. A USGS study further finds that nitrate contamination of groundwater is increasing statewide. The adoption of nutrient management plans by farmers would reduce nitrogen loading to groundwater. Nutrient management planning has increased dramatically in recent years and with a tight agricultural economy, farmers are embracing nutrient management because it is both economically as well as environmentally positive. 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.

- **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.

- **Continue to fund groundwater monitoring and research**: Numerous years of state budget cuts and increased costs have reduced the number of groundwater research and monitoring projects that are funded each year (see Table 3 in Chapter 2). Continued cuts will hamper the State's ability to address critical groundwater monitoring and research needs in the future. Research and monitoring are necessary to identify and test cost-effective groundwater management strategies that 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.

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 for oversight of groundwater and surface water in the Great Lakes basin. Implementing legislation—2007 Wisconsin Act 227—includes a water use permitting system for review and approval of water withdrawals and diversion applications, direction to develop a statewide water conservation and efficiency program, and a statewide requirement for water supply service area planning. 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. In addition, the Great Lakes Compact implementing legislation directs the DNR to develop a statewide water use database. This commitment to managing 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. In FY 09 the WRI Water Resources Library has continued to digitize and post the abstracts and final reports of many WRI and DNR groundwater-related monitoring and research projects funded through the Wisconsin Groundwater Research and Monitoring Program. There are still many projects that need to be posted and more need to be 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. Fact sheets on nitrate and arsenic have been completed and work continues on groundwater quantity and pathogens in groundwater fact sheets. 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.

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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 22, 2008

Department of Agriculture, Trade, and Consumer Protection Board Room
2811 Agriculture Drive, Madison

Members Present: Todd Ambs - Chair (DNR); Kathy Pielsticker (DATCP); James Robertson (WGNHS); Mark Werner for Henry Anderson (DHS); Anders Andren (UW-System); and Eric Scott for Berni Mattsson (Commerce).

Others Present: Lori Bowman (DATCP); Chris Babiarz and Jim Hurley (WRI); Birl Lowery and Brian Lepore (UW Madison Dept. of Soil Science); Jeff Helmuth (DNR);

1) **Introductions and General Business** – The meeting began at 10:00 AM. Introductions were made. The May meeting minutes were approved.

2) **Consideration of Draft FY 08 Report to the Legislature** – Jeff Helmuth presented suggested edits to the draft report sent to all GCC members two weeks earlier. Consensus was reached on all proposed edits. Jeff asked if the inside cover should list current members or all members from the reporting year. The consensus was to list all members and note which ones were no longer members. A question of whether a statement on property assessors considering the expense of contaminated wells was still valid after a recent WI Supreme Court decision was left unanswered. Jeff was asked to continue pursuing the answer with DNR's Legal Services and include the statement only if still applicable. [Note: Jeff later reported that DNR Legal Services opined that the recent decision applied only to property owners, not assessors. The statement was left in the report.] Contingent upon resolving the legal question, the GCC approved the report as revised. The GCC thanked Jeff for his efforts. Jeff acknowledged extra help from Laura Chern and Chris Babiarz in fine-tuning the report.

   Todd Ambs plans to meet with Legislative committee chairs shortly after the November election to assure that they're aware of groundwater issues. Todd expects that there will likely be new groundwater quantity legislation and possibly groundwater quality legislation introduced next year. There is the possibility of small amounts of money for groundwater monitoring and research that Todd would like to route through the GCC' joint solicitation process. Jamie Robertson, Kathy Pielsticker, and Anders Andren all indicated an interest in accompanying Todd.

3) **Plans for FY 10 Joint Solicitation** – Jim Hurley was welcomed back after a year in Washington D.C. on an appointment with NOAA with whom he will continue to work part-time this fall. Chris Babiarz will continue to help out with the FY 10 solicitation. Jim distributed the timeline for the solicitation, as well as draft language, also to be reviewed by GRAC and the funding agencies. Jim, added that the UW budget should be good so he hoped to have more proposals this year. UW would like to have more proposals on socio-economic issues. Jeff Helmuth noted that the DNR priorities would be somewhat broader this year. Todd said he expected that the state budget lapse plans would impact the DNR groundwater monitoring and research budget.

There was some discussion of research needs related to ethanol production. Anders said that they would work to make the UWS priorities more explicit on ethanol impacts. Todd noted that ethanol production technology was becoming more water-efficient so efforts could be focused on dealing with economic issues. Eric Scott said that a Commerce concern is what happens when ethanol fuel is released on top of residual contamination and causes a stable plume to expand.

4) **Education Subcommittee Report** – Jeff Helmuth reported that the Subcommittee met on July 23rd, 2008 and discussed the following topics:
   - Water reuse and conservation fact sheet **-** Kevin Masarik is working on this item with Tom Braun at Commerce. Jeffrey Beiriger (WI Water Well Association and WI Plumbing Heating and Cooling Contractors) is interested as the issue is increasingly important to both the organizations that he represents.
   - "What's wrong with my water?"– With input from the subcommittee and many others, Dorie Turpin coordinated development of DNR web page.
     The website: 1) answers some of the more commonly asked questions that DNR private water staff are asked; 2) helps well owners diagnose their aesthetic water quality problems; and 3) captures and preserves DNR water supply institutional knowledge.
   - Wisconsin Well Water: Planning Web-based Resources Grant**:** Kevin Masarik is coordinating a grant from the Medical College of WI targeted at improving the delivery of drinking water quality testing and interpretive information through the web by centralizing drinking water quality information into a user-friendly resource. The project will include a series of interviews with professionals that use and distribute drinking water quality information to citizens and compile a list of all materials that are currently in use. The subcommittee will be involved.
   - Subcommittee turnover includes Dave Lindorff retiring from DNR (not yet replaced), Jeff Ackerman moving from DATCP to DNR (no longer on subcommittee – Sarah Walling is filling in for DATCP), and new DHS and SLH representatives. The Subcommittee has reviewed its charge for the new members.
   - *Karst: Avoid that Sinking Feeling* brochure – After a prolonged search, Suzanne Wade has found funding for reprinting the revised brochure.

5) **DATCP well construction report search tool** – Cody Cook demonstrated the new DATCP application for searching and viewing scanned images of well construction reports. Cody developed the application to work in a geographic information system environment. Reports can be selected with a box or by using town-range-section locations. DATCP has set up a way for other agency staff to access the application with a username and password. Monitoring and Data Management Subcommittee members will field questions from staff from their agency.

6) **Monitoring and Data Management Subcommittee report** – Jeff Helmuth reported on the following July 29th meeting items:
   - 2005 Water Use Report - USGS will produce an open-record-style report for 2005, not poster-style report as in past years. The report should be published in January 2009. Some findings include that water use in 2005 was somewhat more than in 2000 and it was the first year that irrigation use exceeded use for municipal supply. However, that change was influenced by the use of new water use coefficients generated by a WGNHS study of water use in Waukesha and Sauk Counties.
   - New/updated USGS Water Use web pages

  - National Assessment of Water Availability and Use - Great Lakes Basin pilot project: http://water.usgs.gov/wateravailability/greatlakes/
  - Wisconsin Water Use: http://wi.water.usgs.gov/data/wateruse.html
- Perfluorochemicals (PFCs) in groundwater – Mike Lemcke gave an update on PFCs including PFC-containing waste from a 3M factory in Minnesota impacting drinking water supplies. Discussion focused on sites in Wisconsin with the potential for PFC contamination including: the Junker landfill in St. Croix Co., Old Towne Landfill in Richmond, the Marina Cliffs Barrel Dump Superfund site, and a 3M facility in Prairie du Chien. No PFCs have been found through limited testing at the Wisconsin sites. DNR is writing a white paper on the issue.
- Wisclith **-** Subcommittee members are reviewing advanced copies of the WGNHS Wisclith database
- DNR's high-capacity well inventory project – So far staff have identified ownership of 7,600 wells of the 11,000 wells in the DNR data system. 2007 pumpage reporting yielded about 5,000 wells with good pumpage records and another 1,000 with questionable data. Much greater confidence in the data collected for 2007 than the approval numbers that were the only pumpage data previously available.

7) Agency Updates

DATCP – Lori Bowman reported that DATCP was looking at budget reductions. Personnel changes include Duane Klein moving to a half-time position and Stan Senger appointed Chief of the Environmental Quality Section. Three hydrogeologist positions remain vacant. Changes in Atrazine Prohibition Areas include one area near Poynette expanding. Regarding the Emerald Ash Borer (EAB), DATCP has revised ATCP 21 and created a response plan to prevent the spread of EAB. Nutrient management grants should be announced later this year. Lori is participating in a DHS planning team for public health 2020 and hoping to add safe drinking water to the discussion.

UWS – Anders Andren reported that the Water Resources Institute appropriation was again zeroed out and again added back. This time there may be a slight increase. Meanwhile, the WRI is working with UW Art Professor Henry Drewal to set up Water Matters: A Lecture Series, October 21 - November 18 at the Chazen Museum of Art (http://aqua.wisc.edu/watermatters/) [Note: As part of the series, Anders will give a lecture "Groundwater: Wisconsin's Buried Treasure" on November 18th.] Anders noted an article in Scientific American "Facing the Freshwater Crisis" by Peter Rogers on the urgency of action to avert a global water crisis (http://www.sciam.com/article.cfm?id=facing-the-freshwater-crisis).

Jim Hurley reported that the Sea Grant RFP was in preparation and that Sea Grant's comprehensive plan would be completed in late fall.

WGNHS – Jamie Robertson reported that the survey was busy with flooding and high water issues from the torrential spring rains. Consideration is being given to revisiting water table maps to show areas vulnerable to "groundwater as a natural hazard". Madeline Gotkowitz has been evaluating a proposal for dewatering the Spring Green area and worked with John Attig to prepare a presentation on the geologic and hydrologic conditions in the Wisconsin River valley that contributed to the flooding. Slides from the presentation and a fact sheet on these conditions are presented on the WGNHS website: http://www.uwex.edu/wgnhs/news.htm.

Ken Bradbury is working with Mark Borchardt (Marshfield Clinic) and others on a study of the source of viruses in the Madison wells. The project findings implicate sewers and support investment in infrastructure.

Jamie also announced the creation of a new WGNHS outreach program focused on developing more digital information available on an interactive website. Plans include hiring an Outreach Program Manager to spearhead the effort.

DHS – Mark Werner reported on the split of DHFS into the Dept of Health Services and Dept. of Children and Family Services. Henry Anderson has been appointed interim State Health Officer. DHS continues to deal with flood response issues and is preparing a list of compounds to be considered for the next round of groundwater standards. DHS is also participating in the Environmental Health Tracking Program with 16 other states, developing integrated data platforms. Mark noted that a recent Wisconsin Medical Journal article titled "Measuring the Environmental Health of Wisconsin's Counties" reported on a DHS/UW Population Health Institute study (http://www.wisconsinmedicalsociety.org/_WMS/publications/wmj/issues/wmj_v107n4/107no4_athens.pdf) where water quality (% pop. exposed to nitrate > 2mg/l) is one of three contributing factors.

DNR – Todd Ambs reported that the June floods were causing more problems than did those of August 2007. The Water Division is compiling a report on flooding. In June, there were 170 sanitary sewer overflows, record flows in some rivers, problems at wastewater treatment plants, dam failures, impacted private wells and basements, but no public drinking water systems were impacted. Todd attributed this to a push years ago to move wells to higher ground. The odd weather has raised questions on how to regulate using climate statistic-based models.

A new Water Use Section was created in the Drinking Water and Groundwater (DG) Bureau with Eric Ebersberger appointed Chief. The primary functions are to implement the Groundwater Quantity Law, develop water conservation plans with Commerce and PSC, and implement the Great Lakes Compact. Eight to ten positions will be requested for the section.

Todd added that the Great Lakes-St. Lawrence River Basin Water Resources Compact was rapidly working its way through Congress towards the President [Note: the Compact was signed by the President on October 3rd]. The Compact will go into effect on December 8th, before rules will be in place, so interim approvals will be issued. Act 227 will require general permits for all users from 100,000 gal/day to 1,000,000 gal/day and individual permits for users over 1,000,000 gal/day. New and increased users must demonstrate that they're using current water supply efficiently.

DG continues groundwater quantity work by building a springs inventory. Plans include a 2-year project for mapping and documenting springs with a flow of over 0.25 cfs for more than 80% of the time.

8) **Rapid Movement of Water and Contaminants in Soil Cracks** – Birl Lowery and Brian Lepore presented their UW-funded project on macropore flow. Preferential flow can occur through soil cracks and biopores (earthworm burrows and root channels). The impact of water and solutes flowing through macropores on groundwater quantity and quality is known to be significant, yet it remains poorly understood, and there are limited models available to simulate this. In addition to a lack of good simulation models, methods for real time sampling

of macroporous water and solute fluxes are limited as well. The object of the study was to make in-situ measurements of critical preferential flow parameters and improve a preferential flow model. The study was conducted at the University of Wisconsin-Madison Arlington Research Farm, Arlington, WI on a Plano silt loam soil cropped to corn. A new technique for monitoring macropore fluxes, an Automated Lysimeter Fluxmeter (ALF), was developed and used in several in-situ ponded infiltration experiments. Other measurements were made by equilibrium tension lysimeter (ETL), free drainage pan lysimeter and volumetric water content (VWC) probes. The major modeling effort concentrated on improving the Macropore-Matrix (M&M) submodel of PALMS (Precision Agricultural-Landscape Modeling System) so that it improved estimates of macropore flow. Results from field-based water and solute flux experiments led to estimates of profile macropore volume and interaggregate half-slit width, which were used to parameterize the M&M component of PALMS. The revised PALMS can better estimate water fluxes in macropores and indicates deeper and more rapid infiltration than without incorporation of the macropore infiltration model.

11) Adjourn and Next Meeting – The meeting was adjourned at 1:00. The next meeting will be held at 10:00 on November 14th at the Wisconsin Department of Natural Resources.

Prepared by Jeff Helmuth - Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Meeting Minutes – November 14th, 2008

At the Department of Natural Resources, GEF II building
Room G09, 101 S. Webster St., Madison.

Members Present: Todd Ambs - Chair (DNR); James Robertson (WGNHS); George Kraft (Gov. Rep); Dan Scudder (DOT); Lori Bowman for Kathy Pielsticker (DATCP); and Chris Babiarz for Anders Andren (UW-System).

Others Present: Ken Bradbury (WGNHS); Mike Lemcke and Jeff Helmuth (DNR);

1) **Introductions and General Business** – The meeting began at 10:00 AM. Introductions were made. The August meeting minutes were approved.

2) **FY 10 Joint Solicitation** – Chris Babiarz reported that there had been a procedural complication for UW-Madison applicants in the automated proposal submittal process. In the past, these applicants submitted a transmittal form (T-Form) as proof of administrative approval of the proposal (all other applicants submitted a more streamlined authorization form). After the last joint solicitation (FY 09), UW-Madison discontinued the use of the T-Form in favor of a new online procedure. The new procedure (nicknamed WISPER) presented several challenges that threatened to complicate the Joint Solicitation process for FY 10. Fortunately, WRI staff were able to reach an agreement with the UW administration that allowed all applicants (including those from UW Madison) to use the same streamlined authorization form mentioned above.

   Todd Ambs noted that, with the large State budget shortfall, it was too soon to tell how much funding DNR would have. Monies in General Purpose Revenue and fee accounts were being used for much-needed budget repair. George Kraft noted that funds were needed for information on streamflow, groundwater levels and modeling to support Act 310 groundwater quantity work. The UWS priorities emphasize original research so there is a need for agency support of monitoring data gathering and compilation. Ken Bradbury agreed and added that funding was needed to support local efforts in monitoring and resource characterization. Jamie Robertson emphasized the need to maintain the balance of the Groundwater Research and Monitoring Program.

   Todd noted that part of the new federal economic stimulus package was directed at infrastructure. Climate change, flooding and wetland restoration are all to be targeted. Groundwater is likely to benefit from many of these projects. Todd added that groundwater quantity legislation may go through the Legislature this session but funding is problematic. Although the DNR has been spending about $100,000 per year on groundwater quantity research and monitoring, about $1,200,000 had been shifted from the mitigation fund to cover the budget shortfall. The money for the springs inventory is still in place but the LTEs needed to do the work can't be hired. On a hopeful note, Tim Asplund (DNR Lakes Program) is heading up a climate change workgroup that is looking at how to finance local monitoring. Todd also expressed confidence that the new legislative leadership would have a more informed perspective although they will have a lot of tough decisions to make e.g. environmental quality vs. health care for children. Jamie lamented that the emphasis on human health doesn't seem to include cleaning up a toxic environment.

   Mike Lemcke suggested that more secure monitoring funding could be attained by changing

the appropriations for distributing between Act 310 mitigation and monitoring funds. Ken underscored the need for more monitoring citing numerous issues that could be better addressed with better information, notably how recent flooding near Spring Green could have been predicted if more groundwater level data had been available.

3) Approval for modified UWS procedure to optimize funding - Christopher Babiarz requested the GCC's approval to potentially modify the procedure used to optimize federal funds from the UW Water Resources Institute base support (USGS 104b). In past years the GCC has approved the transfer of one or more projects from state to federal funds for their second year. This transfer frees additional state dollars to fund new projects in during the second year. Due to the limited size and number of continuing projects, this strategy is difficult to implement effectively in FY 10. Instead, the UW Water Resources Institute seeks approval to "forward fund" one or more proposals from the current joint solicitation. Selection of proposals would be based on external and internal reviews, the impact of potential outcomes, alignment with the UWS Groundwater Research Priorities, and GCC approval. The change in procedure was approved. [Note: WRI was able to optimize the use of federal funds without forward funding.]

3) Subcommittee reports – Jeff Helmuth reported on the following subcommittee activities

The Monitoring and Data Management Subcommittee – Due to some recent turnover on the subcommittee, the group reviewed its mission and examined several potential directions for its future work. The following directions were agreed upon:

Ongoing efforts

- Joint solicitation proposal review by Monitoring Workgroup – no changes.
- Information exchange and inter-agency issues – will remain a top priority.
- Monitoring project review – occasional presentations but no comprehensive review.
- Produce informational materials – no needs identified for the near future.

Items to provide context

- Groundwater Monitoring Strategy –DNR's Water Division Monitoring Strategy (Groundwater Chapter) will be reviewed and discussed at the next meeting.
- Process and a prioritization of potential additions and improvements to the USGS/WGNHS Observation Well Network will also be reviewed and discussed at the next meeting.

Near-term projects

- USGS Water Use database development – at the invitation of USGS the subcommittee will review a new, process model approach USGS plans to use for high-capacity well pumpage reporting, return flow, and other water use cycle data.
- Groundwater Climate Response Network – the subcommittee will also look at this network in the near future.

Education Subcommittee – Instead of their usual quarterly meeting, the subcommittee participated in the first meeting of the Wisconsin Well Water: Planning Web-Based Resources project http://www.uwsp.edu/cnr/watersheds/programs_outreach/hwpp.htm. There will be two more meetings. The purpose of the project is to: "Collaboratively develop web-based solutions that will increase the capacity for systematically providing information to Wisconsin's domestic water well users that aids in the individual determinations regarding drinking water safety."

Local Government and Planning – Jeff reported that Bob Pearson was interested in helping to reactivate this subcommittee. The chair, Dave Lindorff, retired in July. Todd Ambs

encouraged this effort and noted an increased need for local government involvement with respect to the new statewide requirement for water supply plans. Ken Bradbury added that WGNHS is receiving more calls from local governments about groundwater issues than ever. Todd suggested the subcommittee explore webcam technology (available at DNR and other agencies) for getting information out to local governments. Jeff will work with Bob to explore agenda topics for this subcommittee.

4) Agency Updates

DATCP – Lori Bowman reported:
- A proposed expansion to the Poynette Atrazine Prohibition Area had gone out to public hearing and only 3 people attended.
- WGNHS/UW-System has been working with DATCP to establish a monitoring system at Arlington farms for groundwater monitoring of low use atrazine.

DOT - Dan Scudder reported that, due to vacancies, Bob Pearson has been asked to manage DOT's wetland program in addition to his existing workload.

DNR – Todd Ambs reported:
- The agency is starting to address Great Lakes Compact requirements.
    - Water supply plans are required by 2025 for all systems serving more than a 10,000 people. The agency wants these plans to be meaningful and useful to the agencies. Jamie Robertson suggested that there be a monitoring component to the plans.
    - The Compact also requires DNR to permit all wells extracting >100,000 gal/day by December 8, 2008. It is yet to be determined how the agency will handle this requirement.
- There is external and internal discussion on the next logical steps for future groundwater quantity legislation.
- An explosion in applications for CAFO permits has drawn attention to alternative manure management technologies. Regional digesters are being discussed along with carbon crediting and other new technologies and policies.
- The next list for potential groundwater standards have been sent to DHS for their determination on whether there is enough toxicological information available to propose standards. This is the beginning of roughly a two year process.

WGNHS – Jamie Robertson reported:
- Due to retirements they plan on increasing their outreach efforts and hire a new outreach position. [Note: In early January Carol McCartney was hired as WGNHS Outreach Manager.]
- Climate change, flooding, and virus work have created many education opportunities for the survey. They have more calls coming in than they have staff to serve the needs.
- Jamie and Ken Bradbury met with many of the leaders within the University System to discuss potential geosequestration of carbon in Wisconsin. By the end of the meeting it was clear that from what is known of the existing rock units, Wisconsin is not a very suitable place for carbon geosequestration.

Governor's Representative – George Kraft reported:
- A Southwestern Wisconsin study at Platteville has generated pesticide data for baseflow and stormflow periods
- The Little Plover River stakeholders are eagerly awaiting the setting of the public right

stage for the river.
- The Central Wisconsin Groundwater Center has begun sifting through old USGS and other documents looking to see if social inferences on water planning where made throughout these documents.

5) **Consideration of future GCC meeting format** – Jeff Helmuth suggested taking a look at GCC meeting format largely because increased workload was making it more difficult for administrators to attend. Jeff asked if cutting the frequency and/or duration of the meetings would help and asked for suggestions. Jamie Robertson preferred to retain the current format but, with all due respect to Jamie, the majority favored the following changes:
   - Meetings will generally be on Friday's from 10:00 – 12:00 or 12:30
   - Meetings will start with technical presentation(s).
   - Technical presentations will be limited to 20 minutes.
   - The February and August meetings will be prioritized. This is in line with State statutes which require the GCC to meet twice a year, and the timing of two of the GCC's most important functions: the joint solicitation and the annual report to the Legislature. Members are asked to contact Jeff if they find that they can't attend these two meetings and the meeting will be rescheduled if a quorum cannot attend.

   Due to the absence of some members, Jeff was directed to subsequently set meeting dates, giving precedence to Kathy Pielsticker and Todd Amb's schedules. [Note: The 2009 meeting dates and locations are: February 27 at WRI, May 8 at WGNHS, August 21 at DOT, and November 13 at DATCP.]

7) **Assessment of Virus Presence and Potential Virus Pathways in Deep Municipal Wells** – Ken Bradbury presented results of his recently-completed study that found live viruses in six deep Madison municipal wells. Working with Mark Borchardt (Marshfield Medical Center), Madeline Gotkowitz (WGNHS), and Randy Hunt (USGS), Ken had hypothesized that the three wells cased through the Eau Claire shale would be much less likely to contain viruses than the three wells with shallow casings. Samples from the six wells and local lakes were sampled approximately monthly and analyzed for viruses, major inorganic ions, and isotopes of hydrogen and oxygen. Untreated sewage was tested for viruses. Precipitation patterns were also examined. Viruses were detected at least twice in every well, but no well was virus-positive in every sample. About 43 percent of the well samples were virus-positive. Lake samples were positive 78 percent of the time. Virus results varied significantly with time with speciation showing different virus serotypes coincident in time in wells, lakes and sewage.

   Ken discussed the 4 types of sewer/groundwater configurations and noted that three of them have the potential for leakage of sewage into groundwater. Given the very high virus concentrations in sewage it would take very little sewage to contaminate groundwater to the level of pathogeneity (5-6 virus/l). Ken noted that viruses have great potential to be used as tracers because they can be quantified over a very wide range of concentration.

   Since the end of the study Ken and others have worked with the Madison Water Utility, the DNR and the press to present and clarify the results and implications of the study. All have been cooperative in addressing the implications of the study. Discussion included Dan Scudder's remark that many of the same questions apply to pharmaceuticals in groundwater.

8) **Adjourn and Next Meeting** – The meeting was adjourned at 12:15. The next meeting will be held at 10:00 on February 27th at the UW Water Resources Institute, in the conference

room of Goodnight Hall at 1975 Willow Drive, Madison. The GRAC meeting will occur that afternoon in the same room so for those attending both, it will be convenient. WRI will send out parking passes beforehand. The timing of the two meetings means that the FY10 UWS Groundwater Research Plan will be distributed and approved by email unless issues indicate that a meeting or conference call is necessary.

Minutes prepared by Jeff Helmuth - Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Meeting Minutes – February 27, 2009

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

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

Others Present: Jim Hurley, Stephen Wittman, Anne Moser, and Carolyn Betz (WRI); Kathleen Standon (WE Energies); Eric Ebersberger and Jeff Helmuth (DNR);

1) **Introductions and General Business** – The meeting began at 10:00 AM. Introductions were made. The November meeting minutes were approved.

2) **DNR's Water Use Program and the Great Lakes Compact** – Eric Ebersberger, Chief of DNR's new Water Use Section, provided information on the new section and its activities. Eric currently has 4 staff positions (1 vacant) focused on NR 820 high-capacity well reviews and approvals; developing and updating the high-capacity well database; and preliminary Great Lakes Compact work. Four positions proposed in the Governor's budget would be targeted at implementing the Compact.

   The Great Lakes Compact requires registration and reporting of basin withdrawals (>100,000 gal/d); management of basin water use water, conservation, and efficiency; and reviewing applications for diversions out of the basin. Diversions are only possible for "straddling" communities and communities in "straddling" counties. Within the basin, Wisconsin will issue general (> 100,000 GPD but < 1 MGD) and individual permits (> 1 MGD) and administer fees for large withdrawals (> 50 MGD). DNR has issued interim approvals for Great Lakes Basin withdrawals in place before the December 8, 2008 effective date of the Compact and is now considering subsequent applications. Water supply service area plans will be required for all public water supply systems serving communities with populations over 10,000 by 2026, but will be required within the Great Lakes Basin for applicants for new or increased withdrawals or diversion requests before the withdrawal or diversion is approved. New Berlin, a straddling community applying for a withdrawal, was the first water supply service area plan submittal.

   Anders Andren asked if Wisconsin was considering using a system like the Water Withdrawal Assessment Tool developed for the State of Michigan. The tool is designed as a screening mechanism to assess the likelihood of an impact to the state's water resources by a specific large quantity water withdrawal. Eric replied that DNR was starting to look into it and that it looked as though the data needed to support such an application is not available for much of Wisconsin. Jamie Robertson suggested considering developing such a screening tool to be used in areas where sufficient data are available and for future use in areas where data will be sufficient. George Kraft and Ken Bradbury were also aware of the Michigan tool and will be looking into it further. Todd Ambs will forward some key Michigan contacts to George. Todd also added that, compared to some other states, Wisconsin has many fewer staff and resources to address these issues.

3) **Little Plover River Flow Reduction Study** - George Kraft reported results of a DNR-funded

project conducted by Katherine Clancy, Dave Mechenich and himself on this once-productive trout stream. The project was prompted by low flows starting in 2003, partial dry-ups in 2005 and 2006 and disagreement over the relative impacts of dry weather and groundwater pumping. The project integrated a wide range of hydrologic information including local precipitation, Little Plover and reference stream discharges, and high-capacity well pumping in the vicinity. Precipitation records, the Palmer drought index, and flow in reference streams all indicate near-normal conditions and suggest that climate alone does not account for the reduced flow.

Statistical and flow modeling approaches were used to estimate the impact of groundwater pumping on flow in the stream. Overall there was good agreement between the two methods, both indicating roughly 3.2 – 5.4 cfs of potential Little Plover discharge (at Hoover Rd.) being diverted by groundwater pumping. About 40 per cent of these diversions are from wells within 0.5 miles of the river, 58 per cent within 1.0 miles and 18 per cent from over 2.0 miles. Pumping from the Village of Plover alone accounted for about 1.2 cfs flow reduction in 2004-2006 with other big pumpers Del Monte and Whiting diverting considerably less from the river. Although well-specific irrigation pumping data were spotty for the project period, the total for that category has been a major factor in Little Plover River flow depletion. George concluded that in the absence of groundwater pumping, Little Plover flows at Hoover Road would have bottomed out at about 6.5 cfs in recent years instead of the 1.6 cfs measured in 2005.

George also gave an interesting overview of the history of irrigation policy in the state and the explosion of center pivot irrigation seen since the 1960's in the Central Sands area.

Todd Ambs noted that he expected to see a second generation of groundwater quantity legislation introduced this session and that the Little Plover River situation made a good case for further action. Todd also reported that DNR was establishing a public rights stage for the river [Note: Public Rights Flows were established by the Natural Resources Board on March 23 for four locations on the Little Plover River (6.8 cfs at Hoover Rd.)]. There are a lot of questions about what to do since the public rights flow is higher than the flow most of the time. The Governor and DNR believe that the public trust doctrine applies to groundwater but the case law is not robust.

4) **Joint Solicitation and UWS Groundwater Research Plan** – Jim Hurley reported that the average cost of proposed projects submitted to the joint solicitation was about $35,000 and that overall costs had increased due to tuition remission. Currently the WRI is supporting 11 projects. The following 2 projects were put on USGS funding: 1) The lethal and sublethal effects of elevated groundwater nitrate concentrations on infaunal invertebrates in the Central Sand Plains (Stelzer) and 2) Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water (Li). WRI is also co-funding a conference on flooding with this funding. The UWS expects to have $230,000 minus a 8-12% system-wide cut. Anders added that USGS funds could be added to the UWS funds to total about $300,000, or about $250,000 - $265,000 after the cuts. Steve Wittman added that they were looking at changing the required format for proposals to be consistent with the USGS format for the future.

Todd Ambs reported that DNR funding was more uncertain this year. Jeff Helmuth will relay information about DNR funding interests to WRI as it becomes available. [Note: at this writing it appears DNR will not fund any FY10 Joint Solicitation projects]

5) **Wisconsin's Water Library (http://aqua.wisc.edu/waterlibrary/)** – Anne Moser provided information on the wide array of print and electronic resources available through the Water Library (formerly known as the Water Resources Library). Its collection contains almost 30,000 volumes of water-related information about the Great Lakes and the waters of Wisconsin as well as a curriculum collection, dozens of educational videos, a children's collection, and more than 20 journals and 100 newsletters. Of special note are an online collection of Great Lakes maps from the 1600's to the present (http://greatlakesmaps.org/) and the new Aqualog daily blog of news, publications and resources about water in Wisconsin and the Great Lakes (http://aqualog2.blogspot.com).

   Anne also provided information from Chris Babiarz on the new joint solicitation project report database currently in development It will be searchable by topic, funding agency, keyword, investigator or project number and will contain as many of the 350+ reports as can be located. A beta version should be available for review in the coming months.

6) **Education Subcommittee Report** – Jeff Helmuth reported that the Subcommittee has a couple new members. Jason Lowery has taken over for Jeff Ackermann to represent DATCP and Carolyn Betz , the new science writer at the WRI will be participating for UWS.

   Carolyn is taking the lead on the WRI Groundwater fact sheets on Arsenic, Nitrate, Manure and Quantity and has distributed the arsenic and nitrate sheets to the subcommittee for final review. The subcommittee, after numerous discussions, has not been able to develop a consistent message related to manure and groundwater. Jeff suggested a couple options and asked the GCC for advice on how to proceed. One option would be to hold off work on the manure fact sheet until recent/current relevant studies are completed and, in the meantime, proceed with the other fact sheets. Consensus on groundwater quantity and pesticide messages is more certain and the group should be able to make progress quickly. Another option would be to end subcommittee involvement on the manure fact sheet and allow WRI to complete it (or not) without further GCC involvement. Kathy Pielsticker strongly supported the subcommittee moving on to quantity and pesticide fact sheets. Todd Ambs encouraged further work on the manure issue and suggested that it could be characterized as the improper land spreading of nutrients which would also include land application of municipal and industrial waste. Another avenue would be to address pathogens, rather than manure as the issue. Suggestions for other topics included radon (Andren) and climate change (Anderson). Jeff will take these ideas back to the Subcommittee for discussion and will report back on progress in May.

   Kevin Masarik and others have continued work on the Wisconsin Well Water Web-based Resources project to coordinate information on the Internet. An initial meeting in December was well-attended by various state and local agencies as well as some industry representatives and resulted in identification of some specific areas where emerging web technologies could improve communication with residential well owners regarding their well and drinking water quality. A second meeting to be held in March was to focus on overcoming technological barriers.

   Other subcommittee activities include updating Groundwater Information Network membership, drafting a UWEX Water reuse and conservation fact sheet, and Groundwater Awareness Week (March 8-14th). For Groundwater Awareness Week Kevin put together a series of news releases/short articles that are typically picked up by a few local papers around the state and Stephen Wittman arranged a groundwater spot on the Larry Meiller show for March 25th featuring DNR Drinking Water and Groundwater expert Steve Ales and Kevin

Masarik.

7) Agency Updates

DNR – Todd Ambs reported:

- DNR will take General Program revenue cuts across the board. DNR has about 300 vacancies, with the Watershed Management Program holding over 20% vacancies. Although new positions are proposed for the Great Lakes Compact and ballast water programs, no more are expected for some time. The UWEX Basin Educator positions are likely to be cut. Although the Wisconsin budget looks very tight, some other states are much worse off. For example California has lain off about 20,000 employees.
- About $140,000,000 is available for wastewater and drinking water infrastructure funding from federal economic stimulus sources but there is only a 3-week window to identify projects.
- The President's federal budget for 2010 contains a 34 per cent increase for EPA, almost $4 billion for the Clean Water and Safe Drinking Water State Revolving Fund loans, and $475 million for the Great Lakes Initiative. Consequently federal money is becoming much more important.

Commerce - Eric Scott reported:

- The Storage Tank Regulation Section has completed the revision of Comm 10 (Flammable, Combustible and Hazardous Liquids) which went into effect February 1, 2009.
- The Safety & Buildings Division continues efforts relating to subsurface infiltration to minimize surface runoff.

DOT – Bob Pearson reported:

- DOT is working with DNR on hydrology studies for some Portage Area Dams
- Construction contractors involved with dewatering operations have been informed of DNR's new high-capacity well requirements

UWS – Anders Andren reported:

- Kevin Reilly, UWS President, initiated work on applying the Wisconsin Idea in China on water issues. A white paper is being developed and will go to the agencies.

DHS – Henry Anderson reported:

- Budget problems are of concern agency-wide.
- A new round of groundwater standards will be sent to DNR in the next month or so. Public hearings should be in summer or fall of 2009.

DATCP – Kathy Pielsticker reported:

- Due to budget problems, the Clean Sweep program has been eliminated, Agricultural Chemical Clean-up staff are being cut, and there will be major lapses.
- Although manure hauler registration and groundwater research funding had been proposed, neither made it to the proposed budget.
- The lead arsenate initiative is now stalled due to no staff.

WGNHS – Jamie Robertson reported:

- Retirements are still impacting the Survey
- A new outreach manager position was recently created and hired. Carol McCartney brings a wealth of experience and knowledge to the position.

- Projects on flooding, and viruses in groundwater are continuing.

8) Adjourn and Next Meeting – The meeting was adjourned at 12:25. The next meeting will be held at 10:00 on May 8 at WGNHS, 3817 Mineral Point Road, Madison.

Minutes prepared by Jeff Helmuth - Department of Natural Resources

Wisconsin Groundwater Coordinating Council
Minutes from meeting held May 8, 2009
Wisconsin Geological & Natural History Survey
3817 Mineral Point Road, Madison.

Members Present: James Robertson (WGNHS); Henry Anderson (DHS); Anders Andren (UW-System); Bob Pearson for Dan Scudder (DOT); Rick Graham for Kathy Pielsticker (DATCP); and Mike Lemcke for Todd Ambs (DNR). By conference phone: George Kraft (Gov. Rep);

Others Present: Jim Hurley, (WRI); Ken Bradbury (WGNHS); Steve Loheide and Rich Deitchman (UW-Madison); Steve Gaffield (Montomery Assoc.); and Jeff Helmuth (DNR);

1) **Introductions and General Business** – The meeting began at 10:00 AM. Jamie Robertson chaired the meeting. Introductions were made. The November meeting minutes were approved.

2) **Technical Presentation: Thermal Remote Sensing of Stream Temperature and Groundwater Discharge: Applications to Hydrogeology and Water Resources Policy in the State of Wisconsin** – Rich Deitchman talked about the study he did under Steve Loheide on using heat as an indicator of groundwater discharge to surface water. Three case studies were completed:
    a) Ground-based, ultra-high-resolution, 24-hour observations at the UW Arboretum showed that heterogeneity in hydraulic conductivity has marked effects on seepage and so preferential pathways control flow. Summer and winter are the best times to do this as the groundwater/surface water temperature contrast is greatest.
    b) A single-engine airplane was used to construct longitudinal profiles of the East Branch of the Pecatonica River. One-dimensional modeling of temperature using climate change scenarios indicated potential harm to fisheries under some scenarios.
    c) An unmanned aerial vehicle (UAV) avoids the expense of airplanes and can provide lower altitude, higher resolution data. A wireless ethernet bridge to a laptop computer provides real-time data. An unexpected wrinkle was the time spent getting an FAA permit for the UAV and dealing with concerns related to security and private property. This technique was found to be useful in assessing groundwater input and potential fishery health.

    Discussion centered on complicating factors including variability of hydraulic conductivity, variability of recharge, and higher runoff rates under climate change scenarios.

3) **FY 10 Joint Solicitation update** – Jim Hurley reported that the UWS would fund 5 new projects out of the 18 proposals submitted. UWS budget cuts so far have been 4% (permanent). Two projects were moved on to USGS 104(b) funding. Mike Lemcke reported that DNR was unable to find funding for any new projects in 2010 but would try to fund one continuing project. Jamie Robertson asked about the number and quality of the projects submitted. Jim Hurley stated that the number was relatively low but the quality was relatively high. Jim also noted that there was significant overlap between projects ranked highest for UWS and DNR funding.

4) **Monitoring and Data Management Subcommittee report** – Jeff Helmuth reported that the subcommittee had met on April 22nd and discussed the Groundwater Monitoring Strategy. The Groundwater Monitoring Workgroup, including several subcommittee members, developed the strategy several years ago and targeted updating the Observation Well Network

as the highest priority task. The network has been underfunded and consequently has shrunk in numbers of wells and many wells are lacking needed maintenance. The workgroup also developed a process for prioritizing additions and improvements to the network. The subcommittee will pursue funding for the network and will share information on potential "wells of opportunity" that may come available.

5) **Education Subcommittee report** – Dave Hart reported that the subcommittee met on April 29th. Carol McCartney will use the groundwater fact sheets on nitrate and arsenic at two events at the Capitol. Next, the subcommittee will work with WRI staff on fact sheets on: 1) Groundwater Quantity; and 2) Pathogens. GCC discussion on pathogens and manure issues focused on data gaps. Manure application tonnage and acreage are known but incidence of contamination and related health problems are not.

6) **Plans for 2009 GCC Report to the Legislature** – Jeff Helmuth noted that he had sent out requests for agency staff to update appropriate sections of the GCC's Report to the Legislature. He shared a timeline for the preparation and review of 2 drafts and the final report to be completed in August. Jeff also shared a copy of the Directions for Future Groundwater Protection section of the report and asked for input on this key section. Suggestions included:
   - Revising the statement on protecting the funding and moving it to the introduction
   - Emphasizing the need to define and delineate the resource
   - Work with Wisconsin Initiative on Climate Change Impacts (WICCI) to update and refine the priority on that topic
   - Try to further define how the research and monitoring projects have benefitted the State

   Bob Pearson added that the agencies histories of groundwater protection efforts should be captured to preserve institutional memory and provide a context for proactive resource management. Jeff Helmuth added that the GCC webpage would be the ideal place to capture those histories but that it would take considerable time to undertake such an effort. Jamie Robertson asked that Bob work with the Education Subcommittee to explore the idea further.

7) **Agency Updates**

   DATCP – Rick Graham reported:
   - The agency is struggling with budget problems.
   - DATCP, DNR and DHS are working on advisory language for private well owners with samples >10 ppm nitrate .

   DNR – Mike Lemcke reported:
   - The agency is struggling with budget problems.
   - Substantial progress has been made on the high-capacity well inventory and pumpage reporting though there are still challenges to overcome.

   WGNHS – Ken Bradbury reported:
   - WGNHS will have a booth on groundwater at Economic Development Day at the Capitol
   - Survey staff have visited the historic observation well at the Capitol. There may be an opportunity to log the well with a downhole camera.
   - The project on viruses in Madison's wells is continuing.

UWS

- Anders Andren reported that Jim Hurley received the Distinguished Service Award from the American Water Resources Association – Wisconsin Section for his exceptional contributions to enhance the quality of water resources in Wisconsin.
- Jim Hurley noted that the Wisconsin Initiative on Climate Change Impacts (WICCI) is forming a water resources working group. The group will meet this summer to determine research gaps. After the needs assessment the group will try to prioritize research areas. Jamie Robertson asked Jim to continue to keep the GCC apprised of this effort.

DHS – Henry Anderson reported:

- Response to the Novel H1N1 Influenza (swine flu) virus outbreak has consumed huge amounts of staff time.
- Budget problems are of concern
- The next round of groundwater standards are still under review.

8) Adjourn and Next Meeting – The meeting was adjourned at 12:10. The next meeting will be held at 10:00 on August 21 at the Department of Transportation at 4802 Sheboygan Ave. Madison.

Minutes prepared by Jeff Helmuth – 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	

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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
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		
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,	7/1/1999-06/30-2000	UWS	00-HDG-8

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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 01-01
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
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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
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

Project title	Investigators	Contract Period	Funding Agency	Project Number
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
Enhanced Reductive Dechlorination of Chlorinated Aliphatic Hydrocarbons: Molecular and Biochemical Analyses	William Hickey, Payne	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

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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
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
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
Geochemical characterization of sulfide mineralization in eastern Wisconsin carbonate rocks	Luczaj and McIntire	7/1/2007-6/30/2008	UWS	08-GCP-01
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
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
Hydrostratigraphy and Groundwater Flow Model: Troy Valley Glacial Aquifer, Southern Waukesha Co., WI	Mickelson and Anderson	7/1/2007-6/30/2008	DNR	199
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
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, Kraft – UW-SP	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
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	7/1/2007-6/30/2009	DNR	201
Understanding the Effects of Groundwater Pumping on Lake Levels	Kraft, Clancy and Mechenich	7/1/2007-6/30/2009	DNR	202
Assessing the Potential of Hormones from Agricultural Waste to Contaminate Groundwater	Hemming, Landreman and Hedman	7/1/2007-6/30/2009	DNR	203
Use of the 2009 Behavioral Risk Factor Surveillance Survey to Assess the Safety of Private Drinking Water Supplies	Knobeloch	7/1/2008 – 6/30/2010	UWS	09-SOS-01

Project title	Investigators	Contract Period	Funding Agency	Project Number
Combination of Co-Precipitation with Zeolite Filtration to Remove Arsenic from Contaminated Water	Li	7/1/2008 – 6/30/2010	UWS	09-REM-01
The lethal and sublethal effects of elevated groundwater nitrate concentrations on infaunal invertebrates in the Central Sand Plains	Stelzer, Eggert, and Muldoon	7/1/2008 – 6/30/2010	UWS	09-BEP-01
Assessing Levels and Potential Health Effects of Endocrine Disrupting Chemicals in Groundwater Associated with Karst Areas in Northeast Wisconsin	Bauer-Dantoin, Fermanich, Zorn	7/1/2008 – 6/30/2009	UWS	09-CTP-02
Drawdown in the Northeast Groundwater Management Area (Brown, Outagamie, and Calument Counties, Wisconsin)	Luczaj, Hart	7/1/2008 – 6/30/2009	DNR	204
Human viruses as tracers of wastewater pathways into deep municipal wells	Bradbury, Borchardt and Gotkowitz	7/1/2008-12/31/2009	DNR	205
Development and Validation of a PCR-based Quanification Method for *Rhodococcus coprophilus*	Long	7/1/2008 – 6/30/2009	DNR	206

State of Wisconsin \ GROUNDWATER COORDINATING COUNCIL

Jim Doyle, Governor

101 South Webster Street
Box 7921
Madison, Wisconsin 53707
FAX 608-267-7650
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Joint Solicitation for Groundwater Research & Monitoring Proposals

For FY 2010
(July 1, 2009 – June 30, 2010)

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 17, 2008

Contact James Hurley, Water Resources Institute (*hurley@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

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Madison, Wisconsin 53707
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TDD 608-267-6897

To: Interested Researchers
From: Todd Ambs, Groundwater Coordinating Council
Date: September 30, 2008
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 2010 (FY 10) beginning July 1, 2009.

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 $440,000 will be available for new monitoring and/or research to meet specific agency needs and objectives in FY 10.

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 17, 2008.** Investigators are required to submit proposals using *iPropose*, a web-based proposal submission system that will open for registration on Monday, October 20, 2008. 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 10 Joint Solicitation for Groundwater Research and Monitoring Proposals

September 2008

The University of Wisconsin System (UWS) and the Wisconsin Departments of Natural Resources (DNR), Agriculture, Trade, and Consumer Protection (DATCP), and Commerce annually participate in a joint solicitation for research and monitoring proposals dealing with groundwater, pesticides and/or onsite wastewater treatment systems. Up to $440,000 will be available for groundwater-related monitoring and research in fiscal year 2010 (FY 10) 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 08, the UWS has invested $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 through the National Institutes for Water Resources program (US Geological Survey). The UWS will have $250,000 to fund new projects in FY 10.

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 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. The DNR anticipates having up to $190,000 to support groundwater research and monitoring studies in FY10.

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 08, 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 10. DATCP will, however, take part in the proposal review process.

4. Department of Commerce Private Onsite Wastewater Treatment System Research – The Division of Safety & Buildings (formerly in the Department of Industry, Labor, and Human Relations) received an annual appropriation of $50,000 from 1990 to 1993 to fund research on alternatives to current private sewage-system technology. In 1994, when the appropriation expired, $75,000 generated through plan review and licensing fees became available each year for research on private sewage systems. Through FY 08, 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 10. 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 Monitoring" page on the GCC website: *http://dnr.wi.gov/org/water/dwg/gcc/index.htm*. The reasons for this solicitation to be made jointly are to:

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

James Hurley, UW Water Resources Institute: (608) 262-0905; *hurley@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*. The website will open for registration and submittal of proposals on October 20, 2008. **The deadline for submittal of proposals is 5:00 pm Monday, November 17, 2008.**

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. An administrative authorization form with signatures of individuals authorized to sign proposal submissions.

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 each start on a new page, have at least 1.5 line spacing (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 these instructions. 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 pages 13-20 for detail).

Funding decisions will be made by the end of March 2009. 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, please contact Jeff Helmuth or James Hurley.

Dissemination of Project Findings

Final reports are required for each project funded through this solicitation. 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. All project investigators must submit a two-page Project Summary upon completion of the final report. The summaries and final reports are made available on the WRI web site as they become available (www.wri.wisc.edu), thus providing the public with a real-time link to information about current groundwater research. Multiple-year projects funded through UWS are also required to submit concise annual reports through iPRO, an online interactive project management database hosted on the WRI website. Projects funded by DNR, DATCP, and Commerce are required to submit brief quarterly reports in lieu of the annual report.

Wisconsin's Water Library catalogs all WRI research reports into WorldCat and MadCat, two library indexing tools that provide worldwide access to the research. By having this information permanently indexed, the results are easily available to other scientists, policy makers, and stakeholders. The Water Resources Library has also partnered with The UW Digital Collections Center to digitize and post final reports. Full-text reports are available in the Ecology and Natural Resources Digital Collection (http://digital.library.wisc.edu/1711.dl/EcoNatRes.Groundwater).

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 17, 2008.** The submission system will open on October 20, 2008 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 proposal assembly process, and we recommend that investigators concentrate on step one and step two prior to submitting online:

STEP 1: Prepare full proposal. Please use the Microsoft Word or Corel WordPerfect templates that can be downloaded from 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 pages**; minimum of 11 point font and 1.5 line spacing)
    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 pages**; minimum of 11 point font and 1.5 line spacing)
    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 related problems and agency priorities.

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 from 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 General Program Revenue (GPR) funds. *Campus indirect costs do not apply.* In the event a proposal from a UW System campus 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 the campus' indirect costs, depending on the source of the funding the agency uses to fund the proposal.

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 20, 2008. 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 17th), 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 17, 2008.**

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 17, 2008. Your proposal will not be considered for funding without an appropriate authorization form on file. A fill-able PDF form (WRI Proposal Transmittal/Authorization form) can be downloaded from the UW Water Resources Institute website (*http://wri.wisc.edu*). A substitute form can be used in place of the WRI form as long as it has the required administrative approvals for proposal submission.

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 17, 2008.

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, economics, 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 will have up to $250,000 to fund new projects in FY 10. Because the cost of fringe benefits will affect the amount of money available, the exact level of funding depends on the budgeted categories used in the selected proposals. The remaining funds for UWS groundwater research have been previously committed to ongoing projects.

Applicant Requirements: Most often the PI will be a faculty member on any campus in the UWS. However, academic staff members who have achieved nomination to PI status by endorsement of their 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.

Reporting: All applicants will be notified about the results of the review process by the end of March 2009. Principal Investigators on awarded projects shall submit a progress report at the end of each project year using the Water Resources Institute's WEB-based reporting application, iPRO. Annual progress reports are due each year in July. A final report and a two-page project summary shall be submitted through the iPRO system within 90 days after the project end date.

UWS GROUNDWATER RESEARCH PRIORITIES FOR FY10

The UWS Groundwater Research Priorities for Wisconsin were developed by the UW Groundwater Research Advisory Council. The council members have statewide expertise on groundwater research and policy. UWS funding for groundwater research is administered through the UW Water Resources Institute, which is an active member of the National Institutes for Water Resources (NIWR). The National Institutes were established to implement the provisions of the Water Resources Research Act of 1984 (Public Law 98-242) through the collective activities of the 54 member agencies. The 2008 strategic plan for NIWR contains three objectives designed to "provide relevant and timely information that can assist the Nation's water resource managers in their development and implementation of programs aimed at providing a sustainable water supply." These national objectives align well with the UWS Groundwater Research Priorities and were used as a framework to organize the list below. This synergy between local and national goals highlights Wisconsin's leadership in groundwater research and protection. Note: Due to the emerging interest in fossil fuel alternatives, we encourage proposals that focus on the *effects of alternative fuel production and utilization on groundwater resources.*

Objective 1: Maintain or enhance *groundwater quantity*.

- Implications of the Great Lakes Basin Compact for groundwater use, high capacity wells, and the resulting economic impact on Wisconsin and the region.
- Assessments of water availability and the impacts of human water use on groundwater levels, groundwater storage, surface water features, and ecological features.
- Effects of climate variability on groundwater levels, flow patterns, and quantity.
- Impact of land-use practices on groundwater quantity including the effects of agricultural, industrial, municipal, residential, or waste management activities that recharge groundwater.

Objective 2: Maintain or enhance *groundwater quality*

- 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.
- Effects of climate variability on groundwater quality.
- Impact of land-use practices on groundwater quality including the effects of agricultural, industrial, municipal, residential, or waste management activities that contaminate groundwater.
- 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 surface-water quality; and wetland impacts on groundwater.
- Impacts of alternative fuel production and use (including blends) on groundwater quality.

Objective 3: Maintain or enhance *groundwater management*

- Investigations into the best methods for optimizing groundwater use for human and environmental needs in Wisconsin, including strategies for long-term management.
- Development & evaluation of tools or protocols for regulatory approval of high-capacity wells.
- Development and use of new technologies for groundwater characterization or management.
- Investigations that examine the controls on pollutant transport in groundwater, including the development or validation of predictive models.
- Economic impact of groundwater use.
- Impacts of contaminated groundwater on Wisconsin families, including human health effects on reproduction, development, and chronic disease; or on economic losses attributable to groundwater contamination.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
FY 10 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 at *http://dnr.wi.gov/org/water/dwg/gw/research.htm*). 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 may be 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 may be available through the Wellhead Protection provisions of the Safe Drinking Water Act.

The DNR anticipates having approximately $190,000 to fund new monitoring and research projects in FY 10 (July 1, 2009, through June 30, 2010). 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.

Contractual Requirements: Projects must meet all departmental requirements and guidelines related to groundwater monitoring wells (installation, documentation and abandonment/filling and sealing), 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 10. 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 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
   - Methods for evaluating sites 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.)
   - Tools/Mapping to help landowners in areas that are susceptible to groundwater contamination determine best management practices
   - 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/2003/data/acts/03Act310.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. DNR is committed to updating the existing springs information. In addition to the basic information collected by DNR, 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. The Groundwater Advisory Committee recommended a scientific approach to expanding groundwater protection areas in its 2007 report (*http://dnr.wi.gov/org/water/dwg/gac/GACFinalReport1207.pdf*, section 2.2.3 p. 15). There is a need to further evaluate the proposed methodology and its specific numerical criteria. Additionally, 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 DNR 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 predicting, evaluating, and mitigating cumulative impacts of pumping on water resources in these areas.
- *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; impacts of economic factors such as higher grain prices and demand for ethanol, and quantification of environmental, social and economic impacts of groundwater withdrawals.

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

- Identification of groundwater recharge areas
- Identification of water-dependent environmentally sensitive resources (e.g. calcareous fens)
- Reduced water demand through conservation, reuse and irrigation efficiencies
- 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. Modernization of the State Observation Well Network is a key component of the Strategy. 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. **Wellhead Protection Implementation.** The DNR has delineated source water areas, mapped potential sources of contamination, and assessed the susceptibility to contamination for all public water wells in Wisconsin. 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* – More information on the occurrence, transport and fate of viruses, pharmaceuticals, personal care products and other emerging contaminants is needed to help understand 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).

5. **Evaluation of impacts to groundwater by wastewater treatment methods**. The effectiveness of wastewater seepage cells in preventing nitrogen and other contaminants from entering groundwater is poorly understood. There is a need to study these impacts to develop innovate techniques to enhance their effectiveness.

6. **Protecting groundwater from impacts by stormwater infiltration**. There is a need to study impacts of stormwater infiltration practices within recharge areas and develop innovative techniques to enhance their effectiveness.

7 **Evaluation of potential virus contamination of groundwater from landspreading of waste.**

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 prions, 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), low pH, radium, molybdenum, and VOCs from construction and demolition landfills 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).

New Water Treatment Devices – Technology to treat contaminated water for drinking water purposes is constantly evolving. New technologies need to be evaluated for their effectiveness.

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 10

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 10. 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 10

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 10. 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 10

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.