

WISCONSIN GROUNDWATER COORDINATING COUNCIL

REPORT TO THE LEGISLATURE



August 1999

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August, 1999

To: The Citizens of Wisconsin
The Honorable Governor Tommy G. Thompson
Senate Agriculture and Environmental Resources Committee
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Assembly Natural Resources Committee
Secretary Charles H. Thompson - Department of Transportation
Secretary William McCoshen - Department of Commerce
Secretary Ben Brancel - Department of Agriculture, Trade and Consumer Protection
Secretary Joe Lekan - Department of Health and Family Services
Secretary George E. Meyer - Department of Natural Resources
President Katharine Lyall - University of Wisconsin System
State Geologist James Robertson - Geological and Natural History Survey

This is the 1999 Groundwater Coordinating Council (GCC) Report to the Legislature. The GCC was formed in 1984 to help state agencies coordinate non-regulatory activities and exchange information on groundwater. The GCC has served as a model for interagency coordination and cooperation among state government officials, the Governor, local government and federal government. It has achieved the distinction of being one of the few groups in the nation to effectively coordinate groundwater activities in its state from an advisory position.

Examples of GCC-coordinated groundwater accomplishments by your state agencies during the past year include:

- The GCC worked with the Wisconsin Water Well Association to put on an Educational Event at the Capitol Rotunda during the State's Groundwater Protection and Awareness Week, Feb 2-4, 1999. A brochure titled "Meet the Groundwater Coordinating Council" (attached) was available as were many other educational materials. Fifteen researchers prepared poster displays on projects recently funded through the GCC-coordinated joint solicitation process, and these researchers were present in the Rotunda to explain their posters and answer questions. There were also state and federal agency displays, a water testing booth and a groundwater presentation by high school students. Approximately 30 Legislators and numerous members of the public attended.
- The GCC continued to address important data management issues. Six electronic forms (well construction report, well/drillhole/borehole abandonment, monitoring well development, soil boring log information, monitoring well information, and groundwater monitoring inventory form) were released to facilitate electronic data submittal. Wisconsin Unique Well Number labels were made available for monitoring wells in addition to water supply wells. Projects to make scanned images of well construction reports available and to eliminate duplicate Wisconsin Unique Well Numbers (WUWN) were initiated.

We hope you, your staff, and the public will find this report a useful reference in protecting Wisconsin's valuable groundwater resource.

Sincerely,

Susan L. Sylvester, Chair
Groundwater Coordinating Council

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LIST OF ABBREVIATIONS AND ACRONYMS

ACCP	Agricultural Chemical Cleanup Program
BMP	Best Management Practices
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CDC	Center for Disease Control
CWGC	Central Wisconsin Groundwater Center
DATCP	Department of Agriculture, Trade and Consumer Protection
DHFS	Department of Health and Family Services
DNR	Department of Natural Resources
DOT	Department of Transportation
DPI	Department of Public Instruction
EIS	Environmental Impact Statement
EPA	U. S. Environmental Protection Agency
ERS	Division of Environmental and Regulatory Services
ES	Enforcement Standard
FSA	(USDA) Farm Service Agency
FY	Fiscal Year
GCC	Groundwater Coordinating Council
GEMS	Groundwater and Environmental Monitoring System
GIS	Geographic Information System
GS	Groundwater Section
GRAC	Groundwater Research Advisory Council
GRN	Groundwater Retrieval Network
LUST	Leaking Underground Storage Tank
LWRV	Lower Wisconsin River Valley
mg/L	milligrams per liter
MOU	Memorandum of Understanding
NPM	Nutrient and Pest Management
NRCS	(USDA) Natural Resource Conservation Service
PAL	Preventive Action Limit
PECFA	Petroleum Environmental Clean-up Fund Act
ppb	parts per billion
ppm	parts per million
SLOH	State Laboratory of Hygiene
SMP	State Management Plan
SWAP	Source Water Assessment Program
µg/L	micrograms per liter
USDA	U.S. Department of Agriculture
UW	University of Wisconsin
UWS	University of Wisconsin System
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WGNHS	Wisconsin Geological and Natural History Survey
WHP	Wellhead Protection
WPDES	Wisconsin Pollution Discharge Elimination System
WRI	Water Resources Institute
WUWN	Wisconsin Unique Well Number

EXECUTIVE SUMMARY

This is the Report to the Legislature by the Groundwater Coordinating Council (GCC) as required by s. 15.347, Wisconsin Statutes. The report describes the condition and management of the groundwater resource and summarizes the Coordinating Council's activities for fiscal year (FY) 1999.

In 1984, the Legislature enacted 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 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."

Membership of the GCC includes the Secretaries of the Departments of Natural Resources (DNR); Commerce; Agriculture, Trade and Consumer Protection (DATCP); Health and Family Services (DHFS); Transportation (DOT); the President of the University of Wisconsin System (UWS); the State Geologist; and a representative of the Governor. Members are listed on the inside of the front cover.

Since its last report, agency staff, coordinated by the Groundwater Coordinating Council have accomplished the following:

1. The GCC and the UWS Groundwater Research Advisory Council continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies. Twenty-four projects were funded in FY 99 by one or more of the following agencies: UWS, DATCP, and DNR. The projects funded are listed in Table 1. The locations of the field sites for the projects are shown in Figure 1. A joint solicitation for groundwater-related monitoring and research project proposals for funding in FY 00 was distributed in October 1998. A copy of the joint solicitation is contained in the Appendix. A total of 24 project proposals were received. Fourteen new projects were selected by the UWS, DNR, and/or DATCP for funding in FY 99 in addition to 11 projects which will carry over into the new fiscal year. The FY 00 groundwater monitoring and research projects and their funding agency are listed in Table 2. The GCC endorsed the UWS groundwater research plan for FY 00 as required by s. 160.50(1m), Wis. Stats.
2. The GCC worked with the Wisconsin Water Well Association to coordinate an Educational Event at the Capitol Rotunda during the State's Groundwater Protection and Awareness Week, Feb 2-4, 1999. This event was very successful. A brochure titled "Meet the Groundwater Coordinating Council" was available, as were many other educational materials. The Research Subcommittee assisted in organizing poster exhibits for a display. Fifteen researchers prepared poster displays on projects recently funded through the joint solicitation process, and these researchers were present in the Rotunda to explain their posters and answer questions. The Education Subcommittee organized state and federal agency displays, a water testing booth and a groundwater presentation by high school students. Approximately 30 Legislators and numerous members of the public attended.
3. Through several of its subcommittees, the GCC continued to address important data management issues. Six electronic forms (well construction report, well/drillhole/borehole abandonment, monitoring well development, soil boring log information, monitoring well information, and groundwater monitoring inventory form) were released to facilitate electronic data submittal. Wisconsin Unique Well Number labels were made available for monitoring wells in addition to water supply wells. A project to make scanned images of well construction reports available was initiated, as was a project to eliminate duplicate Wisconsin Unique Well Numbers.
4. The GCC has continued to work with representatives of federal agencies to promote communication and coordination of federal and state groundwater activities. Representatives from the Natural Resource

Conservation Service (NRCS), the U. S. Geological Survey (USGS), and Farm Service Agency (FSA) attend GCC meetings and serve as *ex officio* subcommittee members. The groundwater activities of the USGS and NRCS are summarized in the Appendix.

INTRODUCTION

PURPOSE

The Groundwater Coordinating Council 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 FY 98.

The section, "Summary of Agency Activities" describes groundwater management programs and implementation of ch. 160, Wis. Stats., by the individual state agencies. "Groundwater Monitoring and Research" provides information on monitoring and research activities to address groundwater issues in Wisconsin and describes the condition of the groundwater resource. The activities of the Groundwater Coordinating Council and its subcommittees are described under "Coordination Activities" and in the minutes which are contained in the Appendix. The recommendations of the Council are contained in "Directions for Future Groundwater Protection." In addition, this year we have included an article "Walking on Water" in the Appendix that captures Wisconsin's Sesquicentennial spirit by providing an historical perspective on groundwater management. This article appeared in the June/July issue of the DNR's Natural Resources Magazine

SUMMARY OF WISCONSIN'S GROUNDWATER LEGISLATION

Wisconsin has a long history of groundwater protection. The culmination of 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. The Groundwater Protection Act created chapter 160, Wisconsin Statutes, which serves as the backbone of Wisconsin's program. Chapter 160, Wis. Stats., 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 protection program:

- 1) Standards. Under chapter 160, Wis. Stats., the Department of Natural Resources (DNR) must establish state groundwater quality standards based on recommendations from the Department of Health and Family Services (DHFS). Standard setting is a continuing process based on a priority list of substances detected in groundwater or having a high possibility of being detected, established by the DNR in conjunction with other state agencies. The state groundwater standards are contained in chapter NR 140, Wisconsin Administrative Code. For each substance there is an enforcement standard (ES) which determines when a violation has occurred and a preventive action limit (PAL) which is set at a percentage of the ES. The PAL serves as a trigger for possible remedial action.
- 2) Regulatory Programs. Once groundwater quality standards are established, all state agencies must manage their regulatory programs to comply. Each state regulatory agency must promulgate rules to assure that the groundwater standards are met and to require appropriate responses when the standards are not met. The state regulatory agencies are the DNR (solid and hazardous waste, industrial and municipal wastewater, spills, wetlands and water supply); the Department of Commerce (private sewage systems, petroleum product storage tanks); the Department of Agriculture, Trade and Consumer Protection (DATCP) (pesticide use and storage and fertilizer storage); and the Department of Transportation (DOT) (salt storage). The implementation of the groundwater standards by the state agencies is described under "Summary of Agency Activities".
- 3) Aquifer Classification. One of the most important features of Wisconsin's groundwater law is an item that was

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

- 4) Monitoring and Data Management. At the time the groundwater legislation was created, there was concern that Wisconsin needed a groundwater monitoring program to determine whether the groundwater standards were being met. Therefore, a groundwater monitoring program was created under s. 160.27, Wis. Stats. Money from the Groundwater Account of the Environmental Fund has been used for problem-assessment monitoring, regulatory monitoring, at-risk monitoring, and management-practice monitoring, as well as establishment of a data management system for collection and management of the groundwater data. See the "Groundwater Monitoring and Research" discussion in this report for further information.
- 5) Research. Although all state agencies must comply with the groundwater standards, the processes by which groundwater becomes contaminated, the technology for clean-up, the mechanisms to prevent contamination, and the environmental and health effects of the contamination are often not well understood. In addition, the basic data on geology, soils, and groundwater hydrology is often not available. The UWS and the state agencies have recognized that additional efforts in these research areas are badly needed. The Governor and the Legislature included a new groundwater research appropriation for the UWS beginning with the 1989-1991 biennial budget. During the past year, the UWS, DATCP, and DNR participated in a joint solicitation for groundwater-related research and monitoring proposals for funding during fiscal year 1999. See the "Groundwater Monitoring and Research" section for more details.
- 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 Groundwater Coordinating Council was created to advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater. The Coordinating Council has been meeting since 1984. See the "Coordination Activities" discussion in this report.
- 7) Local Groundwater Management. The Groundwater Protection Act clarified the powers and responsibilities of local governments to protect groundwater in partnership and consistent with state law.
 - a. Zoning authority for cities, villages, towns and counties was expanded to "encourage the protection of groundwater."
 - b. Counties can adopt ordinances regulating disposal of septage on land (consistent with DNR requirements); cities, villages, or towns may do so, if the county does not.
 - c. Counties can regulate (under DNR supervision) well construction and pump installation for certain private wells.
 - d. Property assessors must consider the time and expense of repairing or replacing a contaminated well or water supply when assessing the market value of real property; they must consider the "environmental impairment" of the property value due to the presence of a solid or hazardous waste disposal facility.

The following report is intended to update the Legislature and Governor on the status of the state's groundwater program and the activities of the Groundwater Coordinating Council.

SUMMARY OF AGENCY ACTIVITIES

The groundwater management efforts undertaken by the member agencies of the Groundwater Coordinating Council during the past year show that Wisconsin continues to have a strong commitment to protection of its groundwater resource.

DEPARTMENT OF NATURAL RESOURCES

The DNR has statutory authority as the central unit of state government to protect, maintain and improve groundwater within the state (s. 144.025(1), Wis. Stats.). The DNR establishes the groundwater quality standards for the state under authority of s. 144.025(2)(b) and ch. 160, Wis. Stats. The DNR also has specific groundwater-related regulatory programs.

DNR regulatory programs to protect groundwater are the responsibility of four Bureaus:

1. Bureau of Drinking Water and Groundwater – Regulates public water systems and private drinking water supply wells. The Groundwater Section (GS) assists in coordinating groundwater activities of the DNR, as well as other state agencies.
2. Bureau of Waste Management - Regulates and monitors groundwater at proposed, active, and inactive solid waste facilities and landfills.
3. Bureau of Remediation and Redevelopment - Oversees clean-up actions at spills, abandoned containers, state funded responses, closed wastewater and solid waste facilities, hazardous waste corrective action and generator closures, and sediment clean-up actions.
4. Bureau of Watershed Management - Regulates Wisconsin Pollutant Discharge Elimination System (WPDES) permittees at wastewater land disposal sites. The Bureau of Watershed Management cooperates with the Bureau of Remediation and Redevelopment at leaking underground storage tank (LUST), Environmental Response and Repair, and Superfund Cleanup sites, by issuing WPDES permits for the discharge of contaminated groundwater.

The GS is responsible for adoption of groundwater standards contained in ch. NR 140, Wis. Adm. Code, development of an annual groundwater monitoring plan, coordination of the joint solicitation for groundwater-related monitoring and research proposals, review and management of groundwater monitoring projects, coordination of groundwater components of basin plans and of nonpoint source priority watershed projects, coordination of wellhead protection and source water assessment activities, and maintenance of a data management system for groundwater data.

Chapter 160, Stats., requires the DNR to develop numerical groundwater quality standards, consisting of enforcement standards and preventive action limits. Chapter NR 140, Wis. Adm. Code, establishes groundwater standards and creates a framework for implementation of the standards by the DNR. On January 1, 1999, groundwater standards for 20 new substances went into effect in ch. NR 140, Wis. Adm. Code.

On June 30, 1999, the DNR's Natural Resources Board authorized the DNR to hold public hearings on the proposed revisions to ch. NR 140. The proposed amendments to ch. NR 140 would revise groundwater standards for toluene and xylene to conform with federal drinking water standards and to account for taste and odor concerns associated with these substances. Changes are also proposed to clarify the exemption criteria for health and welfare standard exceedances. Four public hearings will be held throughout the state in August 1999 on the proposed amendments to ch. NR 140.

GS staff serve on the Standards and Streamlining Team which identifies policy issues, develops guidance, and provides training regarding the implementation of chs. NR 720, 722, 724 and 726 dealing with soil cleanup standards, selecting and implementing remedial actions and case closures. The team is also responsible for developing additional NR 720 soil standards, supporting groundwater standards development and streamlining the cleanup process.

GS staff also serve on the Statewide Consistency Team which evaluates and makes recommendations promoting consistency for statewide issues affecting the DNR's Bureau for Remediation and Redevelopment. These issues include, in part, site investigations, soil and groundwater remediations, and general case closure decisions. This team's function is critical in obtaining statewide consistency in how the Bureau of Remediation and Redevelopment evaluates, addresses and closes soil and groundwater contamination sites.

GS staff serve on the PECFA (Petroleum Environmental Cleanup Fund Act) Issues Team which is working in concert with the Department of Commerce to develop joint agency rules to cleanup petroleum contaminated sites in Wisconsin. The focus is on cleaning up sites in a cost effective manner while protecting public health and the environment. Both agencies have adopted emergency rules and are in the process of making the emergency rules permanent.

GW staff serve on the PCB (Polychlorinated Biphenols) Advisory Committee which has the charge of advising the Department in establishing rule language for PCB soil criteria protective of human and ecological health, in order to regulate land application of dredged sediments, sludges and other materials that have been contaminated with PCBs.

In September 1996, GS staff published revisions to the DNR's Groundwater Sampling Desk Reference and Field Manual. Both the Desk Reference and the Field Manual were revised for the first time since 1987 due to numerous advances in groundwater sampling and monitoring technology in recent years. The new documents go into much greater detail on how to consistently collect high quality, representative groundwater samples and measurements. During FY 98 both the Desk Reference and Field Manual were widely distributed and well received. The two documents are available on the Bureau of Drinking Water and Groundwater's web page (<http://www.dnr.state.wi.us/org/water/dwg/gw/sample.htm>).

Work was completed on the development of a DNR well forms entry program to allow electronic submittal of six DNR well-related forms. The program electronically captures, prints, exports, and imports all well-related information. The six forms are: Monitoring Well Construction Form 4400-113A, Monitoring Well Development Form 4400-113B, Well/Drillhole/Borehole Abandonment Form 3300-5B, Soil Boring Log Information Form 4400-122 and 122A, Groundwater Monitoring Well Information Form 4400-89, and Groundwater Monitoring Inventory Form 3300-67. The entry program is used in conjunction with the introduction of special Wisconsin Unique Well Number (WUWN) tags specifically designed for monitoring wells.

GS staff have worked with basin planners to develop more specific groundwater reports for basin plans. This includes better baseline water quality information and inventorying of potential threats to the resource.

GS staff continued inspection of two monitoring well drilling operations in FY 99. These inspections are designed to educate drillers and environmental consultants about NR 141 and to enhance compliance with the code. Efforts continue to educate operators and consultants on the proper techniques for geoprobe operation.

The application and effectiveness of new technologies for remediation have been reviewed by GS staff. Horizontal drilling, mini-wells and different sampling protocols are among the major items reviewed.

The Bureau of Drinking Water and Groundwater continues to operate a web site (<http://www.dnr.state.wi.us/org/water/dw/index.htm>). The site provides information on Public Water Supplies in Wisconsin, frequently asked questions, wellhead protection, community water systems, well abandonment,

drinking water systems, homeowner information, groundwater information, staff listings, and well driller and pump installer information. Access to several new systems has recently been made available through a web interface. Information from the Public Drinking Water System, Well Construction System, and the High Capacity Well Data System are all available online. The groundwater information section of the site has been greatly expanded to include extensive sections on wellhead protection and source water protection. All new publications developed in the Groundwater Section are posted online either for downloading or viewing or both.

A world wide web site for the Groundwater Coordinating Council (GCC) continues to operate ([Http://www.dnr.state.wi.us/org/water/gcc/index.htm](http://www.dnr.state.wi.us/org/water/gcc/index.htm)). The site provides information on the activities of the council, a list of members on the council and members of the subcommittees, documents in web viewable and downloadable format, and links to other relevant groundwater or related web sites.

DNR continues its groundwater monitoring program, composed of problem assessment monitoring, at-risk monitoring, management practice monitoring, regulatory monitoring, and monitoring planning. During FY 1999, \$289,126 was awarded to 8 projects selected during the joint solicitation process described under "Groundwater Monitoring and Research" in this report. During FY 2000, \$301,542 was awarded to eleven projects for management practice monitoring. Six projects are new studies selected during this year's joint solicitation process.

Under direction of the GCC, the UW Water Resources Institute (WRI) and GS staff continued to distribute the findings of groundwater monitoring and research funded through the joint solicitation process. In FY 96 DNR and WRC staff and principal investigators wrote summaries of 72 final reports. These summaries were published together in the AWisconsin Groundwater Research and Monitoring Project Summaries≅ (WDNR PUBL-WR-423-95) in September 1995. In FY 97 these summaries were made available on the WRI world wide web site (www.library.wisc.edu/libraries/Water_Resources/wgrmp/wgrmp.htm). Paper copies of all final reports and summaries continue to be distributed by the WRI and DNR.

The DNR is the lead state agency for developing and implementing the Wisconsin Wellhead Protection (WHP) Plan. The specific goal of Wisconsin's plan is to achieve localized groundwater pollution prevention in public water supply wellhead areas consistent with the state's overall goal for groundwater protection. To achieve this goal the DNR, working with other state and federal agencies, and extensive citizen input, developed a two-part state WHP Program. A WHP plan must be developed for any new municipal water supply well constructed since May 1, 1992. The plan must be approved by the DNR Public Water Systems Section. 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 existing wells.

The DNR continues a statewide public information effort aimed at encouraging water utilities to protect their water supplies from potential sources of contamination through wellhead protection planning. Wellhead protection activities are coordinated through a Wellhead Protection Standing Team created in January of 1998. The team met five times during fiscal year 1999 to discuss priorities for wellhead protection activities. Among the activities undertaken this past year are:

1. Upgrading the DNR's WHP website to include basic information on WHP, an annotated bibliography, a list of contacts for more information, a list of available publications, example WHP ordinances, and past and present issues of the Wisconsin Wellhead Protection News. Several of the DNR WHP publications have been added to the website in a viewable and downloadable format.
2. Initiating work on a video promoting WHP. Work began on a public service announcement to provide information to the public on groundwater and wellhead protection. Based on the results of focus group meetings, this effort is now focused on a short promotional video for water utilities and local officials as well as a longer WHP training video.
3. Working with local communities on WHP planning. In January, the DNR sent letters to about 230 communities who had previously expressed some interest in WHP. These communities were asked to

respond to a questionnaire to let the DNR know how best to help them. Fifty communities responded with a request for information or assistance. The DNR has provided packets of WHP materials to the 50 communities and is currently prioritizing our efforts to assist these communities. The DNR will work with the Wisconsin Rural Water Association in helping communities protect their water supplies.

4. Updating WHP publications. The DNR has updated and published a revision to the 1993 publication, "A Guide to Conducting Potential Contaminant Source Inventories for Wellhead Protection." A revision to two other publications will be completed later this summer.
5. Promoting advanced WHP Area delineations. In order to provide the most accurate information available to assist in WHP planning, the DNR has funded or is funding groundwater modeling efforts in Dane County, the Lower Fox River Valley and 7 counties in southeast Wisconsin. The DNR is also investigating the possibility of additional modeling activities in Sauk, Eau Claire and LaCrosse counties, and the Central Sands. It is anticipated that one of the products of the modeling will be advanced WHP delineations for each of the municipalities in these areas.
6. Coordinating efforts with the Source Water Assessment Program (SWAP). Two issues of the Wisconsin Wellhead Protection News newsletter in 1998 contained questionnaires soliciting input on Wisconsin's proposed SWAP. The WHP Team reviewed the draft SWAP plan and continues to work closely with the Source Water Protection Team to provide consistency and continuity between the two programs.
7. Quantifying the cost of groundwater contamination. Letters were sent to some 60 water utilities to gather information on the costs of dealing with well contamination from volatile organic compounds. Preliminary results from about half the communities indicates a cost of over \$16 million.

The DNR submitted a Source Water Assessment Program to USEPA to meet the requirements of the 1996 Safe Drinking Water Act Amendments. In FY 99 GS staff solicited stakeholder input on the SWAP through advisory committees, making public presentations and sending out questionnaires on the SWAP. The program will: 1) delineate source water protection areas for all public water systems in the state; 2) conduct inventories of significant potential sources of contamination (SPSCs) within those areas; 3) perform an analysis of susceptibility for each system; and 4) make the results of the assessments available to the public. USEPA must approve or disapprove the plan by November 6, 1999. In coordination with the public water system vulnerability assessment program, GS staff have produced calculated fixed radius delineations for all community in the state. Maps of those delineations were sent out to each system with a request for system operators to identify SPSCs within the delineated area.

During FY 99, the Water Division worked with the Lands Division and the Regions to develop an integrated planning process for work planning and project implementation at the GMU level. These discussions focused on developing a process that would result in identification of ecosystem-based priorities and projects to restore or maintain ecosystem health for each GMU. For integrated planning, each GMU will develop a "State of the GMU" report during the 2000-2001 biennium, which will replace the development of Water Quality Management (WQM) plans required under Section 208 of the Clean Water Act and NR 121, Wis. Adm. Code.

State of the GMU reports will provide baseline information on surface water, groundwater and land resources; however, their main focus will be on priority issues that are identified by the DNR and stakeholder groups. The plans will also identify geographic priorities for the nonpoint source program for future targeted competitive funding.

The GS has been involved in the development of this integrated planning process and will provide a direct role in the development of these plans; the GS is uniquely suited to highlight areas in need of management based on groundwater issues. The GS section will also provide data to GMUs for the nonpoint source priority identification process.

The Bureau for Remediation and Redevelopment (RR) program implemented several actions that have influenced responses to contaminated groundwater.

- The program used the Environmental Fund to initiate or continue environmental cleanup actions at approximately 45 locations where groundwater contamination is known or suspected. The Environmental Fund is used when contamination is significant but private parties do not undertake the cleanup because: no one has legal responsibility for the contamination, the person(s) legally responsible do not have the financial ability to proceed, or the responsible person simply refuses to proceed. Private contractors conduct these cleanups with oversight by department staff. The program spends an average of \$5 million per year from the fund to address contamination at new and continuing project sites. Whenever feasible, the RR program and legal staff attempt to recover costs from responsible persons after the cleanups are undertaken.
- The RR program continues to provide redevelopment assistance at brownfield sites with groundwater contamination. “Off site” letters are provided to owners of property who demonstrate that the contamination under their properties did not originate on the property. These letters facilitate development of the property while the Department provides oversight of the cleanup being conducted by the person responsible for the contamination. In addition, lease letters are provided to lessees who rent properties overlying contaminated groundwater. These letters clarify the activities that lessees may undertake in order to remain free of liability for the contamination.
- The RR program also continues to provide “Certificates of Completion” at brownfield properties. The certificate provides a level of security above a standard case closure letter that contamination has been properly addressed. After a person has conducted an environmental investigation of the property, and cleaned up soil and groundwater contamination to standards, the certificate provides a release from future liability for any contamination that occurred on the property prior to issuance of the certificate (for example, if cleanup standards change). Fees for the department’s review time are assessed on an hourly basis.
- The department worked through 1998 and into 1999 on development of rules and statutory amendments to administer a new reimbursement program. The program reimburses 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 cleanup at dry cleaner sites will be conducted following the NR 700 rule series.
- The Departments of Commerce and Natural Resources jointly developed an emergency cost containment rule for the PECFA program. PECFA reimburses eligible petroleum storage tank site owners for clean up costs. The Comm 46 rule established risk criteria to determine whether owners using an “active” remedy will be reimbursed, or natural attenuation is an acceptable approach to groundwater contamination. The rule established numeric levels below which natural attenuation is presumed to be occurring at low permeability sites. These sites may be closed with groundwater contamination above standards without a site-specific demonstration of natural attenuation. A groundwater use restriction must be recorded with the deed for the property. The restriction requires special DNR review before a water supply well can be constructed on the property.
- Even prior to Comm 46, the RR program had begun closing sites with groundwater contamination above enforcement standards under specified conditions. At the beginning of 1999, 30% of the petroleum contaminated sites in the PECFA program obtained this type of closure. Administrative rules allowing this were first promulgated at the end of 1996, allowing closure after the responsible person demonstrates, on a site-specific basis, that groundwater contamination is naturally attenuating and will reach standards within a reasonable period of time, regardless of the permeability of the formation. A groundwater use restriction must be recorded with the deed for the property.

The Bureau of Watershed Management continued to issue WPDES permits to all communities and industrial facilities which discharge treated domestic or industrial wastewater to a land treatment system. Wastewater land

treatment systems are primarily spray irrigation systems, seepage cells and ridge & furrow treatment systems. WPDES permits, issued to facilities discharging through a land treatment system, contain groundwater monitoring and data submittal requirements which are used to evaluate facility compliance with state groundwater quality standards established in ch. NR 140 Wis. Adm. Code. WPDES permits issued to new municipal discharges to groundwater via seepage cells reflect the more stringent effluent limits for total nitrogen and chloride contained in ch. NR 206, Wis. Adm. Code. A concerted effort is being made to evaluate and require upgrading of groundwater monitoring systems at existing facilities.

The Bureau of Watershed Management continues to work with unsewered communities, served by individual on-site treatment systems, in their efforts to construct centralized wastewater treatment facilities. Bureau staff are reviewing and commenting on new proposed Commerce design regulations for on-site systems. The Bureau is also working with Commerce to resolve jurisdictional concerns associated with the new proposed regulations.

The Bureau of Watershed Management revised NR 204 regulations that govern the treatment, use, and disposal of municipal wastewater treatment plant sludge, and NR 113 pertaining to septage management, to incorporate new federal standards. The revised NR 204 became effective January 1, 1996, and NR 113 became effective January 1, 1997. Both regulations contain land application site requirements and restrictions that are designed to prevent runoff to surface water or leaching of nutrients and pollutants to groundwater. The Bureau has completed work and implemented use of a new statewide computer system which records and monitors treatment and use of municipal sludge, septage, and industrial land application activities, including an inventory and history of all sites used for land application.

A three-year investigation into elevated iron and manganese concentrations in groundwater at industrial wastewater land application sites has been completed. The Mid-West Food Producer's Association (a trade organization representing the vegetable producing industry) conducted this study in conjunction with the University of Wisconsin - Madison. Results of this investigation are scheduled to be submitted by the end of the year.

The DNR's Runoff Management Program addressed five major issues in FY 99:

Priority Watershed Projects - The *Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed* was presented to the Land and Water Conservation Board for approval. This leaves only two priority watershed plans that will need approval: Big Wood Lake and Horse Creek, both Priority Lake Projects. The program is also in the process of re-distributing \$1.8 million in rural Anticipated Cost Share Reimbursement Amounts (ACRA) funds. Two million dollars was available for allocation towards new priority watershed projects in the 1997-99 budget. One-year grants were awarded to 18 urban and rural projects for construction of practices to control nonpoint sources of pollution.

Animal Waste - NR 243 permitting is ongoing for 80 operations (50% dairy; 33% poultry; 17% swine & beef). Of the 80 operations, there are 60 existing permittees and 20 operations are seeking permits for the first time. It is anticipated that the new federal regulations will affect about 3,000 operations in Wisconsin. Round 1 permits (>1,000 animal units) would be issued by the end of calendar year 2002; Round 2 permits (300-1,000 animal units) would be issued by calendar year 2005. Considerable growth in numbers of operations over next 5 years is anticipated.

Storm Water - DNR has designated 22 entities around Milwaukee, 17 municipalities around Madison, and 7 municipalities around Racine for NR 216 Permitting. In addition, DNR has developed a Cooperative Compliance Program for salvage yard storm water permits that will cover 200 salvage yards under a first permit, and an anticipated 300-500 under a second permit. DNR and DOT signed a MOU for storm water management on highway and bridge projects. This is an addendum to the Cooperative Agreement. The storm water Phase II final rule deadline has been set for October 29, 1999.

Nonpoint Program redesign - An Outreach Advisory Committee (OAC) composed of six work groups largely comprised of agency staff have been meeting regularly since August 1998. The work groups have been

addressing the following elements of the redesign: compliance, nutrient management, technical standards, financial assistance, agricultural performance standards, and non-agricultural performance standards. The OAC expects that drafts of administrative rule revisions will be developed during the summer and that the administrative rule revision process could begin soon thereafter.

Working with other agencies - The nonpoint program continues to support UWEX Basin Educators. These educators are completing Construction Erosion Control Workshops for builders, contractors and building inspectors. Work continues on a series of agricultural brochures to be used by all partnership agencies. The nonpoint program continues to work with NRCS on phosphorus management, barnyard runoff design criteria, Y2K compliance, data management and developing new modeling technologies to meet multiple needs.

Nutrient management plans – Approximately 60,000 of the state's 9,000,000 acres of cropland are now covered by these plans. DATCP has formed a work group to develop concepts to be used as the basis upon which to develop administrative rules as directed under s 92.05 Wis. Stats. This work is being done concurrently with the nonpoint source redesign groups to ensure consistency.

For more information, contact Susan Sylvester at 608-266-1099 or sylves@dnr.state.wi.us, or Mike Lemcke at 608-266-2104 or lemckm@dnr.state.wi.us, DNR, P.O. Box 7921, Madison, WI 53707-7921;

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

Protecting Wisconsin's groundwater is a priority for the DATCP. DATCP's major activities in this area include management of pesticides, research, and funding of local soil and water resource management projects.

Under the Wisconsin Groundwater Law, DATCP manages pesticides and pesticide practices to assure that established groundwater standards for contaminants are not exceeded. This may include prohibition of certain activities including pesticide use. The agency also manages practices to "minimize" groundwater contamination to the extent "technically and economically feasible." DATCP regulates storage, handling, use, and disposal of pesticides, and the storage of bulk quantities of fertilizer.

DATCP is also responsible for coordinating the development of Wisconsin's "generic" and "pesticide-specific" state pesticide management plans (PMPs - previously known as SMPs) for protecting groundwater from pesticides. In FY 96, DATCP, in cooperation with DNR and other agencies, submitted Wisconsin's "Generic SMP for Protection of Groundwater from Pesticides" to the EPA for concurrence. EPA concurred with the Generic SMP in June, 1996. According to the EPA document, "Pesticides in Groundwater Strategy" (1991), when EPA determines that a pesticide presents a significant risk of leaching to groundwater in a state, it may either cancel the registration of that compound or allow the state to prepare an PMP describing how the state will manage the pesticide to protect groundwater. The generic PMP presents a comprehensive review of Wisconsin's regulatory and nonregulatory efforts to prevent groundwater contamination due to pesticides. This generic plan will serve as a framework for pesticide-specific PMPs that will be required by the EPA for four commonly used herbicides.

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.

DATCP's primary effort related to nonpoint contamination (i.e., due to general use) of groundwater 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. Rule revisions for the 1999 growing season increased the number of atrazine use prohibition areas, based on groundwater sample results available as of September 1998. Information suggests

that atrazine use has declined as a result of the atrazine management rule and concern about groundwater contamination.

Since the late 1980s, DATCP has also initiated a number of surveys to investigate pesticides in groundwater resulting from nonpoint sources. In FY 96, DATCP completed a resampling of 122 Wisconsin wells that previously exceeded a pesticide enforcement standard. This Exceedence Survey was funded by DATCP. 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% declined in concentration and 16% increased. Forty-three percent of the wells tested above the atrazine enforcement standard and 57% tested below the standard. About 50% of well owners continue to use their contaminated well and about 25% have installed new wells at an average cost of \$6,300. This survey was conducted again in FY 97 and FY 98 with similar results. DATCP hopes to conduct this survey annually to analyze contamination trends in prohibition areas.

In FY 98, DATCP began sampling monitoring wells in 17 selected fields across the state. These fields are located in prohibition areas in which atrazine has not been used since 1993. Ch. ATCP 31, Wis. Adm. Code requires DATCP to collect scientific data to show if renewed use of atrazine in prohibition areas will cause further groundwater contamination. Quarterly sampling for this project will continue for five years. Although it is too early in the project to make recommendations, 1998 summary data showed that atrazine concentrations increased from Spring to Winter at all but one site, with one or more wells at 36% of sites over the enforcement standard for atrazine (3.0 parts per billion). The nitrate enforcement standard was exceeded at 86% of these sites over the same sampling period.

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

In FY 97, DATCP also resampled 100 private wells that had a triazine immunoassay test result of 0.8 µg/l or higher, but had never had a more comprehensive gas chromatography analysis performed. Of these 100 wells, 73 had detections of atrazine and/or its chlorinated metabolites, with the average concentration at 1.19 µg/l. Six of the 100 wells exceeded the enforcement standard for atrazine.

Previous DATCP and DNR surveys have identified significant point sources of contamination of groundwater quality at pesticide storage and handling facilities. These surveys indicated that activities at these sites continue to result in groundwater contamination, putting nearby private and, in some cases, municipal wells at risk. Surface water run-off from contaminated areas can also result in direct human and livestock exposure, property damage and/or surface water contamination.

In August 1993, section 94.73 of the Wis. Stats. was created and established the Agricultural Chemical Cleanup Program (ACCP) to address these point sources of contamination. The ACCP reimburses responsible parties for cleanup costs related to pesticide and fertilizer contamination at facilities and in nearby wells. Point source contamination on farms may also be handled by the program. To date, over 250 cases involving soil and/or groundwater remediation related to spills, misuse, and improper storage, mixing or loading have been initiated at pesticide and fertilizer handling facilities and on farms.

The ACCP also funds DATCP oversight of pesticide and fertilizer cleanup activities. Program staff investigate pesticide and fertilizer contaminated sites throughout the state. Investigations at these sites are prioritized based on suspected contamination levels, with higher levels investigated first. Investigations include discussions with facility

staff or farmers to determine the most likely locations of contamination at the site. Other oversight activities include, but are not limited to, sample collection, laboratory analysis, and financial auditing.

DATCP solely funded three and co-funded one pesticide research project during FY 98 (see Table 1). DATCP's research fund, which is based on fees paid by pesticide manufacturers, provides approximately \$135,000 annually to meet pesticide related research needs of the Department.

DATCP, through its land and water resource management program, provides funding primarily to counties to assist in the protection of these resources. A portion of this funding is dedicated to the development and implementation of improved nutrient and pesticide management practices. In FY 98 approximately \$100,000 was provided to develop and demonstrate better management practices for nutrients and pesticides.

In FY 98 DATCP provided \$440,000 to fund Clean Sweep projects in 31 counties for collection and disposal of waste pesticides and containers. Approximately 240,500 pounds of waste were collected from farm sites, thereby reducing the potential for inadvertent environmental damage. DATCP is requesting additional proposals from counties for the 1999 fiscal year. Approximately \$560,400 will be available during FY 99 for these projects.

For further information, contact Mr. Nicholas Neher, DATCP, 2811 Agriculture Drive, P.O. Box 8911, Madison, Wisconsin, 53708-8911; phone: 608-224-4567; e-mail: nehernj@wheel.datcp.state.wi.us.

DEPARTMENT OF COMMERCE

Private sewage systems - A revised private sewage system code, (Comm 83), is scheduled for legislative committee hearings in 1999. The new code is substantially revised from the previous draft that went to hearing in 1997. Major changes include the requirement that large septic systems, designed to treat more than 12,000 gallons per day will be required to obtain a WPDES permit from the DNR before Commerce will approve the plans for the system. Nine manuals for standard system designs will be referenced in the code. These manuals include the following systems: conventional, mound, pressure distribution, at-grade, holding tank, intermittent sand filter and drip line dispersal.

Recent research by the University of Wisconsin, small scale waste management project on sand filters and aeration units has resulted in approval of their use as replacement systems for existing failed systems and their recognition in the new code as additional treatment alternatives. One advantage of both the sand filter and aeration units is that homeowners will often be able to eliminate or reduce the size of a mound system compared to what is required under the current code. To assist county staff in becoming familiar with this new technology, Commerce has sponsored training presented by the University and manufacturers that focuses on the theory of operation and inspection services.

The Department is developing a database to assist counties in the administration of their maintenance tracking programs that are currently required under the provisions of the Wisconsin fund program. The new code will greatly improve the maintenance program for all installed on-site systems. The new code will provide for mandatory system maintenance schedules and reporting of maintenance events over the life of the system.

Petroleum Storage Tanks - Flammable and combustible liquids which have a flash point of less than 200⁰F are regulated by the State Administrative Code Chapter Comm 10. The regulatory authority for the storage tank program is within the Division of Environmental and Regulatory Services (ERS) in the Department of Commerce. The ERS Division has three bureaus: Bureau Of Storage Tank Regulation, Bureau Of Retail Petroleum Services, and the Bureau Of PECFA.

The ERS division continues to maintain regulatory oversight of the Federal EPS Underground Storage Tank (UST) upgrade compliance deadline that was December 22, 1998. Systems that did not meet the upgrade requirements after the deadline were "red-tagged" and taken out of service. Wisconsin State Statute does not designate or authorize the department regulatory authority for the non flammable/combustible hazardous substance tanks included in the federal rule.

Since 1991 the database inventory of petroleum product tanks regulated under Comm 10 has increased from 143,681 to 171,509 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 June 2, 1999 the database reflects 77,046 federally regulated tanks with only 13,837 tanks in use. In order to maintain a federally regulated tank in use, the tank must have a valid use permit, which is complimented by an annual inspection. Annual inspections involve verification of leak detection and record keeping.

Program initiatives have resulted in identifying a larger population of underground tanks, reducing the number of underground tanks in use, and upgrading those in use to meet the 1998 federal upgrade requirements. 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 at a strong pace as realtors and lenders recognize the potential problems and liability.

The closure of underground storage tanks is being supplanted by private fueling moving to retail fueling and some operators moving storage tanks to above ground. Residential heating fuel has not been significantly impacted as the closures are generally associated with the conversion to natural gas or liquid propane gas (LPG).

Educational outreach efforts and annual inspections by the department and its agents should result in a high level of regulatory compliance, and a reduction of system failures and environmental contamination. Wisconsin's progress continues to reflect very favorably with the US EPA.

Petroleum environmental cleanup fund act (PECFA) - the PECFA program from August 1989 through June 1999 has reimbursed petroleum storage tank system owners approximately \$584.5M to remediate petroleum contamination both in the soil and groundwater. The program, in addition to auditing owner invoices and authorizing payments, performs technical reviews for site investigations exceeding \$40k, comparisons of remedial options, and grants closures for a limited number of sites.

The PECFA program is continuing to experience a funding shortfall and the backlog of audited claims awaiting payment continues to grow. Claims for reimbursement received in summer 1998 will receive the reimbursement check in spring 2000, and claims received by the program in summer 1999 may not receive payment until summer 2002. The program currently receives claims at a rate of approximately \$15M per month and has spending authority of approximately \$7M per month. The petroleum inspection fee supports PECFA's spending authority.

Comm 47 became effective in December 1998 to address the above mentioned backlogs and refocus remedial efforts on site closures. The rule includes elements to; clarify the decision making process for remedial action approvals, reduce the frequency of payments and base access to the fund and decisions by owners on outcomes rather than reimbursement on a time and materials basis. The remedial alternative selection process includes the creation of environmental factors that determine paths and options for a remedial alternative selection. Additionally, provisions for reviews of existing sites include establishing site bundles, public bidding of the remedial action, and reestablishment of cost caps to the point of site closure.

Comm 46 (version 2) was implemented jointly by Commerce and DNR as an emergency rule in February 1999. The Natural Resources Board in June 1999, adopted Comm 46 (version 3) and agreed to make the rule part to the NR 700 (NR 746) series. Adaptation of Comm 46 as a permanent rule in the summer of 1999 will result in one version of Comm 46 in effect as incorporation of the rule into the NR 700 series continues. The Joint Committee for Rules and Regulations (JCRAR) continues to oversee this process.

Per the MOU between Commerce and DNR, quarterly reports to the Department of Administration (DOA) provide a summary of the progress made in implementation of the MOU. These reports summarize progress in such areas as; transfer of sites between the agencies, cost cap development, public bidding and less than \$80,000 remediations.

For more information, contact Mr. John Alberts, Department Of Commerce, P. O. Box 7839, Madison, Wisconsin 53707-7839, phone: 608-266-9403, fax: 608-267-0592; e-mail alberjo@mail.state.wi.us.

DEPARTMENT OF HEALTH AND FAMILY SERVICES

Chapter 160, Wis. Stats., directs the DHFS to recommend health-based enforcement standards for substances found in groundwater and specifies the protocol for developing the recommended standards. Recommended standards are sent to the DNR which proceeds through the rule-making process to amend ch. NR 140, Wis. Adm. Code. In June 1998, the DNR board requested that a previously proposed enforcement standard for ammonia be considered at a public hearing. In preparation for this hearing, DHFS staff revised the background document for the ammonia proposal and are awaiting comment from external peer reviewers. DHFS staff have also offered comment on a draft list of substances under consideration as candidates for the adoption of new enforcement standards.

DHFS staff are the 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 public meetings and conferences, and provide direct assistance to Wisconsin families via home visits, letters to well owners, and telephone consultations. DHFS staff review correspondence sent to well owners by DNR representatives. The agency provides additional advice to owners of wells that are seriously contaminated with volatile substances such as benzene and vinyl chloride. Follow-up letters sent by DHFS explain the health effects of the specific contaminant and suggest strategies for reducing exposure until a safe water supply can be established. DHFS also prepares and distributes a wide variety of informational materials.

For more information, contact Henry Anderson, Lynda Knobeloch or Mark Werner, 1414 E. Washington Ave., Rm.96, Madison, Wisconsin, 53703-3044; phone: 608-266-1253 (Henry) or 608-266-0923 (Lynda), or 608 266-7480 (Mark).

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

The WGNHS performs basic and applied groundwater research and provides technical assistance, maps, and other information and education to aid in the management of groundwater resources. The WGNHS groundwater program is complemented by geology, soils, and climate programs that provide maps and research-based information essential to the understanding of groundwater recharge occurrence, quality, and movement. WGNHS personnel are currently preparing groundwater-related maps (such as water-table or aquifer maps) at a scale of 1:100,000 for Dane, Polk, Green Lake, and Buffalo Counties.

In FY 99, the WGNHS continued to respond to requests for information and assistance from other local, state, and federal agencies, consultants, students, and the public. These requests ranged from the simple, "What will I find underground if I dig or drill here?", to more complex questions about groundwater flow, contaminant transport, or wellhead protection.

Public information, records, and research results that the WGNHS stores and disseminates save the considerable expense of gathering the same geologic or groundwater information several times for different purposes, or "re-discovering" the same information over time. To help this service, the WGNHS continues to review, sort and catalog about 18,000 well construction reports per year (in cooperation with the DNR), measure monthly

groundwater levels in a monitoring network of 145 wells (in cooperation with the USGS), collect, and describe geologic samples from 300 wells per year.

Beginning in 1999 the WGNHS began a new initiative to carry out computer scanning and basic database entry for all well construction reports in the WGNHS files to support DNR's source water assessment program. This project is expected to be complete within two years. The result will be a computer-searchable database of all well construction reports, which should be of major benefit to all state agencies, consulting firms, and private well owners.

Groundwater-related digital data will continue to be collected for statewide programs and local projects during FY 2000. The Well-Constructor's Report database is currently the most active and contains information from locatable and representative domestic wells. Wells will continue to be added to the database from our county and regional studies. Checking and correcting well locations is an important continuing program that is necessary before the drillers reports can be used with confidence in a geographic information system. Development of a statewide database for approximately 36,000 geologic logs and drill holes that have more complete lithologic information will be continued.

Geologic and groundwater studies at the county scale continue to be an important part of WGNHS programs. During FY 2000 the Survey will complete the publication of a new hydrogeologic report (including a water-table map) and new bedrock geologic map for Dane County. Both publications will be as WGNHS bulletins, with maps at a scale of 1:100,000. In addition, the Survey will publish a report on the Dane County groundwater flow model. In Dane County the completed groundwater model is being widely used for evaluating future pumping, well placement, and wellhead protection scenarios. The model is also being used as a basis and framework for the additional study of important springs in several parts of the county (Token Creek, Pheasant Branch Creek, Nevin Fish Hatchery). During FY 2000 the WGNHS will assist with these spring investigations, which are being undertaken by UW-Madison and USGS personnel.

In FY 98, the WGNHS began a surficial materials study of Green Lake County, with the goal of developing improved maps of sand and gravel resources potential there. During FY 2000 we will complete this project, with the addition of water-table and depth-to-bedrock maps for the county at a scale of 1:100,000.

The WGNHS is also undertaking major studies of the hydrogeology of southeastern Wisconsin in cooperation with the Southeastern Wisconsin Regional Planning Commission and the DNR. Southeastern Wisconsin includes the cities of Milwaukee, Racine, and Kenosha, and recent population increases in this area have stressed local groundwater resources. As part of this effort the WGNHS began a detailed investigation of the hydrogeologic properties of the Maquoketa Formation, an important regional aquitard in southeastern Wisconsin. The shaley Maquoketa lies between the Silurian dolomite and Cambrian sandstone aquifers in southeastern Wisconsin, and limits the exchange of water between them. However, the hydraulic properties of the Maquoketa are poorly known. In 1997 the WGNHS obtained the first of two continuous rock cores through the entire Maquoketa section. This is the first continuous core of the Maquoketa ever obtained in southeastern Wisconsin. The resulting hole has been instrumented with a multilevel sampling system for acquisition of water samples and water-level data. The geochemical and hydraulic head information should be invaluable for improving our understanding of the regional hydrogeology of southeastern Wisconsin.

Carbonate rocks (limestone and dolomite) underlie much of Wisconsin, and form important aquifers over large parts of the state. Groundwater in carbonate rocks often moves 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. Consequently, carbonate rocks are very vulnerable to groundwater contamination. Predicting groundwater flow in fractured carbonate rocks is challenging because these aquifers tend to develop two-component flow systems: rapid flow through small, discrete fractures and slower flow, but significant storage, in the matrix blocks. 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.

Over the past few years, the WGNHS has developed a program of research and public education on groundwater movement in carbonate rocks, and has provided assistance to various agencies facing carbonate-rock problems. Examples of recent work include completion of a wellhead protection project for the City of Sturgeon Bay, completion of a project characterizing the hydrostratigraphy of the Sinipee dolomite, assistance to the DNR in selected regulatory issues, including the proposed expansion of the Superior Meadows landfill in Jefferson County, advice and assistance to county officials concerned with the expansion of large manure pits in Door County and in southwest Wisconsin, and advice to the committee revising the state-wide NRCS technical guidance document on manure storage facilities.

In September, 1998 the WGNHS hosted a major professional conference on fluid flow in carbonate rocks, with participants from across the United States as well as several foreign countries.

Research projects completed this year or in progress include:

1. Tracer study of groundwater movement in fractured dolomite.
2. Investigations of stratigraphic controls on groundwater movement in Door County.
3. Field verification of well capture zones for the City of Sturgeon Bay
4. Hydrogeologic properties of the Maquoketa Shale.
5. Hydrostratigraphy of Southeast Wisconsin.
6. Regional groundwater flow model of Southeast Wisconsin
7. Hydrogeology of Dane County
8. Delineation of hydrogeologic units throughout Wisconsin
9. Hydrology and hydrogeology of the Kickapoo River
10. Nitrate monitoring near Arena, Lower Wisconsin River Valley.
9. Delineation of wellhead protection areas for the City of Sturgeon Bay.
10. Review of material submitted regarding proposed mine near Crandon, Wisconsin.
11. Development of new methods for determining groundwater recharge rates

For more information, contact Ken Bradbury or Ron Hennings, WGNHS, 3817 Mineral Point Road, Madison, Wisconsin, 53705-5100; phone: 608-263-7389.

Recent WGNHS Publications

Bulletin 91: *Quaternary geology of Ozaukee and Washington Counties, Wisconsin*, D.M. Mickelson and K.M. Syverson, 1997, 56 p. plus map (scale 1:100,000).

Bulletin 96: *Wisconsin lake plant atlas*, S.A. Nichols, 280 p.

Bulletin 97: *Quaternary geology of northern Oconto County, Wisconsin*, J.W. Attig and N. Ham, 1999, 20 p. plus map (scale 1:100,000).

Miscellaneous Map 47: *Water-Table Elevation of Trempealeau County, Wisconsin*. M.A. Muldoon and J. Craven, 1998. Scale 1:100,000.

Miscellaneous Map 50: *Water-Table Elevation of Price County, Wisconsin*. K.J. Cates and W.G. Batten, 1999. Scale 1:100,000.

Educational Series 15: *Groundwater Levels in Wisconsin, Annual Summary, 1998*. A. Zaporozec, 1999, 4 p.

Open-File Report 1998-2. *Tracer study for characterization of groundwater movement and contaminant transport in fractured dolomite*, M.A. Muldoon and K.R. Bradbury, 1998, vii + 85 + 2 p.

Open-File Report 1998-4: *Application of a discrete fracture flow model for wellhead protection of Sturgeon Bay, Wisconsin*, K.R. Bradbury, T.W. Rayne, M.A. Muldoon, and P.D. Roffers, 1998, vi + 62 p.

Open-File Report 1998-9: *Variability of nitrate loading and determination of monitoring frequency for a shallow sandy aquifer, Arena, Wisconsin*, M.A. Muldoon, F.W. Madison, and B. Lowery, 1998, iv + 26 p. +1 diskette (193 p. on diskette).

Open-File Report 1998-11: *Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin*, T.T. Eaton and K.R. Bradbury, 1998, ii + 34 p.

DEPARTMENT OF TRANSPORTATION

The DOT regulates the storage of highway salt under ss. 85.17 and 85.18, Wis. Stats., to protect the waters of the state from harm due to contamination by dissolved chloride. Additional groundwater management and protection related activities performed by DOT as part of the design, construction, and maintenance process of state and federal highways include: road salt research; hazardous materials (petroleum) and hazardous waste investigation and remediation; wetland compensation; and erosion control and storm water management. DOT is also responsible for potable well sampling at 140 rest areas and waysides. The responsibility for the management of these activities is divided among several groups in DOT:

- Salt Storage - Bureau of Highway Operations
- Salt Research - Bureau of Highway Construction (Geotechnical Section)
- Hazardous Materials (petroleum) - Bureau of Environment and District Environmental Coordinators
- Hazardous Waste - Division of Business Management (Risk & Safety Management Section)
- Wetlands - Bureau of Environment and District Environmental Coordinators
- Erosion Control and Storm Water Management - Bureau of Environment and District Environmental Coordinators.
- Potable Well Sampling - Bureau of Highway Operations

Salt Storage and Road Application - Highway salt is stored statewide by suppliers, counties, cities, villages, and private companies. Annual inspections and reports are made of 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 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 so that covered facilities are as close to the actual use area as possible.

Current policy in the State Highway Maintenance Manual restricts the spreading of deicer salts to a maximum of 300 pounds per lane mile per application. Electronic controls for salt spreader trucks are continually being tested to record and verify application rates and coverage effectiveness. New technology equipment (zero-velocity spreaders and liquid, onboard prewetting units) has been installed on county highway patrol trucks to help keep a greater percent of the salt applied to the roadway on the pavement surface. Additional efforts to minimize and conserve salt applications are being pursued by use of an in situ weather monitoring system consisting of temperature sensors and remote processing units which determine and record temperatures of road pavements at 51 separate statewide locations along major highway routes. The pavement temperature information helps determine the sand and salt application rates. Also, annual training for proper snowplowing and salt spreading techniques is provided for county snow-plow operators, and the counties provide weekly reports of salt usage.

During the 1997-98 winter season several counties began using alternative anti-icing and deicing chemicals on test sections in an effort to reduce the amount of chlorides applied to pavement and its impact on groundwater. Use of pro-active anti-icing techniques should result in lower chemical usage and reduce total winter maintenance costs. During the 1998-99 winter season: 7 counties used liquid MgCl₂ as direct spray on pavements and bridge decks for

anti-icing; 2 counties used IceBan as direct spray on bridge decks; 13 counties used IceBan as a prewetting solution for road salt applications; and 6 counties used MgCl₂ as a prewetting solution for road salt applications.

Salt 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 (1 or 2 shallow monitoring wells per site). To date approximately 20 sites throughout the state have been studied. In general, each site is 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 future groundwater monitoring plans are being evaluated (i.e., longer monitoring periods and multiple well arrangements per site). 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).

Hazardous Materials (Petroleum) and Hazardous Waste - As part of the highway improvement program, DOT performs an estimated 50 to 100 environmental assessments annually along right-of-way where potential sources of petroleum or hazardous waste contamination may occur. Assessments consist of standard environmental audits of properties adjacent to highways, and environmental drilling and sampling to identify or delineate the extent of soil or groundwater contamination. Numerous contaminated sites are identified as part of the environmental assessment process. This information is shared with DNR so appropriate enforcement and remedial action is taken to protect groundwater resources. In addition, DOT works with DNR and Commerce on 5 to 15 sites per year where underground storage tank removal or other remedial actions are necessary to accomplish highway improvement (e.g., managing the removal, treatment, and disposal of contaminated soils or groundwater). DOT manages about 7,000 to 15,000 tons of contaminated soil per year and about 10 million gallons of contaminated water per year.

Wetlands - Compensatory wetland mitigation is required under section 404 of the Clean Water Act for transportation projects. During the past several years, DOT has engaged in a cooperative study with the U. S. Geological Survey to investigate groundwater relationships with respect to wetland creation and restoration projects. The groundwater studies are intended to increase the certainty of establishing wetland hydrology. The final report on this study was completed February 15, 1999 and is titled Hydrogeological, Geomorphological, and vegetative Investigations of Select Wetland Creation and Restoration. In addition, DOT has several ongoing wetland monitoring projects which evaluate wetland hydrology, water quality and biotic response to constructed mitigation sites.

Since July 1993, DOT has had an interagency approved wetland mitigation banking program. Currently wetland loss due to highway, bridge and airport projects may be compensated for in the bank system. As of March 1999, there have been 1,496 wetland acres lost to 674 DOT construction projects throughout the state since 1990. This loss was compensated by 2,131 acres of wetland restoration and creation. Thirty wetland bank sites have been planned and constructed. There are 20 constructed bank sites containing 1,112 available wetland acres and five bank sites in planning and design that should produce an anticipated 861 wetland acres. Five bank sites containing 375 acres have been closed. Compensation through the bank system is currently at 68%.

Erosion Control and Storm Water Management - DOT has established erosion control standards for airport, railroad, and highway construction projects as well as maintenance projects administered by DOT. These standards were created to minimize on-site erosion damage and to minimize adverse impacts to waters of the state resulting from sediment or pollutant accumulation. Construction projects must adhere to best management practices, performance standards, and erosion control implementation as stated in ch. Trans. 401 Wis. Adm. Code. Best management practices, given in Chapter 10 of DOT's Facilities Development Manual, include devices and procedures employed to minimize erosion. Best management practices were developed in consultation with the DNR, Federal Highway Administration (FHWA) and the road building industry.

Chapter 10 of the Facilities Development Manual has been revised to include management of storm water runoff from transportation facilities. The revised Manual contains interim storm water management policy. Currently, storm water best management practices are being incorporated into projects on a case-by-case basis.

Other Groundwater-Related Research and Projects - DOT is currently participating in a FHWA study investigating methods for treatment of highway runoff which flows directly into karst sinkholes for the purpose of protecting groundwater resources in karstic hydrogeologic settings (e.g., Door County or SW Wisconsin). Another effort to improve water quality from highway runoff includes a research project to evaluate the effectiveness of high efficiency street sweepers for pollutant reduction and participating in a study sponsored by the Civil Engineering Research Foundation to verify the effectiveness of various storm water treatment devices. Finally, DOT is proactively monitoring several sites to evaluate the effectiveness of natural attenuation as a remedial option for petroleum contaminated groundwater. This information will be shared with the DNR.

For more information, contact Ms. Carol Cutshall, Director, Bureau of Environment, Room 451, P. O. Box 7965, Madison, Wisconsin 53707-7965; phone: 608-266-9626, or e-mail carol.cutshall@dot.state.wi.us.

UNIVERSITY OF WISCONSIN SYSTEM

The UWS has research, teaching and information/education responsibilities. These three missions are integrated through cooperation and joint appointments of teaching, research, and extension personnel who work on groundwater issues.

Research - During FY 99 the UWS directed a wide-ranging program of priority groundwater research consisting of 13 projects. The projects include short-term and long-term studies, and may be either of a fundamental or an applied nature. They provide a balanced program of laboratory, field, and computer-modeling studies and applications aimed at preserving or improving groundwater quality. The groundwater problems investigated include:

- Determination of groundwater recharge rates in southern Washington County;
- Assessing the effect of agricultural chemicals on Wisconsin's declining and endangered amphibians;
- Developing a better understanding of nitrate contamination at the watershed scale by studying groundwater chronology and chemistry at the groundwater/surface water interface;
- Evaluation of exploration borehole seals using time domain reflectometry;
- Investigation of air sparging: numerical modeling, laboratory verification, and design guidelines;
- Determination of hydraulic conductivity and specific storage of the Maquoketa shale;
- Developing a new approach to concentrating sample analytes to improve the detection limits of trace quantities of contaminants in groundwater;

- Assessment of the sedimentology, stratigraphy, and porosity-conductivity relations of the Silurian aquifer in Ozaukee County;
- Obtaining an improved understanding of the dynamics of groundwater flow and heat transport in wetland systems;
- Using a probabilistic approach to assess how uncertainties in hydrogeologic conditions, reaction rates, and wall emplacement conditions affect the reliability of permeable reactive walls (PRWs);
- Development of a method to quantify intrinsic bioremediation by adapting an existing air chemistry procedure to groundwater;
- Development of methods for evaluating the distribution and activity of methanotrophic bacteria in relation to bioremediation of contaminated groundwater;
- Demonstration of a more efficient approach to resolving land use issues as they affect water quality and availability.

The 13 funded projects provided training in several disciplines for postdoctoral research associates, graduate student research assistants, and undergraduate students at UW-Madison, UW-Milwaukee, and UW-Stevens Point.

The UWS selected nine new groundwater research projects from this year's Joint Solicitation for support during FY-2000 (July 1, 1999 - June 30, 2000) (see Table 2). Five projects, one of which is supported jointly with DATCP, selected from the previous year's Joint Solicitation will receive continuation support during FY 2000. New projects are centered at UW-Madison, UW-Milwaukee, UW-Stevens Point, and UW-Parkside.

Teaching - The UWS institutions continue to offer courses and programs at the undergraduate and graduate level focusing on diverse aspects of groundwater resources. In addition, several campuses offer credit, field-oriented water curriculum courses for middle school and high school teachers during summer sessions. Specifically, the Water Resources Institute views education as an important component of its total program. At the joint American Water Resources Association-Wisconsin Section and Society of Environmental Toxicology and Chemistry-Midwest Chapter meeting this year the WRI provided funding for one of the two student paper awards. The awards, one for an oral presentation and one for a poster presentation, each carry a stipend to be used for travel to present the paper at a national meeting of the student's choice. The importance of K-12 education is also recognized as a basic component of the WRI's training program. To address this issue, the WRI distributes its two publications--*Local Watershed Problem Studies-Elementary Activities* and *Local Watershed Problem Studies-Middle and High School Curricula Guide*--upon request. These two curricula guides were produced to assist educators in the development and dissemination of curricula concerning soil and water resources. To promote and improve water education throughout Dane County, the WRI cooperates with the Dane County Agriculture and Extension Office in support of the Dane County Water Education Resource Center (WERC). This is one of five pilot centers in Wisconsin established by the Wisconsin Water Educators, University of Wisconsin-Extension, and the Wisconsin Department of Natural Resources. The WERC provides water education materials, training and equipment to teachers and youth, civic, conservation and community group leaders throughout the surrounding area.

Information Transfer - The updated (June 1999) UWS Water Resources Institute web site (www.wri.wisc.edu) now provides convenient links to the UW-Madison's WRI Library, the Wisconsin Groundwater Research and Monitoring Project Summaries, a compilation of the WRI's Publications from 1966 to present, and a WRI Staff Directory. The recently updated WRI Library site includes information about the library; an electronic reference service (AskWater); quick access to the UW Electronic Library catalog, databases and services; and an extensive list of links to Wisconsin and national water resources information on the World Wide Web.

The WRI Library is one of only two libraries in the United States devoted to water resources. It houses over 21,000 hard copy and microfiche documents covering all major topics in water resources, and over 35 journals and 135 newsletters dealing with water issues or technology. The Library produces a monthly Recent Acquisitions list which is distributed to over 300 people nationally. The entire collection is on MadCat, the UW online catalog, making it a national resource accessible to all over the Internet. Since adding the collection to MadCat, circulation has increased by 80% and student usage by 500%. Use of the library web site has grown dramatically. More than 5,200 files from the site were downloaded during April 1998, or an average of 174 files/day – an 800% increase from January 1996 when statistics were first kept. During FY 99 the library staff responded to 2,313 requests for individual titles and subject searches. More than 1,100 UW-Madison faculty, staff, and students, WDNR staff, private consulting organizations, and members of the public contacted the WRI Library during the past year. The Library has two new Electronic Library workstations for walk-in use by WRI Staff, UWS faculty, staff, and students, state government employees, and Wisconsin business, industry, and citizens.

The WRI's contributions to groundwater research were highlighted during Wisconsin Groundwater Protection and Awareness Week, held February 2-4, 1999 in the rotunda of the Wisconsin State Capitol. This educational effort was designed to inform legislators and their staff and the general public about ongoing research and monitoring activities supported by the Wisconsin Groundwater Coordinating Council. In addition, displays provided information on the status and quality of Wisconsin's groundwater resource.

Work supported by the WRI provided the focus for the 1996 Fall Field Conference of the Great Lakes Section of SEPM (Society of Sedimentary Geologists). Approximately 50 geologists and students from the region surrounding the Great Lakes visited several field sites, examined cores from those sites, and discussed the relationship between sedimentology, stratigraphy and geology. Feedback from this conference was so positive that four WRI-supported researchers were asked to co-convene a SEPM research conference on fluid flow in carbonate rocks. This international conference, entitled, *Fluid Flow in Carbonates: An Interdisciplinary Approach*, was held in Door County, northeastern Wisconsin, during September 1998. Approximately 60 individuals from state agencies, industry and academia attended the conference, including scientists from Switzerland, Ireland, England, Belgium, and the Netherlands. The field sites and findings of WRI-supported researchers provided a major case study for the conference. After examining field sites on the first day of the conference, attendees debated many aspects of fluid flow in carbonate rocks, in particular, the contributions that hydrogeologists, stratigraphers, sedimentologists and reservoir engineers could make while working together to address issues ranging from groundwater contamination to the geologic history of various rock units. Many attendees expressed the idea that this conference represented one of the best interdisciplinary examinations of these issues that they had ever seen.

The network edition of the Wisconsin Groundwater Research and Monitoring Project Summaries had its second full year of operation during FY-99. During this period, the WRI Project Summaries web site hosted 1,152 visitors who retrieved a total of 2,518 project summaries. The average number of summaries retrieved from among the 72 that are currently posted was 35, with a range 10 to 137 downloads per summary.

The UWS Water Resources Institute is currently completing an editorial review of the "Directory of Water Resources Expertise in Wisconsin" during FY-99 in anticipation of an updated release of the *Directory* in late summer 1999. The abundance and quality of Wisconsin's surface and groundwater is a reflection of the diverse talents, expertise, and dedication of the 765 listed individuals who are the stewards of Wisconsin's water resources. They are affiliated with Wisconsin's Colleges and Universities, State, Local, Tribal, and Federal Government Agencies, commercial and consulting enterprises, private associations, public service commissions, and citizens groups. The updated directory will initially be made available in paper format by the WRI. Our goal, however, is to post the entire database on our web site (www.wri.wisc.edu) with complete on-line search capabilities. We are currently contacting individuals listed in the directory to update their entries and keywords and to ask permission for posting their information on our web site. We will also post a full directory on our web site for retrieval as an Acrobat.pdf file.

The Water Resources Institute underwent a major administrative change at the end of June 1998 when Dr. Gordon Chesters, Academic Program Director, and Dr. George Blondin, Program Coordinator, retired. Dr. Chesters'

replacement is Dr. Anders W. Andren, who is combining his duties as Academic Program Director of the Wisconsin Sea Grant Institute with parallel duties in the Water Resources Institute. Both programs are housed together on the second floor of Goodnight Hall on the University of Wisconsin-Madison campus. Dr. James P. Hurley has been named Assistant Director for Research at WRI. His duties include coordination of the UWS portion of the Joint Solicitation as well as coordination of peer reviews and rankings for all projects submitted to the Joint Solicitation. Dr. Hurley works 50% time for the UW-WRI and 50% for the Bureau of Integrated Science Services, Wisconsin Department of Natural Resources.

Information/Education - The UWS institutions and county-based staff continue involvement in groundwater education activities. In cooperation with other state and federal agencies, groups and individuals, innovative problem-solving educational programs on groundwater resources are provided to the State's citizens through publications, meetings, teleconferences, satellite programs, water testing, and other forms of assistance. Activities of several specific programs follow.

The UWS Farm Assessment System (Farm*A*Syst) and Home Assessment System (Home*A*Syst) programs help farmers and rural non-farm residents assess water pollution risks related to their structures, management practices, and site characteristics. The system is available statewide and has been integrated into a number of Wisconsin Priority Watershed projects. It is also being used as an educational tool for Environmental Quality Incentive Programs and county conservation planning. At least 3 Wisconsin Native American Nations are using elements of these programs to assist with their efforts to protect and manage natural resources.

Project evaluation shows Farm*A*Syst to be an effective, voluntary program which increases knowledge and, most importantly, leads to changes in practices. The expanded, national project is working with all 50 states, several Canadian provinces, Australia, and Mexico in adopting this system. This is a cooperative project funded by the U.S. Department of Agriculture (USDA) Cooperative State Research Education Extension Service, the NRCS, and the EPA. Recent materials available through the national program are listed under publications.

Give Water a Hand is a national youth watershed education program developed and coordinated at the UW Environmental Resources Center. Give Water A Hand seeks to engage youth, age 9 - 14, in local natural resource service projects, including those related to groundwater. Program goals are to protect and improve local water quality by encouraging youth to investigate local issues, and plan and complete a service project with assistance from a local natural resource expert to address a problem they identify. Program materials, available through UW Extension Publications, consist of an Action Guide for youth, with step by step instructions for addressing local watershed concerns, and a Leader Guidebook to assist teachers and youth leaders in facilitating youth projects.

The UW Nutrient and Pest Management (NPM) program mainly serves Wisconsin farmers and the other agricultural professionals who assist them in making management decisions. The primary focus of NPM programs in 1998-99 was improved nutrient management practices to save money and reduce the potential for non-point source pollution. Principal activities included on-farm demonstrations, a focused neighborhood approach in critical areas, and creating and publishing innovative, practical materials for farmers. NPM cooperates with county-based UWEX educators, LCD priority watershed staff, and state and federal agencies to deliver these agricultural programs. For example, activities linking improved manure management practices and water quality were funded by a multi-agency EQIP education grant.

A secondary NPM focus was increasing educational programs on integrated pest management to assist farmers moving beyond pesticide-dependent cropping systems. Activities included hands-on IPM training for farmers, publications, and field research and demonstration projects.

The UWS cooperates with other state agencies involved with water resources and natural resource issues. In 1998, UW-Extension entered into a new partnership with the DNR and USDA-NRCS in Wisconsin. This new partnership provides land and water resources education in the state's 22 major river basins. In 1998 seven, multi-agency supported river basin educators were hired. These river basin educators provide educational program

support to approximately 10 basins. They work collaboratively with three publication/editorial specialists, two evaluation experts, and one coordinator who works on volunteer-based issues. Collectively this river basin focus works to support other local conservation professionals such as county Extension agents, Land Conservation Department staff, and NRCS staff. This focus on river basins includes drinking water fact sheets, newsletter articles about groundwater, and in some instances, specific watershed studies that address unique water quality problems.

Extension's Environmental Resources Center publishes a monthly newsletter, *Keeping Current*, which brings information about water issues to more than 1,400 agency staff throughout the state.

UW-Extension coordinates the Multi-Agency Land and Water Education Grant Program which funded three groundwater-focused projects between July 1, 1998, and June 30, 1999. These projects examined the effects of intensive rotational grazing on groundwater quality, provided well testing for rural landowners, and conducted Farm-A-Syst assessments to help farmers identify and address groundwater contamination on their property.

The Central Wisconsin Groundwater Center's (CWGC) mission is to provide groundwater education and technical assistance to the citizens and governments of Wisconsin. Programs range in breadth from answering citizen questions (e.g., Is my water safe? How deep should I drill my well? Where is this nitrate coming from?) to helping communities with wellhead protection planning, and describing the extent and causes of groundwater nonpoint pollution in Wisconsin. The Center frequently works through county Extension faculty in program delivery.

In 1998, the Center assisted 2,543 households in having their water tested in conjunction with county Extension offices and the UW - Stevens Point Environmental Task Force Lab. Of these, 8% exceeded drinking water standards for nitrate-nitrogen. Sixteen percent were unsafe because of coliform bacteria. Twenty-six percent had moderate to severe corrosivity indexes. Eight education programs helped 767 well users understand potential remedies for these problems and the relationship of land use practices to groundwater quality.

The Center has been active in the nonpoint source pollution program redesign, and a leader in education and research into nonpoint problems. It has provided assistance in many of the projects undertaken by the Education Subcommittee in the last year, such as groundwater education at the Capitol Rotunda and at Farm Progress Days. Other outreach included grant-funded workshops which provided sand-tank groundwater flow models to six Central Wisconsin schools and continuing to assist in a Golden Sands Resource Conservation and Development area project to develop and distribute education materials on corrosive water. The Center's main Web site is at <https://www.uwsp.edu/cnr-ap/watershed/Pages/GWHome.aspx>.

For more information on research or information transfer contact Dr. Anders W. Andren, Director, UW-Madison Water Resources Center, 1975 Willow Drive, Madison, WI 53706; phone (608) 262-0905, Fax (608) 263-2063, email awandren@seagrant.wisc.edu. For teaching and information/education, contact Jim Peterson, UW Environmental Resources Center, 1450 Linden Drive, Madison, WI 53706-1562, phone (608) 262-3799, fax (608) 262-2031, email jopeters@facstaff.wisc.edu.

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Protecting Wisconsin’s Water Resources through Integrated Weed Management

Eight years of Nitrogen Management Demonstration Results

Free Fertilizer – Better Water, Too

1999 Calendar – Spread the Word; It’s Good Fertilizer

GROUNDWATER MONITORING AND RESEARCH

CONDITION OF THE RESOURCE - GROUNDWATER QUALITY

As part of 1983 Wisconsin Act 410, the Groundwater Account of the Environmental Fund was created to support groundwater monitoring by state agencies to determine the extent of groundwater contamination in Wisconsin and identify the sources of contamination. Groundwater monitoring has found that the primary contaminants of concern are volatile organic compounds (VOCs), pesticides and nitrates. Each is discussed below.

Volatile Organic Chemicals

VOCs volatilize under normal temperatures and pressures. Examples of VOCs include gasoline and industrial solvents, paints, paint thinners, drain cleaners, air fresheners, and household products (such as spot and stain removers). Many VOCs are suspected carcinogens when exposure is long term. In the short term, high concentrations of VOCs can cause nausea, dizziness, tremors, or other health problems.

Sources of VOCs include landfills, underground storage tanks, and hazardous substance spills. The DNR requires monitoring at state Environmental Repair Fund sites, abandoned facilities, Comprehensive Environmental Response Compensation Liability Act (CERCLA- superfund), LUST, and spill sites. Thousands of wells have been sampled for VOCs. Fifty-nine different VOCs have been found in Wisconsin groundwater. Trichloroethylene is the VOC found most often in Wisconsin's groundwater.

The DNR currently tracks more than 17,000 LUST sites, approximately 4,000 waste disposal facilities, and approximately 1,400 high priority Environmental Repair sites. 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.

Wisconsin has 90 active, licensed solid waste landfills, all of which are required to monitor groundwater. Two studies conducted over a four-year period revealed that out of 51 landfills (both industrial and municipal, engineered and unengineered), 27 (53%) had VOC contamination in groundwater. All of these landfills are currently closed. VOCs contaminated groundwater at 21 (81%) of the 26 unengineered municipal solid waste landfills included in the two studies. While 20 different VOCs were detected overall, 1,1 – Dichloroethane was the most commonly occurring VOC at all solid waste landfills. The two DNR publications – “Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills”, dated February 1988, and “VOC Contamination at Selected Landfills – Sampling Results and Policy Implications”, dated June 1989 – further describe the research results. In a follow-up VOC study conducted from July 1992 through July 1994, the DNR reviewed historical data and sampled groundwater at 11 closed, unengineered landfills and at six older, engineered landfills. VOC levels have decreased after closure at all but two of the unengineered landfills, though at many sites VOC levels do not show continued decline. Also, the level of contamination remains high at many closed sites. No VOC contamination was attributable to leachate migration at any of the six older, engineered landfills.

Over the past few years increasing numbers of residential developments have been located close to old, closed landfills. Further, it has been recently discovered that several of these landfills are impacting groundwater. Last year, at the request of one of our counties, the DHFS sampled private wells downgradient of 19 small, closed landfills in the county. Several of the private wells had results above maximum contaminant levels. The results of this sampling showed that there may be many landfills with serious problems that have not yet been identified.

The DNR Bureau of Waste Management, Remediation and Redevelopment, and Drinking Water and Groundwater in cooperation with the DHFS, responded to this issue in early 1999 by choosing 15 old, closed landfills - three from each of the five regions across the state - that have private wells nearby and may be impacting groundwater.

Private wells around 8 of the sites were sampled in March. Significant levels of contamination have been found. Of the 66 wells that have been tested, 30 had detects of VOCs. Fifteen of the homes had levels exceeding drinking water standards and sixteen homes have been given health advisories not to drink their water.

To recommend ways to ensure integration and communication within the DNR when addressing the problem of private wells near old, closed landfills, an ad hoc team, the Landfill Encroachment Work Group, was formed with members from the Bureaus listed above. The work group's goal is to work together to prevent people from drinking contaminated groundwater from private wells near landfills and locating homes where this may already be occurring. There are also plans to coordinate with other state agencies, local agencies and the private sector.

The work group presented its recommendations to the three different Bureau Directors in June 1999. The workgroup identified the following most important ways to avoid old, closed landfills impacting private wells:

1. improve our database of the location and characteristics of active, inactive and abandoned landfills across the state;
2. provide easy access to that list through the internet and other more traditional media for developers, realtors, planners and potential homeowners;
3. work with these external groups to determine what information would be the most valuable to them; and
4. rank unmonitored old, closed landfills to determine which of these sites should be investigated to determine if there are private wells nearby that should be sampled.

More information regarding residential encroachment and the issues faced by the different Bureaus involved can be found in the paper, "Can Wisconsin's One-of-a-Kind Environmental Monitoring System Adequately Evaluate Its Old, Closed Landfills?" by Jack Connelly and Diane Stocks, dated July, 1999. Contact the Bureau of Waste Management for a copy.

Wisconsin requires underground storage tanks with a capacity of 60 gallons or greater to be registered with Commerce. This registration program has identified a total of 167,073 tanks as of July 1, 1998 of which 75,059 tanks are regulated by the federal underground storage tank program. Only 15,575 regulated tanks are currently in use, and 59,484 tanks have been removed. A federally regulated tank is any tank, excluding exempt tanks, that is over 110 gallons in size, has at least 10 percent of its volume underground, and is used to store a regulated substance. 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.

Underground storage tanks over 110 gallons have been federally regulated since 1988. As of June 1, 1999, DNR records indicate there are 7,900 active underground storage tank contamination cleanups and approximately 9,100 inactive sites. The contaminants most commonly associated with leaks from petroleum underground storage tanks are benzene, toluene, ethyl benzene, and xylene (BTEX compounds). More than 5,000 LUST sites have BTEX groundwater standards exceedances. Drinking water at more than 275 households has been contaminated by leaks from underground storage tanks.

Hazardous waste treatment storage and disposal facilities are another VOC source. The DNR Bureau for Remediation and Redevelopment is investigating or remediating contamination at 27 sites. Approximately 140 sites statewide are subject to corrective action authorities. However, only a small percentage will follow the corrective action process because of minimal contamination at the site or jurisdiction under other regulatory authorities.

Generators improperly managing hazardous waste are another source of VOC contamination. All new generator remediation cases statewide and many existing actions are to be addressed in accordance with the NR 700 Wis. Adm. Code series.

The Hazardous Substance Spill Law, ch. NR 292.11 Wis. Adm. Code, formerly section 144.76, Wis. Stats, requires immediate notification when hazardous substances are discharged, as well as taking actions necessary to restore the

environment to the extent practicable. Approximately 1200 discharges are reported annually to the DNR, and of those, approximately 65% are petroleum related, with another 15% being agrichemicals. The NR 700 Wis. Adm. Code series contains the requirements for notification and for taking immediate and/or interim actions when releases occur. Groundwater monitoring is performed when necessary to delineate the extent of contamination.

Pesticides

Pesticide contamination of groundwater results from field applications (i.e., nonpoint sources), pesticide spills, misuse, or improper storage and disposal (i.e., point sources). Serious concerns about nonpoint sources of pesticide contamination in Wisconsin were first raised in 1980 when aldicarb 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.

DNR expanded its sampling programs in 1983 to include analysis of pesticides commonly used in Wisconsin. Federal and state groundwater quality standards for many of these compounds were also adopted, and, to date, standards for over 30 pesticides are included in ch. NR 140, Wis. Adm. Code.

Pesticide and Groundwater Impacts Study - DATCP began a study in 1985 to determine if normal field application and use of pesticides and fertilizer was causing groundwater contamination problems. What began as a two-year study is now entering its 14th year. Currently, 26 monitoring sites are sampled annually for nitrate and common corn herbicides in highly susceptible areas of the state (e.g., Central Sands and Wisconsin River Valley). In 1998, 85% of these sites exceeded the enforcement standard (ES) for nitrate. The mean nitrate concentration at these sites was 23 mg/l, more than twice the enforcement standard. Atrazine and alachlor ESA are the most commonly detected pesticides. In 1998, atrazine and alachlor ethane sulfonic acid (ESA - a breakdown product of alachlor) exceeded their respective enforcement standard and Interim Health Advisory levels at 10% and 12 % of the sites tested.

Exceedence Survey - This program resamples wells that previously exceeded a pesticide enforcement standard. From 1995-1998 DATCP has conducted an annual sampling program called the *Exceedence Survey*. 145 wells have been resampled in this program for atrazine, deethylatrazine, deisopropylatrazine, diaminoatrazine, alachlor, alachlor ESA, cyanazine, metolachlor, metribuzin, and nitrate-nitrogen. Most wells are in atrazine prohibition areas. About 2/3 of the wells have had a decrease in atrazine concentration from 1995 to 1998. About 50% of the well owners who had a well with an ES exceedence still use their well for drinking water. This report is available by contacting the DATCP.

Monitoring Reuse of Atrazine in Prohibition Areas - In FY 98, DATCP began monitoring the limited reuse of the herbicide atrazine in selected areas of Wisconsin where its use has been prohibited since 1993 due to groundwater contamination. Chapter ATCP 31, Wis. Adm. Code, requires DATCP to gather scientific data to show if renewed atrazine use in these areas will cause further groundwater contamination. DATCP will test groundwater under 17 monitored fields (10-40 acres in size) quarterly for 5 years. Growers planted corn in the first year of the study and must plant corn in at least two other years, with atrazine applied to corn. Products containing cyanazine or simazine cannot be used on the monitored field during the study, but other pesticides and fertilizers can be applied as needed. Growers choose the tillage and pesticide application methods best suited for their operations. The monitoring wells will be removed at the end of the project. Although it is too early in the project to make recommendations, 1998 summary data showed that atrazine concentrations increased from spring to winter at all but one site. Atrazine concentrations were over the enforcement standard at 36% of sites in winter 1998, while the nitrate enforcement standard was exceeded at 86% of sites over this same sampling period.

Atrazine Rule Evaluation Survey - DATCP conducted this survey to evaluate the restrictions on the use of atrazine in Wisconsin. The purpose of the survey was to determine how levels of atrazine and its metabolites in groundwater were changing three and five years after the atrazine rule was put into place. The survey was conducted in two phases: phase one in 1994 and phase 2 in 1996. A total of 567 samples were collected from 429 wells (138 wells were sampled in both phases.) DATCP made statistical estimates of several atrazine properties in groundwater

including: the percent of Wisconsin groundwater containing a detectable amount of atrazine residues, and the concentration of atrazine and metabolites in wells with detectable levels. The results show a significant decline in atrazine concentrations in Wisconsin between 1994 and 1996. The average atrazine plus metabolite concentration in wells with detections declined from 0.96 to 0.54 ppb in the two year period, a 44% decrease. The percent of contaminated wells, however, did not show a significant decline.

Groundwater Survey for Alachlor in Southern Wisconsin - Since the late 1980s, DATCP has also initiated a number of surveys to investigate pesticides in groundwater resulting from nonpoint sources. A study completed in 1994 sought to determine the extent of alachlor and alachlor ESA contamination in Southern Wisconsin private wells. The study was conducted in 11 counties where alachlor sales and use have been concentrated. Test kits were sent to approximately 1300 homeowners whose wells had either a previous detection of a triazine-based compound or a previous detection of nitrate over 10 ppm. 669 samples were returned for immunoassay analysis (triazine screen) at DATCP's Bureau of Laboratory Services. Triazine-based compounds were detected in approximately 45% of these samples. Well owners with a detection were offered free follow-up sampling and more comprehensive laboratory analysis for alachlor, ESA, other commonly used pesticides, and nitrate. Two hundred ninety-three follow-up samples were analyzed. Follow-up analysis indicated that approximately 4.1% of the 293 follow-up samples had detections of alachlor and that 70.3% had detections of ESA. Alachlor was detected above the ES of 2.0 parts per billion (ppb) in six follow-up samples. ESA was detected above the Interim Health Advisory of 20 ppb in two follow-up samples.

DATCP plans to conduct site investigations around wells with alachlor exceedences of the ES or ESA exceedences of the Interim Health Advisory to identify the source(s) of groundwater contamination. Information from the investigations will be used to determine what actions DATCP will take in response to alachlor and ESA contamination in groundwater.

Triazine/Atrazine Split Sampling - In 1993, DATCP completed a study in cooperation with CIBA-GEIGY that involved splitting well samples for triazine screen and gas chromatographic analysis. The two main results were 1) low triazine detects were confirmed (i.e. the triazine screen was not producing false positives) and, 2) the triazine screen overestimates parent atrazine and underestimates total chlorinated residues.

Triazine Screen - Beginning in January of 1991, the Wisconsin State Laboratory of Hygiene (SLOH) initiated a testing program for the public based on the immunoassay screening test for triazine-based compounds. The triazine immunoassay screen is a test that uses specific antibodies (proteins produced by an immune system in response to the presence of a foreign substance) designed to selectively bind to target compounds present at low concentrations. Tests continue to be available to the public via a toll free telephone number and a small fee. The DNR is funding a part time staff position at the SLOH to assist in the quality control process for data collection from triazine screening samples.

Since the start of this program, DNR groundwater databases have amassed more than 10,000 individual results for drinking water wells from the triazine screen analysis. Data received from the SLOH indicates that approximately 42 percent of the samples indicated detection of a triazine-based compound. Approximately 17 percent of the samples have a result that exceeds the PAL for atrazine of 0.3 ppb, and approximately 1.7 percent have exceeded the ES of 3.0 ppb. Comparison to the ES and PAL is used only for reference since the immunoassay triazine analysis screens for ten compounds other than atrazine specifically, and does not detect two of the three atrazine metabolites included in the groundwater standard. Comparison to the ES and PAL for atrazine has some reference value because atrazine has been so heavily used in Wisconsin, and there have been few detects of the other triazine-based compounds in groundwater.

The SLOH can now screen for many other pesticides and has expanded the immunoassay screening program to include other pesticides as requested.

Nitrate

During the past year, DHFS received two reports of infants who may have been affected by nitrate-contaminated water. One of these cases involved a 6-month old Columbia County infant who was placed on bottled water after county health nurses noticed that he had a bluish skin color. No other medical treatment was required. A subsequent test of the well water that had been used to dilute his formula revealed a nitrate-N concentration of 22.9 mg/L. The second report was received from the DNR South Central Regional office. That case involved a 4-week old Grant County infant who was hospitalized at the University Hospital during the spring of 1999 for treatment of severe methemoglobinemia. Water collected from the family's well at the time of her illness had a nitrate-N concentration of 28.0 mg/L. DHFS staff plan to conduct a detailed investigation of this case.

Nitrate-nitrogen is the most common contaminant found in Wisconsin's groundwater. Detections of nitrate in private water supplies frequently exceed the state drinking water standard of 10 milligrams/liter (mg/l). Consumption of water that contains high concentrations of nitrate by infants under 6 months of age can induce a condition called methemoglobinemia or "blue baby syndrome." This condition occurs when red cell hemoglobin is oxidized to a form that is unable to carry oxygen to the body's tissues. All infants are at risk of nitrate poisoning, but those suffering from gastrointestinal illnesses appear to be more sensitive than healthy infants.

The chronic health effects of nitrate exposure are not well understood, however, many experts believe that long-term exposure may increase the risk of cancer. This theory is supported by some scientific studies. For example, in 1996 researchers in the Netherlands found that residents who consumed water that was high in nitrate had higher levels of cancer causing nitroso-compounds in their urine. These researchers also found that genes in the blood cells of these individuals had higher numbers of mutations. Two years earlier, these same researchers had reported a link between consumption of high-nitrate water and the incidence of thyroid disorders. In 1996, a study conducted jointly by the National Cancer Institute, the University of Nebraska, and Johns Hopkins University found an association between nitrate-contaminated water and Non-Hodgkin's lymphoma. A large cohort study conducted jointly by the University of Iowa, Mayo Clinic and the University of Minnesota found a positive association between nitrate levels in municipal water supplies and the incidence of bladder and ovarian cancer among adult women.

Currently, DHFS and the DNR recommend testing of all newly constructed private wells and wells that have not been tested during the past five years. Due to the concern over nitrate, the GCC endorsed a resolution in 1989 recommending that newly constructed water supply wells be sampled for nitrate in addition to coliform bacteria. Testing is recommended for wells used by pregnant women and is essential for wells that serve infants under 6 months of age.

Nitrate contamination of groundwater and surface water is difficult to prevent. Commerce continues to evaluate state-of-the-art septic system designs for nitrate removal. In addition, DATCP has been evaluating the need for regulation of nitrogen-based fertilizers. DATCP proposed regulatory authority for fertilizer use in the FY 96-97 budget but the proposal was not approved. A new nutrient management budget initiative was proposed in FY 97 that would give DATCP the authority to promulgate regulatory and non-regulatory rules related to nutrient management.

Biological Hazards

The DNR is aware of several areas in Wisconsin where biological contamination of the aquifer is common. Biological agents include bacteria, viruses, and parasites. These agents can cause acute illness and result in life-threatening conditions for some population groups. Approximately 23% of well water samples statewide test positive for total coliform bacteria, an indicator species of other biological agents. Approximately 3% of well water samples test positive for E. coli, an indicator of water borne disease that originates in the mammalian intestinal tract. The DNR recommends that well owners test for biological quality annually or when there is a change in taste, color, or odor of the water.

Natural Groundwater Quality

Natural groundwater quality varies greatly throughout Wisconsin. Undesirable constituents commonly found in Wisconsin groundwater include iron, manganese, sulfate, arsenic, and radioactive materials. High levels of iron have been detected throughout the state. High levels of manganese, arsenic, and sulfates are less commonly found and are more localized in extent.

Naturally occurring radioactivity in groundwater, including uranium, radium and radon, have become a concern in Wisconsin in recent years. The state has initiated programs to test groundwater for radioactivity. Recent sampling has identified radionuclides in groundwater in north-central Wisconsin. High levels of radium have also been found in water supplies in eastern Wisconsin. Studies have been initiated to examine the occurrence and extent of these naturally occurring contaminants.

CONDITION OF THE RESOURCE - GROUNDWATER QUANTITY

This is the Executive Summary of the "Status of Groundwater Quantity in Wisconsin" report published in April, 1997. The full report is available from the DNR and is downloadable from the world wide web at: <http://www.dnr.state.wi.us/org/water/dwg/gw/Pubdwnld.HTM>

Purpose of Report

In August of 1994, the Wisconsin Groundwater Coordinating Council (GCC) suggested that the Wisconsin Department of Natural Resources (DNR), in cooperation with the GCC and other interested parties, prepare a report describing groundwater quantity problems and issues in Wisconsin. This report was prepared by the Groundwater Section of the DNR's Bureau of Drinking Water and Groundwater with the assistance of a Technical Advisory Committee (TAC). The objectives of this report are to summarize what we know about Wisconsin's groundwater quantity problems; discuss information that is available on groundwater quantity and where more information is needed; and discuss potential options for addressing groundwater quantity issues.

Findings

Despite a general abundance of groundwater in Wisconsin, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural, and domestic use and for adequate baseflow to our lakes, streams, and wetlands. Groundwater quantity problems have occurred naturally and from human activities. Natural shortages of groundwater have occurred due to weather conditions (e.g., drought) and geologic setting (e.g., crystalline bedrock aquifer with low yields).

Human activities such as groundwater withdrawal and land use activities may also cause groundwater quantity problems. The effect of groundwater withdrawals are well documented on a regional scale in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. There are substantial declines in groundwater levels in these three areas.

Localized effects from groundwater withdrawals are not as well documented as the regional effects. Cases exist around the state where wells, springs, and wetlands have gone dry; lake levels have dropped; streamflow has been reduced; and contamination has prevented installation of new wells.

The availability of groundwater may also be affected by groundwater quality. The presence of naturally-occurring substances in groundwater (e.g., iron, sulfate, arsenic) or human-caused contamination has limited groundwater use in some areas.

Information from the U. S. Geological Survey (USGS) indicates water use in Wisconsin has increased steadily since 1950. Groundwater use grew from 570 to 754 million gallons per day (Mgal/d) from 1985 to 1995.

Groundwater withdrawals can affect both groundwater and surface water. Declining groundwater levels from pumping may increase pumping costs due to the need to pump water from a greater depth, dewater or mine an

aquifer until it no longer meets water supply needs, dry up nearby shallow wells (e.g., domestic wells), decrease baseflow (i.e., natural groundwater discharge) to lakes, streams, and wetlands, and cause surface water to recharge a depleted aquifer. A loss of baseflow may harm fisheries or wildlife habitat.

There is an ongoing effort by state and federal agencies and university staff to gather data and information on groundwater quantity issues. The Wisconsin Geological and Natural History Survey (WGNHS) and the USGS maintain a statewide groundwater-level observation network to evaluate short-term changes and long-term trends in groundwater levels. The USGS also maintains a network of streamflow gauging stations across the state to record surface water flow. Historical groundwater-level and streamflow data is valuable as we look at the relationship between surface water and groundwater.

Historically in Wisconsin, only a few research studies have focused on groundwater quantity issues. Currently, groundwater quantity studies are underway in Dane County, the Little Plover River Basin, the Lower Fox River Valley, and the Driftless Area. Because of the many factors involved, gathering definitive data on the effects of groundwater withdrawals is complex, time-consuming, and expensive. Additional information is needed to increase our understanding of groundwater-surface water interactions, identify areas with groundwater quantity problems, and determine the impacts of groundwater withdrawals.

Under Wisconsin Law, chapter 281, Wis. Stats. (formerly ch. 144), the DNR is the "central unit of government to protect, maintain, and improve the quality and management of the waters of the state, ground and surface, public and private.≡ The DNR carries out these responsibilities through its Drinking Water and Groundwater, Watershed Management, Waste Management, and Fisheries Management and Habitat Protection programs. The DNR regulates high capacity wells and surface water diversions. Other agencies involved in groundwater quantity issues include the WGNHS, Central Wisconsin Groundwater Center, GCC, Public Service Commission, the USGS, local units of government and water utilities.

Groundwater quantity will continue to be an issue of concern in Wisconsin. A coordinated effort is needed to determine appropriate management options for addressing groundwater withdrawals, to prioritize information needs, and to implement information and education programs. Funding is needed for additional data collection and research to address groundwater quantity management issues.

COORDINATION OF GROUNDWATER MONITORING AND RESEARCH

Four state agencies have had approximately \$750,000 available each year for groundwater-related monitoring or research. The sources of money and purposes of monitoring or research include:

1. DNR Management Practice Monitoring - The DNR has had approximately \$350,000 available each year since FY 86 up through FY 95 to support groundwater monitoring studies evaluating existing design and/or management practices associated with potential sources of groundwater contamination. Since FY 96 there was approximately \$200,000 to \$300,000 available for monitoring projects. Through FY 99, the DNR has spent approximately \$4.3 million on 157 monitoring projects. Seven projects have been co-funded with DATCP, four projects have been co-funded with the UW, and one project has been funded by DNR, DATCP and UWS. The money has come from the Groundwater Account of the Environmental Fund (which is funded by various fees). The intent of these studies is to reduce the impacts of potential sources of contamination by changing the way land activities which may impact groundwater are conducted.
2. UWS Groundwater Research - The UWS has received funding since FY 90 for groundwater research. The money is part of the base UWS budget. They received \$200,000 in FY 90 and \$300,000 annually since then. Through FY 99, the UWS has spent \$2.9 million on 77 groundwater research projects. Five of the 77 projects have been co-funded with DATCP, four have been co-funded with the DNR and one project was jointly funded by DNR, DATCP and UWS.

3. DATCP Pesticide Research - Since 1989, DATCP has had approximately \$125,000 available annually as a result of the pesticide law to fund research on pesticide issues of regulatory importance. The money comes from fees paid by pesticide manufacturers to sell their products in Wisconsin. Through FY 99, DATCP has spent about \$1,180,000 on 19 pesticide projects. Five have been co-funded with the UWS, seven have been co-funded with the DNR, and one project was jointly funded by DNR, DATCP and UWS.
4. DILHR/Commerce Private Sewage System Research - DILHR received a special GPR appropriation of \$50,000 from 1990 to 1993 to fund research on alternatives to current private sewage system technology (s. 145.20(5), Stats.) 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 99, DILHR/Commerce has spent approximately \$550,000 on five projects. Commerce opted not to participate in the joint solicitation for new projects in FY 98 or FY 99.

Approximately \$8.9 million has been spent through FY 99 on 249 different projects dealing with groundwater or related topics.

The GCC provides consistency and coordination among the four state agencies in funding groundwater monitoring and research to meet state agency needs. 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.

Based on discussions with the GCC, the GRAC prepared a groundwater research DIN for inclusion in the University's 1989-1991 biennial budget request. The GCC endorsed the DIN in 1988. The DIN was included in the governor's budget and was approved by the Legislature at a level of \$500,000 for the 1989-1991 biennium for groundwater research. This amount was increased to \$600,000 for the 1991-1993 and subsequent biennial budgets. 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.

To expedite this agreement, a MOU was signed in 1989 by representatives of the GCC, the GRAC, and the UWS on use of the UWS groundwater research funds. 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.

The UWS funded 19 groundwater research proposals during FY 90 and FY 91 with concurrence from the GCC. The results of the first studies that were funded by the UWS were published in October 1991 by the UW Water Resources Center in a report titled, "UWS Groundwater Research Program, Summary of 21 Projects."

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 plan is to determine the most appropriate funding source for a particular project.

FY 99 Joint Solicitation

The joint solicitation for FY 99 was distributed in October, 1997. A total of 30 project proposals were submitted in response to the joint solicitation. To assist in the review process, a joint meeting of the Monitoring & Data Management and Research Subcommittees of the GCC was held in January 1998 to review and rank the projects submitted for funding. As a result of the subcommittee meeting, the GRAC meeting in March, and review of the proposals by agency staff, 12 new projects were selected for funding in FY 99. Eleven on-going projects were carried over into FY 99. A total of 23 projects were funded through the joint solicitation at a cost of approximately \$680,000 (see Table 1).

FY 00 Joint Solicitation

A joint solicitation for project proposals by the UW System, DNR, and DATCP was distributed in October, 1998 for funding in FY 00. The deadline for proposals was December 1, 1998. The joint solicitation package contains a listing of the priorities for each of the agencies (see Appendix). The priority needs for the DNR's management-practice monitoring program for FY 00 were reviewed by the Monitoring & Data Management and Research Subcommittees of the GCC and DNR staff. The two subcommittees met in January to rank the 24 proposals submitted. Fourteen of the 24 proposals received will be funded in full or in part through the joint solicitation process. The projects to be funded in FY 00 are listed in Table 2.

In FY 96, the GCC began compiling information about other groundwater research programs. There was discussion at GCC meetings of groundwater-related research programs within and outside of Wisconsin. Groundwater-related research projects funded through the Fertilizer Research Council in FY 99 are listed in the Appendix.

The GCC resolved to contact other states with groundwater research programs to prevent research duplication and to make efficient use of limited research funds. A strategy for interstate coordination of groundwater research was developed which consists of identifying groundwater research program contacts in each neighboring state and sending each contact information on the GCC, the joint solicitation process, the state groundwater monitoring and research programs, and the project summaries. Initial contacts were made in FY 96 and have continued through FY 99.

Table 1 - Groundwater Projects Funded through the Joint Solicitation for FY 99
(Map numbers are for locating projects on the State map in Figure 1. * denotes continued project)

DNR Projects

* Relationships Between Water Quality in Stream Base Flow and Private Wells and Land use in the Tomorrow/Waupaca River Watershed. B. Shaw \$28,400 (Map #4)

* Determination of the Hydrostratigraphy of the Deep Sandstone Aquifer in Southeastern Wisconsin. T. Eaton \$27,578 (Map #6)

* Groundwater-Surface Water Interactions in the Nine Springs Watershed. J. Bahr \$46,382 (Map # 8)

Acute and Chronic Toxicity of Nitrate to Brook Trout (*Salvelinus fontinalis*). R. Crunkilton \$35,230

Makoqueta Shale as Radium Source to the Cambro-Ordovician Aquifer System. T. Grundl \$29,987 (Map #18)

Mechanical Controls on Fracture Development in Carbonate Aquifers: Implications for Groundwater Flow Systems. M. Cooke \$27,967 (Map #19)

Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers. W. Hickey \$45,198 (Map #20)

Viral Contamination of Household Wells Near Disposal Sites for Human Excreta. M. Borchardt/W. Sonzogni \$48,384 (Map #21)

The total cost for all projects funded by the DNR through the FY 99 joint solicitation process is \$289,126.

UWS Projects

* Investigation of Air Sparging: Numerical Modeling, Laboratory Verification and Design Guidelines. J. Hoopes \$22,337

* Watershed-Scale Nitrate Contamination and Chlorofluorocarbon Ages in the Little Plover Basin: A Study at the Groundwater/Surface Water Interface. B. Browne \$29,900 (Map #13)

* Determining Ground-Water Recharge Rates in Southern Washington County. D. Cherkauer \$28,048 (Map #14)

* Evaluation of Exploration Borehole Seals Using Time Domain Reflectometry (TDR). T. Edil \$27,469

Sedimentology, Stratigraphy, and Porosity-Conductivity Relations of the Silurian Aquifer of Ozaukee County, Wisconsin. M.Harris \$24,206

Hydraulic Conductivity and Specific Storage of Maquoketa Shale. H.Wang \$22,284 (Map #22)

A Rational Design Approach for Permeable Reactive Walls. C. Benson \$26,282

Water and Land Use: Interpretation of Existing Data to Foster Constructive Public Dialogue and Policy Formulation H.Read. \$13,760

Groundwater Flow and Heat Transport in Wetlands: Transient Simulations and Frequency-Domain Analysis. H. Bravo \$21,781 (Map #23)

Monitoring: Evaluation of the Abundance, Diversity, and Activity of Methanotroph Populations in Groundwater. M. Collins \$ 25,898

Natural Attenuation of Fuel and Related Groundwater Contaminants - A Measurement Method. W. Sonzogni \$14,754

The total cost for all projects funded by the UWS through the FY 99 joint solicitation process is \$281,980

UWS/DATCP Co-Funded Projects

* The Direct Effect of Agricultural Chemicals on Wisconsin's Declining and Endangered Amphibians. W. Karasov \$13,893 UWS/ \$13,893 DATCP

On-line SFE/GC for Improved Detection of Trace Organic Pollutants in Ground Water Monitoring. D. Armstrong \$11,368/11,368

DATCP Projects

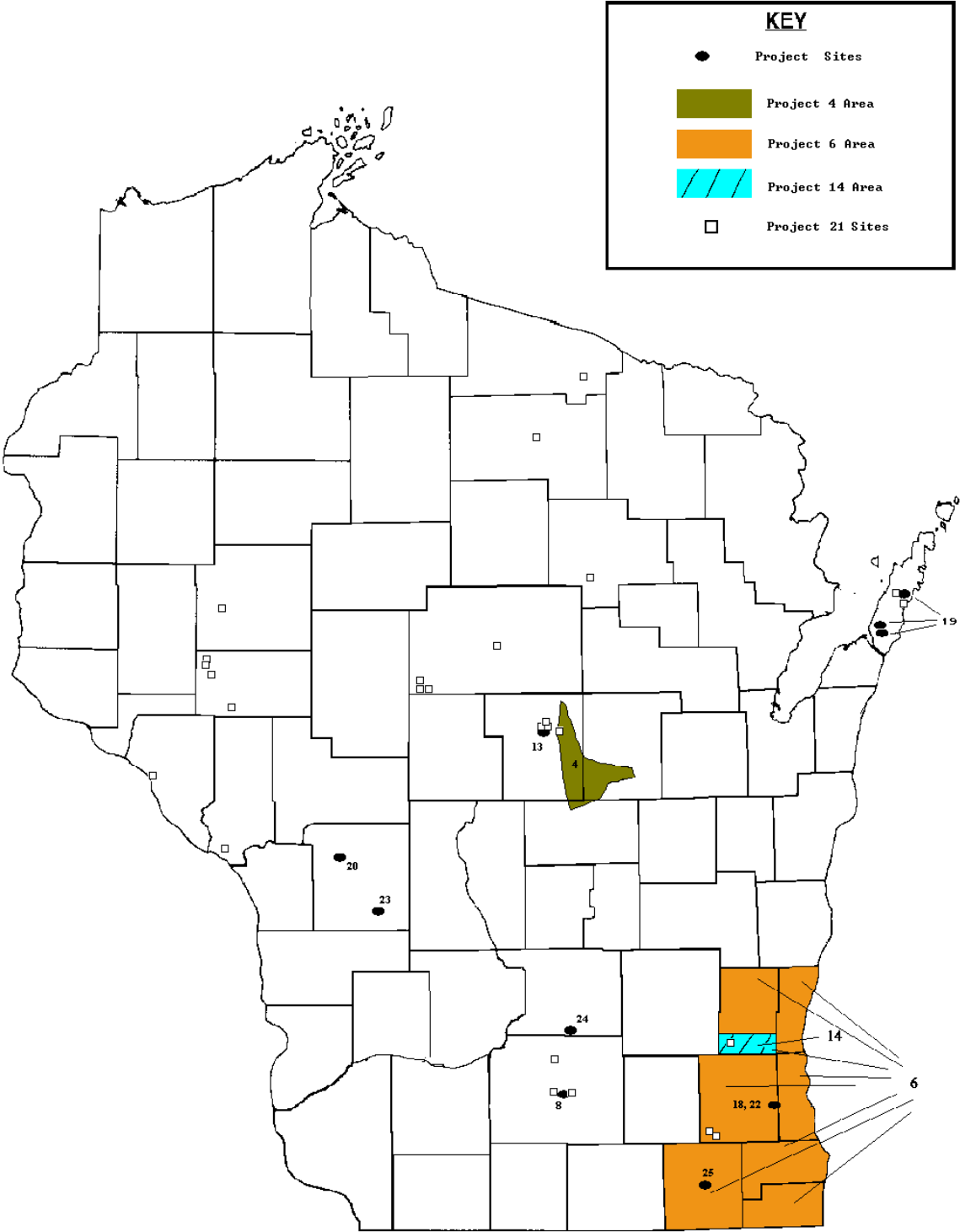
* Fate of the Herbicides Atrazine, Cyanazine, and Alachlor and Selected Metabolites. D. Stoltenberg \$32,272

* Using Geographic Information Systems and Soil Landscape Models to Predict Critical Sites for Nonpoint Source Pollution B. Lowery \$22,950 (Map #24)

* Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems. K-J. Kung \$25,000 (Map # 25)

The total cost for all projects funded by the DATCP through the FY 99 joint solicitation process is 105,483.

Figure 2 – Locations of Groundwater Projects Funded through the Joint Solicitation in FY 99



**Groundwater Projects Funded Through
the Joint Solicitation For FY 99**

Table 2 - Groundwater Projects to be Funded Through the Joint Solicitation for FY 00

DNR Continuing Projects

Acute and Chronic Toxicity of Nitrate to Brook Trout (*Salvelinus fontinalis*). R. Crunkilton \$28,745

Makoqueta Shale as Radium Source to the Cambro-Ordovician Aquifer System. T. Grundl \$29,962

Mechanical Controls on Fracture Development in Carbonate Aquifers: Implications for Groundwater Flow Systems. M. Cooke \$29,605

Analysis of Microbiological and Geochemical Processes Controlling Biodegradation of Aromatic Hydrocarbons in Anaerobic Aquifers. W. Hickey \$48,028

Viral Contamination of Household Wells Near Disposal Sites for Human Excreta. M. Borchardt/W. Sonzogni \$49,881

The total cost for all continuing projects funded by the DNR through the FY 00 joint solicitation process is \$186,221

DNR New projects

Refinement of two methods for estimation of groundwater recharge rates. K. Bradbury, M. Anderson and K. Potter \$27,365

Field verification of capture zones for municipal wells at Sturgeon Bay, Wisconsin. K. Bradbury, T. Rayne M. Muldoon \$11,879

Improvement of Wisconsin groundwater monitoring network. Alex Zaporozec \$9,880

Evaluating options for changing groundwater and leachate monitoring requirements for landfills to reduce mercury used by laboratories. J. Connelly, R. Stephens and B. Shaw \$22,950

The total cost for all new projects funded by the DNR through the FY 00 joint solicitation process, including the co-funded projects below is \$115,3212

The total cost for all projects funded by the DNR through the FY 00 joint solicitation process is \$301,542.

DNR/UWS co-funded new project

Remediating groundwater using reactive walls containing waste foundry sands. C. Benson and G. Eykholt DNR \$27,496, UWS \$7,000

DNR/DATCP co-funded new project

A groundwater model for the Central Sands of Wisconsin: Assessing the environmental and economic impacts of Irrigated agriculture. Martha Anderson, W. Bland and G. Kraft DNR \$15,751, DATCP \$15,751

UWS Continuing Projects

Sedimentology, Stratigraphy, and Porosity-Conductivity Relations of the Silurian Aquifer of Ozaukee County, Wisconsin. M.Harris \$18,000

A Rational Design Approach for Permeable Reactive Walls. C. Benson \$27,500

Groundwater Flow and Heat Transport in Wetlands: Transient Simulations and Frequency-Domain Analysis. H. Bravo \$19,500

Monitoring: Evaluation of the Abundance, Diversity, and Activity of Methanotroph Populations in Groundwater. M. Collins \$ 22,000

The total cost for all continuing projects funded by the UWS for FY 00 is \$87,000

UWS New Projects

Hydraulic Conductivity and Specific Storage of Maquoketa Shale. H.Wang \$27,150

Macropore flow: A means for enhancing groundwater recharge or a potential source of groundwater contamination. K. Potter and P. Bosscher \$5,941

Development of neural network models for predicting nitrate concentration in well water. H. Lin and B. Shaw \$26,193

Time domain electromagnetic induction survey of eastern Waukesha County and selected locations. J.Jansen and R. Taylor \$26,035

Field monitoring of drainage and nitrate leaching from managed and unmanaged ecosystems. J. Norman and K. Brye \$29,974

Compatibility of containment systems with mine waste liquids. T. Edil and C. Benson \$23,812

Causes of historical changes in ground-water recharge rates in southeastern Wisconsin. D. Cherkauer \$31,609

Admicelle-catalyzed reductive dechlorination of PCE by zero valent iron. Z. Li \$18,552

The total cost for all new projects funded by the UWS through the FY 00 joint solicitation process including the co-funded project above is \$196,266

The total cost for all projects funded by the UWS through the FY 00 joint solicitation process is \$283,266

Continued DATCP Projects

Using Geographic Information Systems and Soil Landscape Models to Predict Critical Sites for Nonpoint Source Pollution. B. Lowery \$22,950

Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems. K-J. Kung \$25,000

The total cost for all projects funded by DATCP through the FY 00 joint solicitation process, including the co-funded project above is \$63,701

BENEFITS FROM MONITORING AND RESEARCH PROJECTS

Table 3 (see Appendix) is a list of groundwater-related monitoring and research projects funded by state agencies since enactment of Wisconsin's comprehensive groundwater protection legislation (1983 Wisconsin Act 410) in 1984. Those agencies which have funded projects are the DNR, DATCP, DILHR/Commerce, and the UWS. There are 228 projects listed. One hundred-thirty-three of these projects have been funded through the joint solicitation process which began in FY 92. The remaining projects were funded by the above agencies through separate solicitation processes prior to 1992. The table includes the project title, principal investigator or investigators, the years the project was funded, the funding agency or agencies, and the project number if assigned.

Many projects have provided valuable information 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. A number have provided valuable information regarding the state's groundwater resources. Others have developed new methods for groundwater evaluation and protection. The following discussion highlights some of the areas that have been the focus of research and monitoring projects and illustrates how agencies have used the project's results to improve the management of the state's groundwater resources.

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 many questions regarding the sources, groundwater susceptibility, and the presence of pesticides other than atrazine unanswered. 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 (Postle, 1986-96) for pesticides 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 Solid Waste Management (SWM) program received project funding eight times from 1985 to 1995 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 unengineered 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 unengineered 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 which confirmed that these sites are performing as SWM program staff had hoped. The results of the three VOC studies have been used to establish requirements for VOC sampling at new and existing landfills. These studies have also indicated that inorganic compounds could be useful in predicting VOC contamination at landfills. Therefore, until recent EPA rules required VOC monitoring, the SWM program allowed sites to sample for inorganic parameters as part of routine monitoring and not sample VOCs until inorganics were elevated. The VOC studies provided valuable data which was used to convince EPA to reduce the number of VOCs required for monitoring at municipal solid waste landfills in Wisconsin. This reduction in monitoring (the use of inorganics and the reduced number of VOCs when

they are required) allowed landfill owners considerable cost savings while maintaining equivalent environmental protection. Additionally, the VOC data was used to require responsible parties to define the degree and extent of contamination and remediate groundwater contamination at their landfills.

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

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

Three studies from 1991 to 1994 on the potential groundwater impacts at deer pits, yard waste sites, and construction and demolition landfills (Pugh, 1992-3; Pugh, 1994) were conducted because little or no data existed on the potential impact to groundwater from these sites. Research has provided the information necessary to revise rules and establish policy regarding monitoring and siting of construction and demolition (C/D) landfills, deer pits, and yard waste sites in Wisconsin. The groundwater study of deer pits showed that impacts were minimal and helped the SWM program to decide not to require liners and to loosen some construction and reporting requirements. Similarly, the yard waste site study showed only minor groundwater impacts, which led the SWM program to encourage active management of these sites rather than stiffen regulations. The study of construction and demolition landfills showed some groundwater impacts at large sites but little or no impacts at smaller sites. These findings led to new regulations (effective June 1996) allowing lined intermediate size C/D landfills, which can provide the economic benefits of a large site without the potential negative impacts of very large sites. Based on the research, the regulations were written to require groundwater monitoring of inorganic parameters at small size C/D landfills but only require VOC sampling when establishing background. Since these studies have been conducted, many states and the EPA have contacted the SWM program about the information collected.

A more recent DNR-funded study undertaken by the SWM 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 SWM program opposed this ban because many Wisconsin monitoring wells produce very turbid water which can lead to false positive results for metals if samples are not filtered. Additionally, the new EPA-recommended procedure, low-flow pumping, requires a significant amount of additional equipment. The study showed that the low-flow pumping method was appropriate in many circumstances but could not be used to sample slowly recovering wells. The results showed that turbidity was the best indicator that a well has been sufficiently purged. The results of the investigation are being used to revise groundwater sampling procedures required by the SWM 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 SWM 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.

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

priority for removal (Door County Lead Arsenate Mixing Sites). In an Arsenic Advisory Area (AAA), well construction criteria were defined to avoid arsenic associated with a mineralized zone located at the contact between the St. Peter Sandstone and the Galena-Platteville Dolomite. The DNR coordinated with the DHFS to conduct health surveys on individuals consuming locally contaminated water supplies and made appropriate health recommendations. Local County Health Departments in affected areas are also actively monitoring groundwater quality and are providing assistance to homeowners. Ongoing research indicates that casing off the upper parts of the St. Peter Sandstone is effective in eliminating or reducing the presence of arsenic in drinking water. DNR guidance recommends the installation of 80 feet of casing through the sandstone for drinking water wells in the AAA. However, in an effort to save costs, the majority of well drillers are not following the recommendations. A current study appears to indicate that shorter casing lengths (~40 feet) may also be adequate in reducing the risk of arsenic exposure. Over the last several years, some wells that were not constructed according to guidance have exhibited increasing arsenic concentrations over time and have required replacement or reconstruction. It doesn't appear that the overall level of arsenic is increasing. The latest study recommends a required casing length in a couple of townships, but that overall in the AAA, recommendations should remain in place. The study also recommends that more education about potential signs of arsenic bearing rock should be provided to area well drillers.

Groundwater Movement in Fractured Dolomite - Door County has been the site of three research projects by the WGNHS to develop a framework for studying the complex groundwater flow regime in fractured rock found in many parts of the state. The first project (Bradbury, 1986-90) started as a nonpoint source watershed project investigating the hydrogeology and groundwater geochemistry in the shallow fractured dolomite aquifer in Door County. Groundwater quality was found to vary widely over time with bacteriological contamination common. The second study (Bradbury, 1992) showed that modeling results obtained from a discrete fracture model varied considerably from results produced by a continuum model for groundwater movement. The discrete fracture model estimated capture zones, groundwater flow paths, and groundwater travel times by using mathematical representations of fractures digitized from aerial photos. The third study (Bradbury, 1993-94) used a tracer for characterization of groundwater movement and contaminant transport. It revealed that hydraulic conductivity can vary widely in the same well depending on what depth interval is tested.

A fourth study applied the discrete fracture flow model above to wellhead protection at the City of Sturgeon Bay. The project, carried out by the WGNHS, was funded jointly by the City and by DNR Management Practice Monitoring moneys. Municipal wells at Sturgeon Bay draw groundwater from a series of horizontal fracture planes in Door County's dolomite aquifer, and delineating wellhead protection areas in such environments is extremely challenging. This complex project has required hydrogeologic information and analytical tools developed through the three Door County groundwater research projects above which targeted processes and models for groundwater movement in fractured rocks. Without the knowledge and experience gained through these previous projects the Sturgeon Bay Wellhead Protection Project could not have been accomplished.

The investigators involved in the above studies were instrumental in putting on a research conference titled: *Fluid Flow in Carbonates: Interdisciplinary Approaches* in September 1998 in Door County. The conference brought together a multidisciplinary group of scientists interested in all aspects of fluid flow in carbonate rocks. The conference attracted 60 geoscientists, including geologists, hydrogeologists, reservoir engineers, and regulatory officials, from North America and Northern Europe. Discussions emphasized integrated case studies of fluid flow in carbonates from regional to site-specific scales, characterization of porosity and permeability, diagenesis, geologic models, field characterization of flow, and fluid-flow and geologic models.

Developing New Tools for Groundwater Protection - Applications of a wide variety of tools for gathering and working with hydrogeologic and groundwater quality data have been funded. Projects involving one of the most promising tools in environmental management, Geographic Information Systems (GIS) have been funded in the Lake Michigan District and in Dane County. The funding agencies hope to continue to develop improved methodologies to make groundwater quality and contaminant source data more readily available.

An environmental inventory utilizing GIS was created in the DNR's Lake Michigan District (Carlson, 1992-93;

Stoll, 1994). Computerized maps were created which link all potential groundwater impact site locations with their respective data. This project has resulted in numerous map products showing potential groundwater contamination source/receptor relationships in a rapidly retrievable, highly summarized fashion. Many consultants, county agencies, state agencies and realtors have utilized this information for environmental management and land transactions. The chief benefits to the public have been the rapidly accessible information and greater purchasing confidence when buying property. Landowners also experience increased responsibility for the land they reside on as they become aware of how readily available this information is. In this way, use of GIS has heightened awareness of the importance of wise land use.

Previous support of county-wide groundwater inventory studies and of modeling methodologies has given WGNHS and USGS personnel the hydrogeologic databases and analytical tools needed for the construction of regional groundwater models such as the recently completed Dane County groundwater model. This computer model, which covers all of Dane County, simulates current and future groundwater conditions and is being used to evaluate how current and future groundwater pumping affects regional water levels and also how groundwater use affects shallow lakes, streams, and wetlands. In addition, this model has been used to delineate groundwater capture zones for all municipal well in Dane County. Such models are critical tools in the planning process, and allow water managers to evaluate the impacts of various future water management and land use alternatives in order to make well-informed land-use decisions. Two projects were funded in FY 98 to gather data for a similar project in Southeast Wisconsin.

Prevention and Remediation of Groundwater Contamination - Fifteen research projects emphasizing new technologies for prevention or remediation of groundwater contamination have been supported by the State of Wisconsin through the UWS Water Resources Center. Several of these projects have been completed. Final technical reports are published or in press. The reports and studies in progress provide information or products which will be important for future efforts aimed at controlling or attenuating groundwater contamination in Wisconsin. The findings cover a wide range of technologies including:

- New and enhanced physicochemical or biological methods to renovate waters contaminated by pesticides and volatile organic carbon compounds (Hoopes, 1997-98), (Hickey, 1996), (Bahr, 1996), (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 contaminants to groundwater (Edil and Park, 1992-93), (Benson, 1995-96);
- Improvements in the predictability of pump-and-treat remediation applications to contaminated aquifers (Bahr, 1994-95);
- Innovative agricultural practices designed to reduce groundwater contamination by pesticides and nitrate (Bundy, 1993-94), (Bahr, 1991-92), (Harrison, 1992-93), (Newenhouse, 1995); and
- Development of new technologies for evaluating the integrity of water supply well and exploration borehole seals (Edil, 1996), (Edil and Benson, 1997-98).

Effects of Groundwater Contamination on Real Estate Values - G. William Page and Harvey Rabinowitz of the University of Wisconsin-Milwaukee School of Architecture and Urban Planning studied the effects of groundwater contamination on commercial and residential property values. Their report affirms that groundwater contamination adversely affects the value of real estate as perceived by prospective buyers and sellers. The value of such real estate is reduced to its "value-in-use" rather than its market value. Thus, it is frequently impossible to sell such real estate or even to use it as collateral for a loan because, in the case of a default, the lending institution would not be interested in taking the property through foreclosure for fear of liability. They find that the fear of groundwater contamination is so pervasive that even local governments are beginning to shy away from taking selected buildings *in lieu* of taxes owed. For example, the City and County of Milwaukee holds off for approximately 3 years, while charging interest, before initiating proceedings to take a property *in lieu* of those taxes. The City's recent experiences with several groundwater contaminated properties in which the clean-up costs exceeded the normal market value of the property by a factor of 10 to 20 has required a policy change. Many of these kinds of properties are now left abandoned across the United States and municipalities are reluctant to fence in or manage the properties because they may lead to liability as has been determined in several court cases in different states. Thus their "use-value" is characterized by negative impacts on property tax bases which often extends to the

neighborhoods where the contaminated properties are located. The report covers Federal and State and Local Government Regulations of contaminated properties and regulation by the marketplace which includes owners, lessees, financial institutions, secondary mortgage companies, appraisers, insurance companies (title, property, and liability), law firms, and real estate brokers.

Biological Effects of Groundwater Contaminants - At the urging of the GRAC, the UW-WRC has solicited research projects during the last 4 years that deal with biological aspects of groundwater contamination. Two of the 5 biological projects, which have been supported, deal with cooperative biological effects among chemical contaminants. This is a subject of widespread current interest because synergistic interactions among chemical contaminants can often greatly enhance or diminish the toxicity of individual components of a mixture. Warren Porter of the UW-Madison Department of Zoology has completed an evaluation of interactions between endocrine disruptors (PCBs, phthalates, etc.) and a common groundwater contaminant (nitrate). Gordon Chesters and Harry Read of the UW-Madison WRC recently completed a DATCP supported project that focuses on biological interactions between different herbicides and the modulation of these interactions by common agricultural chemicals (e.g., nitrate). There is a great deal of current interest in these types of interactions because environmental toxicologists have heretofore focused exclusively on evaluations of the biological effects of individual chemicals which does not effectively encompass the environment of these compounds in the real world.

Mary Lynne Perille Collins of the UW-Milwaukee Department of Biological Sciences completed a 2 year project during FY 98 that was aimed at providing a biological probe for methanotrophic bacteria. Methanotrophs are among the most promising of microbial mono-oxygenase bacteria with a capacity to facilitate remediation of groundwater contaminated with a variety of pervasive organic chemicals. The goal of the project is to design and produce molecular probes for methanotrophs by taking advantage of DNA sequence information that has recently become available. These probes can be used to rapidly and efficiently monitor specific methanotrophic growth and metabolic phenomena at treated sites and to relate these activities to diverse in situ environmental conditions that are likely to affect the success or failure of the remediation effort. George Blondin of the UW-Madison WRC recently completed a 1-year project aimed at providing a statistical model for assembling the most efficient suite of biological test regimes to monitor the biological activity of a complex water sample containing any number and kinds of suspected contaminants. The project addresses the proliferation of new, rapid, and cost effective microbiotests that have evolved as commercially available toxicity monitoring products over the past several years. Since all microbiotests have inherent biases in terms of their biological response to different classes of contaminants, test suites of a few different microbiotests are usually employed to provide the needed biological diversity to effectively accommodate a given array of suspected contaminants. Unfortunately, test suite components are usually assembled on the basis of intuition or familiarity. This project's goal is to provide a PC based statistical model that will enable the more rigorous assembly of the most efficient test suite. William Karasov of the UW-Madison Department of Wildlife Ecology has recently initiated a new biological study of a possible relationship between common agricultural chemicals and Wisconsin's declining and endangered amphibian population.

Evaluating Nonpoint Source Pollution Reduction Strategies - Nonpoint pollution is the primary source of groundwater contaminants in Wisconsin. Several water quality projects have been undertaken to reduce groundwater nonpoint source pollution, but outcomes have been difficult to establish (Kraft, 1996). The CWGC has concluded monitoring and modeling studies in the Central Sands region which indicate current strategies may not be substantially improving groundwater quality. In the Port Edwards Groundwater Priority Watershed, nitrate loading was still large under agricultural Best Management Practices, in excess of 100 lb/acre as nitrate-N. Five pesticides were detected beneath BMP fields, sometimes in excess of the enforcement standard. For the area around Stevens Point, Whiting, and Plover, agriculture contributes 90% of nitrate to groundwater. Even if 100% of farmers adopt BMPs, nitrate-N concentrations will continue to increase there. New and better strategies are needed to control groundwater pollution.

GROUNDWATER DATA MANAGEMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

The collection and coordination of groundwater data exchange within the DNR and with outside agencies is a continuing priority. The Department continues to focus on the collection and retrieval of groundwater data to meet inter-agency responsibilities and cooperative agreements.

DNR's groundwater data retrieval system, the Groundwater Retrieval Network (GRN), available since 1993, currently has access to information on over 214,873 wells. These represent public and private water supply wells, piezometers, monitoring wells, and non-potable wells. Enhancements to the system, suggested by regional and central office staff, are implemented annually, to improve system functionality and ease of use. The current GRN system links to data systems in the Bureaus of Waste Management and Drinking Water and Groundwater for retrieval. A link to the Watershed Management program's wastewater data system will be made when a redesign for that system is completed. New GRN user documentation is available and training can be provided upon request.

A statewide Geographic Information System (GIS) coverage of well locations is maintained through an update link with GRN. Several options on the GRN program menu allow users to extract well and sample information in comma delimited text format. Using ArcView (a desktop GIS software package produced by the makers of ARC/INFO), GRN data can be used to create a personal computer well GIS "layer" for viewing and querying purposes. Data can also be provided in other GIS formats upon request through the use of ARC/INFO.

An internal project solicitation to allocate groundwater programming hours for two full time programming staff is conducted each year. This is done to continue to develop DNR groundwater systems, databases, and applications. The solicitation develops a list of projects and expected completion hours for the following fiscal year starting in July. Four bureaus participate in the solicitation process within the Department. Staff from outside DNR are contacted each year for project ideas to enhance existing groundwater related systems.

Last October, the Department launched a new initiative to begin labeling monitoring wells with the Wisconsin Unique Well Number. Along with the labeling initiative, Groundwater staff developed a computer program to allow entry, editing, printing, and data sharing from six Department well-related forms. The program provides a way of electronically entering, managing, and sharing that information with DNR staff and others using the software. Information received from this electronic format is being used to develop a statewide database of monitoring wells. Before this program, only paper copies existed which were not consolidated in a centralized location for access.

The Bureau of Remediation and Redevelopment (RR) is beginning to move their Bureau of Remediation and Redevelopment Tracking System (BRRTS) toward a web interface. Work is underway to provide a limited set of queries against information from basic events and site specific information from the Department's Soil and Groundwater Clean-up programs. Much of the BRRTS database is already available through files posted on the RR web site ([Http://www.dnr.state.wi.us/org/aw/rr/index.htm](http://www.dnr.state.wi.us/org/aw/rr/index.htm)).

The Bureau of Waste Management is beginning to explore the issue of providing a web interface to some of their Groundwater and Environmental Monitoring System (GEMS) data. Within the last two years, a revised mandatory electronic data submittal format was implemented for landfill monitoring data. The Bureau is also exploring the development of data submittal through the world wide web, by allowing entry directly online.

The Bureau of Watershed Management's new System for Wastewater Applications, Monitoring, and Permits (SWAMP), designed to managing wastewater facilities and permitting is nearing completion. Current data for facilities, outfall monitoring, and permitting applications is already online. Data from monitoring wells around landspreading and waste treatment sites will be online by September, 1999. All historical data will be added within a few months.

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION

DATCP needs up-to-date, reliable data about pesticide and nitrate-N contamination of groundwater. DATCP uses these data to develop substance specific rules about pesticide use, such as DATCP's "Pesticide Product Restrictions" (Chapter ATCP 30, Wis. Adm. Code), to respond to citizen requests on groundwater quality data for specific locations, and to initiate timely investigations of pesticide contamination of groundwater. DATCP ensures the quality of its database by carefully checking and cross-referencing paper lab slips and computerized data received from DNR, DATCP's laboratory, and other sources. This scrutiny is important, because DATCP uses these data for regulatory purposes. DATCP also works closely with other local and state agencies to coordinate groundwater data collection and to improve the integrity of groundwater data in Wisconsin.

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 wells drinking water wells. The *Monitoring Well System* contains similar information for monitoring wells, and also tracks specific pesticide use history, soils, crop history, well construction, and precipitation and irrigation at monitored sites.

DATCP's *Drinking Water Well System* currently contains information for over 20,500 wells and over 60,000 pesticide and nitrate-N results. These data represent samples analyzed by DATCP, SLOH, and other public and private laboratories. Both of these multi-user database applications will be converted from Paradox to Access97/SQL Server applications in FY 99 to: (1) meet state database and operating system (Windows NT) standards, (2) improve compatibility of data with other established database systems, and (3) begin improving links between these databases and our geographic information system (GIS) tools. Members of DATCP's Groundwater Protection Unit and its Containment and Remediation Unit access the database.

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

WISCONSIN-EXTENSION GEOLOGICAL AND NATURAL HISTORY SURVEY

The University of Wisconsin-Extension Geological and Natural History Survey has responsibility for geologic mapping, collection and analysis of basic data, and survey and research on Wisconsin's groundwater resources. Products from the Survey geologic mapping program support land-use planning and groundwater quality management and protection. County-wide inventories of groundwater resources are supported through cooperative agreements with county governments. Through analysis and integration of data from subsurface records and water quality sampling programs, these studies develop water table elevation maps and other products, providing planners and educators with a good foundation of information for groundwater quality management and protection. Detailed research and monitoring of groundwater movement and quality are undertaken on a project basis. Maps, publications, and presentations are developed for groundwater education and outreach.

Computerized groundwater databases have generally been developed on a project basis to support on-going research and inventory efforts. Many of these data have been incorporated into the Geographic Information Systems (GIS) software. The Survey is continuing initiatives to better integrate, standardize and document their data holdings, which are currently on a variety of personal computers, media and software systems. This effort will improve access and use of our existing and future groundwater and geologic data.

DEPARTMENT OF COMMERCE

Commerce has embarked on an information technology initiative, the purpose of which is data integration. With regard to groundwater protection, commerce will, at the completion of this project, be able to identify sites that have underground petroleum storage tank systems, groundwater and soil remediation and private sewage systems. Sanitary permit information will ultimately be combined with a database that will track maintenance and/or inspection of all private sewage systems.

UNIVERSITY OF WISCONSIN SYSTEM

The Central Wisconsin Groundwater Center maintains a database of private well testing data from the Environmental Task Force Regional Laboratory at UW-Stevens Point, and Drinking Water Education Programs conducted through the Center. There are currently nearly 258,000 individual test results for approximately 40,000 samples covering the state. Chemistry data includes pH, conductivity, alkalinity, total hardness, nitrate-nitrite, 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. 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. Thirty-nine counties are represented by 100 or more samples in the databases, and 20 counties are represented by 500 or more samples.

DEPARTMENT OF TRANSPORTATION

The DOT maintains records of hazardous material investigations associated with highway projects. Records of hazardous materials encountered during these investigations, including any groundwater contamination, are on file in the Bureau of Environment.

Groundwater monitoring is conducted in association with several DOT wetland mitigation projects. The records of this monitoring effort contain information on groundwater elevation, and horizontal and vertical groundwater gradients as it relates to a wetland restoration or creation project.

The DOT has developed a database to incorporate information from wetland delineations, contaminated sites, and groundwater monitoring sites. This database is under going testing and validation. The intent is to eventually incorporate this information into standard GIS mapping to use for transportation planning, design, construction, and maintenance.

DEPARTMENT OF HEALTH AND FAMILY SERVICES

DHFS does not maintain a centralized database on groundwater data. The Department relies on other state agencies for computerized groundwater information.

COORDINATION ACTIVITIES

GROUNDWATER COORDINATING COUNCIL

The Groundwater Law, 1983 Wisconsin Act 410, established the GCC to advise and assist state agencies in coordinating nonregulatory programs and exchanging groundwater information. 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 who have groundwater responsibilities to sit on the Council. The state agencies include the DNR, Commerce, DHFS, DATCP, DOT, WGNHS, and the UWS. Additionally the

DNR has one permanent position with half of its responsibilities related to coordination of the GCC. The GCC had four meetings during the past year. The meeting minutes are included in the Appendix.

The focus of the GCC's activities during the past year changed as past goals were attained and future goals were refined. Accomplishments came as a response to new opportunities for groundwater management.

- The GCC and the UWS GRAC continued coordination of the annual solicitation for groundwater research and monitoring proposals among state agencies. Twenty-four projects were funded in FY 99 by one or more of the following agencies: UWS, DATCP, DNR and Commerce. The projects funded are listed in Table 1. The GCC approved the FY 00 joint solicitation package for groundwater research and monitoring to meet state needs described in a previous section. The package was sent out in October 1998 and is contained in the Appendix. A total of 24 project proposals were received. A comprehensive review process ensued that resulted in the selection of 14 new projects for funding for FY 00. The 16 new projects selected by the UWS, DNR, and/or DATCP for funding in FY 00 are in addition to 11 projects that were carried over from FY 99. At their February 26, 1999, meeting the GCC unanimously approved the proposed UWS groundwater research plan as required by s. 160.50(1m), Wis. Stats. The UWS will fund 4 continuing and 9 new projects in FY 00. The FY 00 groundwater monitoring and research projects are listed by funding agency in Table 2.
- The GCC worked with the Wisconsin Water Well Association to coordinate of groundwater displays at the Capitol Rotunda Educational Event during the State's Groundwater Protection and Awareness Week on Feb 2-4, 1999. A brochure titled Meet the Groundwater Coordinating Council was produced for the event. The Research Subcommittee assisted in organizing poster exhibits for a display. Fifteen researchers prepared poster displays on projects recently funded through the joint solicitation process, and these researchers were present in the Rotunda to explain their posters and answer questions. The Education Subcommittee organized state and federal agency displays, a water testing booth and a groundwater presentation by high school students. Approximately 30 Legislators and numerous members of the public attended. This event was well received.
- Through several of its subcommittees, the GCC continued to address important data management issues. Data management activities include:
 - ◇ Five electronic forms (well construction report, well/drillhole/borehole abandonment, monitoring well development, soil boring log information, monitoring well information) were released to facilitate electronic data submittal.
 - ◇ A project to eliminate duplicate Wisconsin Unique Well Numbers (WUWN) was initiated.
 - ◇ WUWN labels were made available for monitoring wells in addition to water supply wells.
 - ◇ A project to make scanned images of well construction reports available was initiated.
- The GCC continued to promote communication, coordination, and cooperation between the state agencies through its quarterly meetings. The GCC received briefings and heard presentations on:
 - ◇ Subcommittee activities (see below)
 - ◇ FY 00 Joint Solicitation
 - ◇ FY 1998 GCC Report to the Legislature
 - ◇ Water Resources Institute/Sea Grant merge
 - ◇ GCC web site
 - ◇ Source Water Assessment Program
 - ◇ UWS FY 00 Groundwater Research Plan
 - ◇ Triazine Screen reporting language
 - ◇ ATCP 29, 30 and 31 revisions
 - ◇ Coordination of displays at Capitol Rotunda Educational Event
 - ◇ GCC brochure
 - ◇ Nutrient Management
 - ◇ Molecular Techniques for Detection and Identification of Sewage-Borne Human Pathogens in Soils
 - ◇ Biostimulation of Trichloroethylene Degradation in Contaminated Aquifers

- ◇ Use of Heavy Nitrogen to Study Nitrate Flux from Septic Systems
 - ◇ SEWRPC Regional Hydrologic Study
 - ◇ UWS FY 00 Groundwater Research Plan
 - ◇ Biostimulation of Trichloroethylene Degradation in Contaminated Aquifers
 - ◇ Arsenic in Groundwater
 - ◇ Pesticide Registration Database
 - ◇ Groundwater and Surface Water Monitoring Report
- The GCC has continued to work with representatives of federal agencies to promote communication and coordination of federal and state groundwater activities. Representatives from the NRCS, FSA, and the USGS attend GCC meetings and serve as *ex officio* subcommittee members. The Appendix contains a summary of USGS groundwater activities.

SUBCOMMITTEE ACTIVITY SUMMARIES

Research Subcommittee - In late 1998 the Research Subcommittee met to review and revise the priorities for the DNR's groundwater management practice monitoring program for FY 2000. The revised priorities were included in the joint solicitation distributed by the UWS, DNR, Commerce, and DATCP in October, 1998.

The subcommittee met with the Monitoring and Data Management Subcommittee in January, 1999 to review the 24 proposals which had been received as a result of the joint solicitation. Subcommittee members made recommendations that were used by the three agencies and the UWS in deciding which groundwater-related proposals to fund for FY 2000. The projects to be funded in FY 2000 are listed in Table 2.

The Research Subcommittee also assisted in organizing poster exhibits for a display in the Wisconsin Capitol Rotunda during the State's Groundwater Protection and Awareness Week on Feb 2 and 3, 1999. Fifteen researchers prepared poster displays on projects recently funded through the joint solicitation process, and these researchers were present in the Rotunda to explain their posters and answer questions. The display was put on in conjunction with the Education Subcommittee and included state and federal agency displays and a groundwater presentation by high school students. Approximately 30 Legislators and numerous members of the public attended.

Monitoring & Data Management Subcommittee (MDMS) – The MDMS met four times in FY 99. Progress was made on the following data management issues:

- Electronic data submittal - Six electronic forms (well construction report, well/drillhole/borehole abandonment, monitoring well development, soil boring log information, monitoring well information, and groundwater monitoring well inventory form) were released.
- WUWN labels were now available for monitoring wells in addition to water supply wells
- Data confidentiality and disclosure issues were defined.

Several other data management issues will continue to be addressed by the subcommittee:

- Minimum data elements are being evaluated and will be helpful in upcoming database design and redesign.
- A project to eliminate duplicate Wisconsin Unique Well Numbers (WUWN) was initiated.
- Improved access to the Groundwater Retrieval Network (GRN) by other state agencies is being planned.
- Long-term goals and suggestions for redesign of GRN are being considered.
- Procedures to improve data transfer and reporting remain a priority.
- State and county data integration, and surface water.

The MDMS reviewed the priorities for the DNR's groundwater management practice monitoring program for FY 00. The revised priorities were included in the joint solicitation distributed by the UWS, DNR, Commerce, and DATCP in October, 1998. The subcommittee met with the Research Subcommittee in January to review the 24

proposals that had been received as a result of the joint solicitation. Subcommittee members made recommendations that were used by the three agencies and the UWS in deciding which groundwater-related proposals to fund for FY 00. The projects to be funded in FY 00 are listed in Table 2.

The MDMS renewed its commitment to regularly address monitoring issues in addition to data management issues. Monitoring will be a priority in FY 00. There is a need to catalogue each program's monitoring programs and goals to prevent duplication and increase the utility of monitoring results.

Planning and Mapping Subcommittee (PMS): The PMS met twice during FY99. The primary focus of the subcommittee continues to be the review and evaluation of groundwater mapping and analysis tools. Subcommittee members represent state and federal agencies with groundwater planning and mapping responsibilities.

The group focused on three major topics in FY 99: (1) mapping Wisconsin's karst features, (2) status of the Source Water Protection Plan program and how groundwater related data from member agencies could be used in the planning process, and (3) agency updates.

Karst Features: Subcommittee members continued their FY98 work to develop a coordinated approach for locating and describing karst features across Wisconsin. The Wisconsin Geological and Natural History Survey (WGNHS) developed a draft form that all state agency staff could use to describe karst features encountered during field work. The subcommittee discussed ways to distribute the form to appropriate state agency staff, and how to transfer data from the form into a database. WGNHS will be the repository for completed forms and the database developed with this information, and will be responsible for further research of karst features and areas once they are identified. The subcommittee intends to distribute the final form in FY00 and evaluate progress in FY 00.

Source Water Assessment Program: The subcommittee continued its FY98 work related to the Source Water Assessment Program. Members discussed the types of data that would be important for this planning process. Example geographic information system (GIS) applications relating to this program were demonstrated and related information was distributed among members. The subcommittee intends to continue with this issue in FY 00.

Agency Updates: Subcommittee members update the group on planning and mapping activities happening in their respective agencies. This information is very important for coordination of data collection and mapping purposes. Examples of topics discussed in FY 99 included a statewide soil survey mapping initiative, mapping of groundwater use restrictions, use of a quarter-quarter section "look-up" table to map features in databases, address "geo-coding" software, and the use of global positioning system (GPS) technology. We will continue to keep each other informed in FY 00.

Education Subcommittee - The Education Subcommittee met five times during the past year. The subcommittee focused on two major projects- groundwater education at the Capitol Rotunda and Consumer Confidence Reports – in addition to its mission of reviewing and coordinating public information materials, and serving as a forum for groundwater education ideas and concerns.

Approximately 30 legislators visited displays set up in the Capitol Rotunda during Groundwater Protection Week in February, 1999. Approximately half that number had their drinking water screened for nitrate. Member agencies prepared and staffed displays about their groundwater protection and education activities. Researchers funded through the Joint Solicitation presented some of the practical applications of their research findings. Students from Middleton-Cross Plains High School demonstrated a groundwater model.

The subcommittee has been working intensively on a public education strategy for Consumer Confidence Reports. These public water supply "report cards" will be provided to Wisconsin residents who use public water supplies beginning in October, 1999, to fulfill a requirement of the federal Safe Drinking Water Act. The subcommittee has been assisting DNR staff in identifying likely public concerns and materials that can address them. This effort has been another excellent example of what can be accomplished when agencies bring their unique expertise to a public education effort.

A workgroup consisting of subcommittee members and other agency representatives revised the DNR "Tests for Drinking Water from Private Wells" brochure.

The subcommittee, with the Wisconsin Ground Water Association, provided prizes to approximately 50 middle school and high school students who participated in a groundwater "quiz" at Farm Progress Days in 1998. A poster listing groundwater education sites and a new "quiz" for adults has been prepared for 1999.

Local Government Subcommittee(LGS) The LGS was formed in 1993 to represent local units of government and organizations representing local units of government. The subcommittee did not meet in fiscal year 1999.

DIRECTIONS FOR FUTURE GROUNDWATER PROTECTION

PRIORITY ISSUES

- **Promote consistency between the agencies on data management issues:** Through the recent update of the Directory of Groundwater Databases and redesign of the DNR's groundwater computer system, state and local government agencies now have more convenient access to groundwater data. This effort must be maintained by continuing to identify what data needs exist. Data consistency must be promoted by use of translatable geolocational coordinate systems and consistent data elements for use in a GIS environment. The GCC will continue to provide leadership and communication on data management through its subcommittees. This continued effort displays the GCC's commitment to management of the resource through sound scientific methods.
- **Research on land use management and its impact on the groundwater resource:** Additional research is needed on the effect of various land uses (e.g. urbanization) on groundwater quality and quantity. Several projects that study the impacts of land use on groundwater have been and continue to be funded through the joint solicitation. These projects must be managed in such a way as to maximize their relevance to state land use problems. This issue crosses agency lines and promises to be an important issue for years to come.
- **To act as a coordinating and facilitating mechanism for the publication and distribution of information and educational materials on groundwater related issues:** The public has benefited from the consistent educational messages which have been endorsed by the Education Subcommittee. The Education Subcommittee will continue to provide its leadership and assistance to state agencies providing educational materials to the public.
- **Distribution of findings from groundwater research or monitoring projects:** There has been considerable progress in preparing summaries of the results of groundwater-related monitoring and research projects funded through the joint solicitation process. In FY 96 the DNR and UW WRC published a document containing 72 of these summaries. All 72 of these summaries are now available on the UW-WRI web site maintained by UW-WRI. The rate of response to the web site posting of research findings has been very encouraging so far. To maintain and enhance this response it will be important to add new summaries annually as they become available, create a more visually appealing set of front-end pages for the site, and publicize the web site location and content more widely. The Education Subcommittee has taken the summaries to the UW-Extension for preparation of farm-related articles on groundwater research/monitoring results. More work needs to be done to target interested audiences and distribute summaries and final reports more widely.
- **Identify tools that can be used to better predict Wisconsin's groundwater susceptibility to contamination:** Studies have demonstrated the need for developing statewide data layers that would facilitate better groundwater vulnerability assessments. These data layers include land use, soils, regional groundwater flow, hydrogeologic characteristics such as aquifer materials, and potential point sources of contamination such as underground storage tanks and pesticide spills. The studies also illustrate the importance of locational data for contaminant sources. The GCC's Planning & Mapping and Monitoring & Data Management Subcommittees have prioritized, promoted, and helped facilitate the development of data layers as part of a larger data integration initiative. Through the DNR's Source Water Assessment Program, which will be implemented by 2003, this work will continue and will result in improved predictive capabilities.
- **Continued evaluation of alternatives to onsite sewage systems:** Although the DNR and Commerce have funded monitoring projects in this area, additional work is needed to find state-of-the-art private sewage system technologies that provide efficient, cost-effective options.
- **Investigation of the causes and effects of nitrate in groundwater:** The GCC will support the agencies and

the UWS in obtaining information pertinent to the human health implications of consuming nitrate contaminated groundwater and the effect of discharge of this groundwater on surface waters and their ecosystems. In addition, it will continue to facilitate consistent education to provide a clear message on the many causes and effects of nitrate in groundwater for urban and rural citizens.

- **Solutions to groundwater nonpoint pollution problems:** A 1997 DATCP report indicates that 8.5% of Wisconsin's wells still contain detectable atrazine residues. In addition, 10% exceed the nitrate standard. These rates are substantially higher in agricultural areas. Agriculture is the major source of these pollutants. More work is needed to determine how far Wisconsin groundwater will deteriorate without a substantial change in farming practices, and what practices will sustain both agriculture and groundwater quality.
- **Improved communication between local and state government:** The Local Government Subcommittee to the GCC was created in February 1993 to provide a line of communication between local and state governmental entities. Further effort is needed to improve dialogue between state and local governments. In FY 97, the subcommittee began to address data management needs of local governments. However, subcommittee members are often concerned with regulatory issues that affect their communities while the GCC is a non-regulatory body limited to making recommendations to the appropriate regulatory agencies regarding groundwater issues. To increase the responsiveness of state agencies to local government needs, local government needs must be communicated to the GCC and relayed to the appropriate agencies. An effort must be made by the GCC to increase interest in the GCC by local governments, and to offer opportunities to communicate concerns to regulatory agencies.
- **Investigation of adverse impacts from groundwater withdrawals:** In FY 97, DNR staff with help from the Groundwater Quantity Technical Advisory Committee completed a report on the groundwater quantity issue (see "Condition of the Resource - Groundwater Quantity" for the Executive Summary of this report). In the report, localized areas with groundwater quantity problems are identified and the effects of groundwater withdrawals on surface waters and long-term groundwater availability are discussed. There is a need to further quantify hydrographic relationships of surface and groundwater. The GCC should continue to encourage research efforts that will provide information useful in addressing this issue.
- **Investigation of recently discovered groundwater contaminants:** Recent research conducted in Europe and the U.S. indicates that traces of pharmaceuticals and pesticide breakdown products are common contaminants found in groundwater and surface water. Current testing methods do not allow adequate detection of these possible contaminants. Research is needed to determine whether these substances pose a threat to Wisconsin's groundwater resource.
- **Investigation of naturally occurring contaminants in groundwater:** Recently we have learned of continued problems of elevated arsenic, low pH, and other water quality problems in domestic wells over large areas of northeast Wisconsin. DNR needs more information about the extent and causes of these problems in order to give advice to homeowners and well drilling contractors. Additionally elevated sulfate and total dissolved solids have been found in some new deep municipal wells in the Lower Fox River Valley making the wells unusable. In some other existing deep wells as far south as Milwaukee the total dissolved solids have been steadily increasing over the years. These sulfate and TDS levels pose a problem for local water managers, and the origin of the dissolved solids is not completely understood.

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**Wisconsin Groundwater Coordinating Council
Meeting Minutes - August 7, 1998**

Members Present: Susan Sylvester (DNR), Ron Hennings for Jamie Robertson (WGNHS), Anders Andren for Fran Garb (UWS), Lynda Knobloch for Henry Anderson (DHFS), Eric Scott for John Alberts (COMM), Bob Pearson for Carol Cutshall (DOT).

Others Present: Ken Bradbury (WGNHS), John Harkin and George Blondin (UWS), Russ Rasmussen (DOT), Mike Lemcke and Jeff Helmuth (DNR).

The meeting was held in the Room 419 of the Hillfarms State Office Building in Madison beginning at noon.

1. **General Business** - Introductions were made. The minutes of the May 29th meeting and were approved without changes.

2. **Planning and Mapping Subcommittee Report** - Ron Hennings reported that karst feature information collection and mapping had been the focus of the subcommittee meeting held on July 24th. The subcommittee was interested in the National Park Service's system of sinkhole categorization used in the Mammoth Cave Area and discussed the possibility of doing a similar project for the St. Croix County area. The subcommittee also looked at several Karst informational pamphlets from the Mississippi Karst Resource Planning Committee. The subcommittee has produced a draft "Wisconsin Interagency Sinkhole or Karst Feature Reporting Form". Ron asked for comments on the draft form by August 15 and that he would act as the karst contact at WGNHS until Maureen Muldoon's position was filled.

Ron also reported that the subcommittee had discussed address matching, DATCP pesticide spills and remediation site mapping, the Source Water Assessment Program being developed at DNR, and the status of WGNHS county water-level maps.

3. **Source Water Assessment Program (SWAP)** - Jeff Helmuth handed out a draft of Wisconsin's SWAP plan. The delineation and assessment strategies for surface water and groundwater systems had been revised based on stakeholder input. Revisions included scaling back surface water system assessments and doing more advanced delineations for groundwater systems. Jeff reported that information collected in the ongoing vulnerability assessments would be used in the assessments. The SWAP will maximize the use of existing information and will utilize Geographic Information Systems to map source water protection areas and potential contaminant sources for each public water system. A susceptibility analysis will be done for each system based on contaminant inventories, monitoring results, hydrogeologic/hydrologic setting and well construction information. The goal is to produce assessments that will be useful to communities interested in wellhead or watershed protection. States have until February 6, 1999 to submit their final SWAP plan to EPA. Jeff asked that GCC members contact him with their comments on the SWAP.

4. **SEWRPC Regional Hydrologic Study** - Mike Lemcke reported that a modeling study similar to that done in Dane County would be done for the seven-county South East Wisconsin Regional Planning Commission area. Funding for the study was being solicited from communities in the area. The budget will be finalized by November. The study will produce capture zone delineations which will be useful for source water protection, wellhead protection and land use planning. Mike added that with this study the areas covered by regional hydrologic studies include all or parts of 20 counties. These studies will be coordinated to meet the goals of the Source Water Assessment and Wellhead Protection programs.

5. **Education Subcommittee Report** - Ron Hennings reported on the following subcommittee activities:

- Farm Progress Days 9/22- 9/23 - Subcommittee members were to: produce a poster and handout listing groundwater-related sites; notify high school vocational agriculture teachers within 90 miles of the Farm Progress Days site in Dunn County; develop a quiz for students to complete to receive a prize; and produce baseball caps sporting the Buried Treasure logo as prizes. The caps were to be paid for by the Wisconsin Groundwater Association. (Note: all of this happened as planned)
 - "Groundwater - Protecting Wisconsin's Buried Treasure" magazine insert - Comments were made on an update sheet. The magazine insert will be entirely redone by next summer.
 - "Tests for Drinking Water from Private Wells" brochure revision - There is a need for interagency coordination on this issue. The subcommittee established a workgroup consisting of Mark Werner, Lynda Knobloch, Jane Larson, Chris Mechenich, Bob Pearson and Dorie Turpin to look at this document and the issue in general.
6. **Educational Event at the Capitol Rotunda** - Ron Hennings reported that the Education Subcommittee was coordinating with the Research Subcommittee to invite researchers to display practical, relevant findings in the Capitol Rotunda during Groundwater Protection and Awareness Week. The subcommittee is also working with the Wisconsin Water Well Association, which sponsors Groundwater Week each February. There will also be a WWSA meeting and a proclamation signed by the Governor. UWS displays will include the sandtank groundwater model and well water testing. Anders Andren suggested using concise 1-page summaries of the projects for handouts. Ron reminded the GCC members that they should provide a contact name to him to work with on their agency displays. Ron also said that the GCC should have a display showing the interagency integration.
7. **Water Resources Center/Sea Grant Institute Integration** - Anders Andren, Director of Wisconsin Sea Grant Institute, reported that he had been appointed as Director of the Water Resources Center as of July 1, 1998. Anders commented that the two entities have similar missions and share a requirement for matching funding. Anders had been Associate Director of the WRC in 1980-81 and had enjoyed a close association with it in the meantime. The Sea Grant Institute is one of 29 in the nation and is charged with stewardship of oceans and the Great Lakes. The Institute has 30 staff and 2/3 of its budget is for research. Its many resources include web servers and graphic artists. Sea Grant will move to Goodnight Hall with the WRC in early November.
- Ken Bradbury said that there was concern among researchers that the WRC would need groundwater expertise and that the loss of 1 ½ WRC positions would hurt the groundwater research program. Anders said he would appoint an advisory council to get input on the issue. Susan Sylvester encouraged Anders to look for groundwater experience for the half-time position yet to be filled. Anders said that the position announcement for the half-time position that will replace George Blondin had been issued and numerous applications had been received. The position may be increased to full-time if funding can be secured. Susan thanked Anders for his update and spoke for the GCC as a whole by saying she looked forward to working with Anders and the Sea Grant Institute.
8. **FY 1998 GCC Report to the Legislature** - Jeff Helmuth asked for approval of the GCC's 1998 annual report. A redline/strikeout draft of the report had been sent out to GCC members prior to the meeting. George Blondin and Bob Pearson suggested minor changes to the UWS and DOT sections. The report was approved as modified.
9. **Joint Solicitation Process** - Jeff Helmuth reviewed the Joint Solicitation timeline for the FY 00 selection process. The FY 00 timeline had been moved forward a few days to increase the technical review return rate.

George Blondin reported that activity on the project summary website had decreased. This is most likely due to the lack of new summaries. Susan Sylvester stated that it was important to keep the website up-to-

date with recent project results. Anders Andren said he would make every attempt to keep the site updated. Jeff Helmuth said he would send DNR project summaries to the WRC in electronic format for addition to the web site. Susan suggested having the February 1999 GCC meeting at the WRC.

10. **Septic System Research** - John Harkin of the WRC/Soil Science Dept. at UW Madison gave a brief overview of septic system technology and a summary of his findings from two studies on septic systems. Septic systems research benefits include development of synthetic fabrics to cover distribution trenches and mound systems. In general, John said that septic systems provide better treatment of wastes than do wastewater treatment plants. By modeling nitrate transport in soils and aquifers and using tracers, John studied anaerobic/aerobic cycling and was able to make recommendations regarding timing of waste distribution. John's conclusions encouraged the use of mound or pressurized systems as much as possible. For further research John suggested using tracers to compare denitrifying systems with older conventional systems. This comparison would have applications to planning and land use policy. Anders Andren asked if there was a prescribed distance to groundwater for septic systems. John said that two feet of soil was required. Susan thanked John for his presentation.

The meeting adjourned at 3:00. The next meeting is scheduled for 12 noon on November 13th, in Room 3B of the WHEDA Building at 201 West Washington Ave. in Madison.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist
Department of Natural Resources

**Wisconsin Groundwater Coordinating Council
Meeting Minutes - November 13, 1998**

Members Present: Susan Sylvester (DNR), Jack Metcalf (Gov. Rep.), James Robertson (WGNHS), Anders Andren for Fran Garb (UWS), Henry Anderson (DHFS), Eric Scott for John Alberts (COMM), Carol Cutshall (DOT), Jim Vanden Brook for Nick Neher (DATCP).

Others Present: Ron Hennings (WGNHS), Christine Mechenich (UWS), Bob Pearson (DOT), Gary Lueck (WRWA), Robert Langstroth and Lenny Kanter (Commerce), Barb Lensch (NRCS), and Jeff Helmuth (DNR).

The meeting was held in the Room 3B of the WHEDA Building in Madison beginning at noon.

1. **General Business** - Introductions were made. The minutes of the August 7th meeting were approved without changes.
2. **Monitoring & Data Management Subcommittee report** - Ron Hennings reported that the Subcommittee had met on September 28 for the first time since January, 1997. The group had been working in smaller groups on data integration issues since that time. Tasks completed include the update of the Directory of Groundwater Databases, unique well number labels for monitoring wells, and the well forms PC program for automatic form submittal. The subcommittee also discussed the Joint Solicitation timetable and agency research and monitoring priorities. The next meeting will feature discussion of future directions of the subcommittee which may include an increased emphasis on monitoring. Ron added that he appreciated the support that Jeff Helmuth provided for the subcommittees and the GCC and now that Jeff had taken a new position Ron hoped that the GCC position would be refilled.
3. **Education Subcommittee report** - Chris Mechenich reported on the following subcommittee activities:
 - "Tests for Drinking Water from Private Wells" brochure revision - a workgroup consisting of Mark Werner (DHFS), Lynda Knobloch, Jane Larson, Chris Mechenich, Bob Pearson and Dorie Turpin (DNR) is progressing with this document and the issue in general
 - "Groundwater - Protecting Wisconsin's Buried Treasure" magazine insert - Laura Chern and Dave Johnson of the DNR are proceeding with updating this document. Chris advised that people use up remaining copies soon as the new insert will be completed by summer.
 - Nitrate in Wisconsin's Groundwater - several subcommittee members have been involved in writing this white paper which is coordinated by Laura Chern.
 - Consumer Confidence Reports - The subcommittee is concerned about the need to disseminate an understandable explanation of drinking water quality through these reports and will meet with Don Swailes (DNR) to discuss them at the subcommittee's December meeting. GCC members made several suggestions on how to coordinate a consistent message.
 - Farm Progress Days 9/22- 9/23 Dunn County - Chris reported that the map showing groundwater-related sites had proved helpful. The quiz for students to complete to receive a groundwater cap may have been too difficult for the middle school students that were interested in the caps. The quiz had been written for the high school level. The caps were paid for by the Wisconsin Groundwater Association. Bob Pearson the President of WGWA gave some background on the group and described it as an organization interested in groundwater education for professionals and youth. Bob said WGWA would be willing to contribute to such efforts again.
4. **Coordination of Capitol Rotunda Educational Event** - Ron Hennings reported that the Education Subcommittee was working with the Wisconsin Water Well Association (WWWA) to coordinate groundwater education in the Capitol Rotunda during Groundwater Protection and Awareness Week, the first week in February. Ken Bradbury is arranging to have researchers display practical, relevant findings

in poster presentations. Other displays will include a sandtank groundwater model, well water testing for Legislators and a GCC display showing interagency coordination. The subcommittee is working with the WWA, which sponsors Groundwater Week each February, to have a proclamation signed by the Governor. Ron reminded the GCC members that they should provide a contact name to him to work with on their agency displays.

Jeff Helmuth took digital pictures of GCC members and asked that they provide him with biographies for the GCC brochure to be handed out at the Rotunda event.

5. **Water Resources Center/Sea Grant Institute Integration and FY 2000 Joint Solicitation** - Anders Andren introduced Jim Hurley, the new half-time Assistant Director who is also with DNR-Research. Anders said Jim has expertise in contaminant transport in natural waters especially mercury. Jim said he was happy to be on board and looked forward to working with the GCC. Jim added that he was the Technical Chair for the Wisconsin Section of the American Water Resources Association and was involved in setting up the annual meeting which would be held March 25 and 26, 1999 in La Crosse.

Anders reviewed the mission of the WRC which is administered by the United States Geological Survey. There are 54 Water Resource Centers in the U.S. They plan and conduct research of basic and practical nature in affiliation with universities. Federal funding for WRCs recently shrank from \$16 million to \$4 million. However, Anders reported that approximately \$40,000 would be available to add to the Groundwater Research funding for the FY 00 joint solicitation. James Robertson and Ron Hennings said it was generous, wise and farsighted to add to the groundwater funding.

On a sad note, Anders reported that Gordon Chesters, the former WRC Director, had suffered a heart attack in Paris and was in ill health.

6. **Nutrient Management Update** - Jim Vanden Brook reported that the redesign of the DNR's non-point source pollution abatement program was progressing with input from many stakeholders. The redesign envisions changes to the priority watershed, stormwater management, animal waste management and soil and water resource management programs throughout the state. The Land and Water Conservation, DATCP and DNR Boards will be reviewing draft rules during 1999. DATCP is directed by statute to develop rules on nutrient management. Rules are scheduled for adoption in early 2000. An outreach advisory committee and several functional workgroups have been established. The nutrient management workgroup includes UW researchers, farmers, and land conservation district, DNR and DATCP staff. The workgroup has developed performance standards and technical standards and is working on implementation guidelines. Jim stressed the need for nutrient management by pointing out Wisconsin's 10% nitrate standard exceedence rate for drinking water wells statewide and greater than 20% exceedence rates in agricultural areas. Additionally, the growing "dead zone" in the Gulf of Mexico indicates this is a very large problem. Jim added that phosphorus runoff is a major surface water quality problem.
7. **Source Water Assessment Program Update** - Jeff Helmuth reported that a draft SWAP plan would be completed by late December and will be available on the Bureau of Drinking Water and Groundwater's web site (<http://www.dnr.state.wi.us/org/water/dwg/gw/SWP.HTM>). The plan will be discussed with EPA Region V and other states in Chicago in mid-December and will be the subject of public hearing/informational meetings and a public comment period during January. States have until February 6, 1999 to submit their final SWAP plan to EPA. Jeff asked that GCC members contact him with any comments or questions on the SWAP.
8. **1999 Meeting Schedule** - The GCC set the 1999 meeting dates as follows: 2/26 at the Water Resources Center, 5/14 at DNR's Dodgeville area office (Note: the May meeting date will be rescheduled), 8/27 at DHFS, and 11/5 at DATCP.

9. **Molecular Techniques for Detection and Identification of Sewage-Borne Human Pathogens in Soils**

- Bill Hickey and Peter Rose talked about their work in developing polymerase chain reaction (PCR) primers for E. coli and Shigella organisms and to adapt PCR to soil DNA extracts. Bill explained that PCR yields a 10^6 fold increase in DNA and compared it to other methods such as colilert and multiple tube fermentation. Primer design is a key part of the work that Bill and Pete are doing. This is done through computer and lab work to determine optimal PCR primer characteristics. The resulting tests are extremely sensitive and can detect 10 cells of E. coli. or 5 cells of Shigella.

The meeting adjourned at 3:00. The next meeting is scheduled for 12 noon on February 26th, in the Conference Room (room 215) of the Water Resources Institute on the second floor of Goodnight Hall, on the UW campus in Madison (see enclosed map).

Respectfully submitted,

Jeff Helmuth, Hydrogeologist
Department of Natural Resources

**Wisconsin Groundwater Coordinating Council
Meeting Minutes – February 26, 1999**

Members Present: Susan Sylvester (DNR), James Robertson (WGNHS), Fran Garb (UWS), Lynda Knobeloch for Henry Anderson (DHFS), Carol Cutshall (DOT), Nick Neher (DATCP).

Others Present: Anders Andren and Jim Hurley (UWS -WRC), Mike Lemcke and Jeff Helmuth (DNR).

The meeting was held in the Conference Room of Goodnight Hall on the UW campus in Madison beginning at noon.

1. **General Business** - Introductions were made. The minutes of the November 13th meeting were approved without changes.
2. **Water Resources Center/Sea Grant Institute Integration** - Anders Andren welcomed the GCC to the newly combined WRI/SGI facilities at Goodnight Hall and gave an overview of the two institute's functions. Anders noted that the computer network had its own servers and that there would be an emphasis on worldwide web outreach. Anders added that he was grateful the annual support received by the WRI Library from the DNR.
3. **FY 2000 Joint Solicitation and approval of UW Groundwater Research Plan** - Jim Hurley explained several handouts documenting the WRI decision process on FY 00 project funding including the addition of one project since the Groundwater Research Advisory Council meeting. The additional project was added by an email vote by GRAC members. In the end only one project was skipped over in the peer review rankings for funding and that project lacked groundwater relevance. Jim also explained how some budgets were slightly modified due different fringe rate adjustments among different campuses. Otherwise there were no significant budget adjustments. Lynda Knobeloch asked about the 75:25 weighting of peer review: GCC subcommittee rankings. Jeff Helmuth said that the weighting had been established by the GRAC to equalize the effect of various numbers of peer reviews received by any given proposal. James Robertson asked if, by approving the UW Research plan, the GCC was approving the second year of the two-year projects. Susan Sylvester and Nick Neher answered that there must be an implied commitment to fund the second year in order to get two year proposals. James asked that there be some way of assuring that a project is on track before funding for a second year. Susan asked that the WRI use professional judgment in assuring good progress before requesting funding for second-year projects.

Susan Sylvester, James Robertson, Nick Neher and Carol Cutshall all commended Anders Andren and Jim Hurley on how well the UWS project selection had occurred. Anders said that there had been strict attention to the peer review process and that Jim Hurley had done excellent work. Nick Neher moved that the GCC approve the UW Groundwater Research Plan as proposed by the WRI. The motion was seconded by James Robertson and unanimously approved (John Metcalf and John Alberts not present).

Mike Lemcke asked if people had ideas on how to get more good quality proposals in future years. He suggested that DNR and DATCP staff target researchers for future solicitations. Mike also suggested using the GCC poster and a handout describing the joint solicitation at the AWRA/SETAC meeting to let researchers know about the joint solicitation. The GCC agreed that both suggestions should be pursued.

Anders Andren said he and Jim Hurley would go to a national meeting of Water Resource Centers where funding issues would be discussed that he could report on at the next meeting.

4. **Education Subcommittee Report** – Jeff Helmuth reported on the following subcommittee activities:

- The interagency workgroup has almost completed the Tests for Drinking Water from Private Wells Brochure. There is concern over listing state labs as lab service providers due to the possibility of unfair competition. There will be a final draft at the 4/6/99 subcommittee meeting
 - The Health Tips for Your Home booklet has been finalized and was available at the Rotunda Groundwater Education Event
 - Subcommittee members are working with Don Swales and Megan Matthews from the DNR's Public Water Systems Section on the Consumer Confidence Reports (CCRs) required by water utilities by the Safe Drinking Water Act amendments of 1996. Prior to this, only negative information (i.e. violations) has been communicated to the public. The first reports to the public are required by October 19, 1999. Several subcommittee members are concerned about the potential for information on health risks and need for interagency coordination.
 - Groundwater Protection and Awareness Week in the Capitol Rotunda – Approximately 25 Legislators attended and about half that many had their water samples tested. Susan Sylvester and James Robertson said that everything was well done and that the people who did the work should be thanked. Susan asked that resolutions of appreciation from her and John Robinson (AWRA) be prepared for them. Susan added that the GCC brochure was well done and should be sent to Legislators with the Report to the Legislature. Jeff Helmuth suggested, based on comments from Ron Hennings and Chris Mechenich, that it would be best to repeat the event not more often than every 2 years with a one-day length and somewhat simplified posters. Most of the research posters were like those displayed at a technical conference and probably too complex for the general public. Fran Garb agreed that the posters should be simplified in future years.
 - Mike Lemcke added that the subcommittee had approved the final nitrate white paper and that his staff was ¼ into writing a similar paper on phosphorus.
5. **Triazine Screen Workgroup** – Mike Lemcke gave a brief history of the development of language to be used by laboratories in reporting triazine screen results and how its completion had been impaired. Mike believes that acceptable language will be completed by the next meeting. He is currently working with Jane Larson of DATCP to resolve the issue.
 6. **Pesticide Registration Database** - Nick Neher reported that Tom Dawson had taken a leave of absence from the Department of Justice to work on a grant to develop a database of pesticide use. The purpose of the database would be to query it for pesticide use at any particular site. The database will be useful for Food Quality Protection Act reporting. Questions remain regarding inclusion of homeowner use data, level of reporting, farm group support, and other issues. Susan Sylvester asked to have Tom Dawson report on the project at the next meeting if possible.
 7. **Integrated Pest Management Project for Schools** – Nick Neher reported that DATCP staff were working with an Advisory Committee to write manuals and provide one on one education on pest management in schools. Implementation will be voluntary. Nick emphasized the importance of training for untrained school staff that have pest management duties. Lynda Knobloch commended the DATCP staff working on the project.
 8. **DOT Groundwater-Related Research** – Carol Cutshall reported that DOT was funding research on wetland mitigation and the impacts of street sweeping on stormwater quality.
 9. **Geologist Registration** – Mike Lemcke reported that he was continuing to work on writing the rule on professional geologist/soil scientist/hydrologist registration issue. Currently a major issue is whether or not wetland delineations fall within any of the categories.
 10. **Drinking Water and Groundwater Bureau Director Position** – Susan Sylvester announced that Bob Krill would retire at the end of March after 32 years in the Department and 18 years as Bureau Director.

Susan added that she and many others would miss Bob's superb work ethic and many other excellent qualities. An Interim Director will be in place until the position is filled.

11. **Monitoring & Data Management Subcommittee Report** – Jeff Helmuth reported that he had been elected to chair the Subcommittee and summarized their January 15th meeting. Subcommittee members discussed the following data integration and monitoring issues:

- Confidentiality - There is a need for a memorandum of understanding between GCC agencies on what appropriate uses of data include. Common language is needed on information disclosure issues and that laboratory reporting language should make people aware that results are not private.
- Database Issues – The Directory of Groundwater Databases is completed. Minimum data elements must be identified and distributed. A memorandum of understanding regarding Groundwater Retrieval Network access by agencies is being developed. WUWN labels are now available for monitoring wells in addition to water supply wells.
- Electronic Data Submittal – The Subcommittee supports a requirement for well drillers to use GPS units to locate wells. To implement this the WCR form would need to be revised to include a space for the latitude and longitude coordinates
- Local Government Data Needs - The subcommittee will consider contacting the Land Information Board, Land Council, and UWEX Local Government Council to obtain input.
- Monitoring – The subcommittee identified a need to catalogue each programs monitoring programs and goals so as to prevent duplication. The subcommittee resolved to have some time on each meeting agenda for monitoring issues.
- The subcommittee is considering members from other agencies that do monitoring such as DOT and NRCS.

12. **Source Water Assessment Program Update** - Jeff Helmuth reported that Public Hearings/informational meetings were held during the 1st wk of January in 4 locations statewide. There were only 14 non-DNR attendees in 8 meetings. The public comment period ended Jan 22 with no written comments. A few comments were received late. The final plan was submitted to EPA Region V in early February. EPA has until November 6th to approve or disapprove the plan. The plan is available on the Bureau of Drinking Water and Groundwater's web site (<http://www.dnr.state.wi.us/org/water/dwg/gw/SWP.HTM>).

13. **Biostimulation of Trichloroethylene (TCE) Degradation in Contaminated Aquifers** - Bill Hickey summarized a comparative evaluation he had done on the efficiency of organisms to stimulate TCE biodegradation by indigenous aquifer microbes. TCE degradation is mediated by oxygenases that co-oxidize in the presence of a substrate. This substrate induces its own decomposition by inducing production of a degradation gene with the added consequence of TCE degradation. Bill compared four oxygenases, and evaluated the effects of lower temperature, added ammonia, methane and toluene on TCE degradation. Studies were conducted in both microcosms (flasks) and columns, where some general aquifer materials were simulated. Most of the systems responded similarly in that the rate of degradation increased with time. The lower temperature tests had smaller increases. Lynda Knobloch shared concerns over the addition of ammonia to groundwater. Anders Andren added that stimulating oxygenases may increase degradation rates of other contaminants such as PAHs. Bill concluded that in situ biodegradation was feasible at cooler temperatures, ammonia stimulated oxygenases more so than methane or toluene, but nitrate pollution was a concern. Susan Sylvester thanked Bill for his presentation.

The meeting adjourned at 3:00. The next meeting is scheduled for 12 noon on May 21st, in the Conference Room of the DNR's Area Office in Dodgeville. A van will be scheduled for transportation from Madison to Dodgeville.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist
Department of Natural Resources

**Wisconsin Groundwater Coordinating Council
Meeting Minutes – May 21, 1999**

Members Present: Susan Sylvester (DNR), Jack Metcalf (Governor's Representative), James Robertson (WGNHS), Fran Garb (UWS), Carol Cutshall (DOT), Nick Neher (DATCP), Lynda Knobloch for Henry Anderson (DHFS), and Eric Scott (COMM) for John Alberts

Others Present: Barb Lensch (USDA NRCS), Jim Vanden Brook (DATCP), Tom Dawson (WSPIP), Mike Lemcke and Jeff Helmuth (DNR).

The meeting was held in the DNR Area Office Conference Room, Dodgeville, beginning at noon.

1. **General Business** - Introductions were made. Jack Metcalf welcomed everyone to Dodgeville. An informational item on the recent nitrate poisoning case was added to the agenda. The minutes from the February 26th meeting were approved as written.
2. **Announcement of reappointment of Governor's Representative** – Susan Sylvester announced that Jack Metcalf had been re-appointed to the Council until July 1, 2003. Everyone congratulated Jack and expressed enthusiasm about working with him for another 4 years. Jack brought in fresh pastries from the local bakery to celebrate his reappointment.
3. **Water Resources Institutes Directors meeting** – Jeff Helmuth reported that Anders Andren and Jim Hurley were both unable to attend this meeting – Anders due to preparation of a presentation to be given at the White House next week. However, he wanted the Council to know that the Water Resources Institute Directors had all recently visited with the Wisconsin elected officials in Washington DC. They were trying to impress upon them the need for continued monetary support for their programs and additional funding appropriation. Senators Feingold and Kohl may push for a million dollar increase for the national Water Resources Institutes budget. If this were to happen the Institutes would collectively receive \$6 million per year. Anders noticed that many Senators, especially those from Southern states, had become sensitized to non-point source pollution due to the hypoxic area or Dead Zone in the Gulf of Mexico. Senator Feingold was supportive of getting more funding in Wisconsin for nonpoint source issues. Anders will visit with Legislative staff in Washington at least twice a year.
4. **Plans for FY 01 Joint Solicitation** – Jeff Helmuth commented that it is once again time to begin thinking about what each agency wants to list as its priorities for the Fiscal Year 2001 solicitation. He reported that Anders Andren would have the UW Groundwater Research Advisory Council review the UWS research priorities. Jeff also commented that the joint solicitation timeline would need to be established at the August meeting. There was extensive discussion on how to improve the number of researchers submitting proposals the quality of the proposals and the relevance of the proposals to current groundwater management issues. The council settled on several courses of action. They are:

Fran Garb will take the lead on providing links to other parts of the campuses that are currently being inadvertently omitted from the solicitation. She will also make sure that the information is displayed on appropriate University Web pages.

The council will recommend that each principal investigator provide four names of professionals that they feel are qualified to review the information within their proposal. There will also be no indication that any or all of the names would be used for their specific paper.

The council also defined a need to reach out to the Fertilizer Research Council to try to provide linkages between the two solicitations. Jeff Helmuth will find out the timeline for the fertilizer research solicitation

for the next meeting.

The council will also provide an opportunity to new researchers that have not been previously funded by the council to sit in on the meeting to review the proposals as an observer of the process. The observers would be able to improve their future submittals by seeing how the review process works. Fran Garb also indicated that she would work with the appropriate Deans, as needed, to explain how important this is for their faculties' development.

5. **Education Subcommittee Report** – Jeff Helmuth reported that the subcommittee had reflected on the Rotunda event. They decided that if it were to be done again the posters should be centered on a few primary themes, the information should be presented in a very reader friendly form, and that high school or grade school students should again present a groundwater issue. The subcommittee has also just completed a revision of the *Tests for Drinking Water from Private Wells* Brochure. The brochure is now being printed. A workgroup has been formed to look at state agency roles related to the Consumer Confidence Reports required to start this fall by the 1996 Amendments to the Safe Drinking Water Act. Mike Lemcke reported that the verbiage to be used with the triazine screen has been developed, reviewed, and agreed to by all parties. He will be transmitting that language to the SLOH next week.
6. **Monitoring and Data Management Subcommittee Report** – Mike Lemcke reported that the committee had met on March 8th and would again meet on June 3rd. They had been brought up to date on the education committee's activity and discussed several other issues. These issues were: getting Groundwater Retrieval Network (GRN) access for the other agencies through the DNR's firewall, the proposed revamp of the CDC study, agency updates, and minimum data elements. Jim Vanden Brook commented that through recent GRN training he had found the GRN interface to be much improved.
7. **Nitrate Poisoning Case** – Lynda Knobloch reported that there had been a recent nitrate poisoning case of an infant in Grant County. The child was born four weeks premature. Four weeks after its birth it weighed about 5 pounds when the poisoning occurred. The infant was medflighted to UW Hospital after being stabilized in Boscobel. When it arrived at the hospital its methemoglobinemia level was 91%. This means that only 9% of its hemoglobin could still transmit oxygen. The source of the nitrate was from the family's well water. The family had been using water from another source until a long weekend when they used their well water for formula. They had boiled the water for safety reasons. The water was later tested and nitrate-nitrogen concentration was 28 mg/L and also contained E. Coli. The child has recovered substantially but it is unknown if there will be any long term health effects. Adam Hogan (DNR) inspected the well and collected the water samples that were tested. Jim Vanden Brook added that DATCP was conducting an on-site investigation on the incident.
8. **Update on Arsenic in Groundwater** – Mike Lemcke related that Wisconsin has arsenic, a serious, naturally occurring contaminant, within a specific zone of a geological unit. The arsenic-rich zone or zones exist under an area in East Central Wisconsin. At this time water from a number of private wells has been sampled and has shown levels of arsenic up to 1000 ppb. The EPA has set 50 ppb as a Maximum Contaminant Level. Mike will be putting together a group of internal and external experts on this issue. The experts will be trying to determine how the arsenic is mobilized, what advice the DNR should be giving to homeowners, what research needs to be done, and how can we best protect the health of citizens in the area. He also related that Liz Heinen of the DNR's North East Region office has agreed to present the topic at the August GCC meeting.
9. **Outline for 1999 GCC Report to the Legislature** – Jeff Helmuth proposed the following minor changes to last year's report outline: 1) Replace the "Walking On Water" Natural Resources magazine article with the updated "Buried Treasure" Natural Resources magazine insert, and 2) Attach the GCC brochure. The Council approved the proposed changes.

10. **Pesticide Registration Database** – Tom Dawson presented information on the “Wisconsin Strategic Pesticide Information Project”. Tom took a two-year leave of absence from his position at the Department of Justice from October of 1997 to October of 1999 to get this project off of the ground. The objective of the project is to enact legislation to track the use of pesticides in both the rural and urban settings. He and a coalition of support groups were successful in having the Joint Finance Committee insert into the proposed state budget an amendment to provide \$400,000 to DATCP to track pesticide use in both the urban and rural settings by different means. Tom shared the extensive list of supporters for the development of the "Pesticide Database System". He encouraged everyone to evaluate the draft legislation and either join in support of the concept or provide helpful amendments to the verbiage. The council thanked Tom for coming and providing his presentation.

11. **Groundwater and Surface Water Monitoring Report** – Jim Vanden Brook presented information on DATCP's Groundwater Protection Program water quality monitoring efforts. He explained that the foundation of all of DATCP's monitoring was based on four primary agency responsibilities: protect agricultural and environmental resources; abide by Wisconsin's Groundwater Law; be cognizant of groundwater and surface water connections; and partner with industry and other governmental units. Jim described five DATCP water quality programs or projects: 1) surface water monitoring; 2) acetochlor monitoring project; 3) monitoring well program; 4) monitoring reuse of atrazine; and 5) the DATCP exceedence survey. Each of these programs/projects focuses on monitoring water quality at a specific point of potential agri-chemical contamination. These include surface water, shallow groundwater near agricultural fields, and deeper groundwater from private drinking water wells. All groundwater monitoring projects detected atrazine residues and nitrates more frequently than other agri-chemicals. Jim concluded that DATCP's water quality monitoring efforts have been very useful in characterizing contamination trends and in protecting the public's health.

The meeting adjourned at 3:15. The next meeting is scheduled for 12 noon on August 27th at the Department of Health and Family Services in Madison.

Respectfully submitted,

Jeff Helmuth, Hydrogeologist
Department of Natural Resources

**TABLE 3 - STATE OF WISCONSIN
GROUNDWATER MONITORING/RESEARCH PROJECTS 1986-1999**
(title, principal investigator, years funded, funding agency, project # if assigned)

A Simple Stochastic Model Predicting Conservative Mass Transport Through the Unsaturated Zone into Groundwater, J. Hoopes, 1986, DNR, DNR Project #1.

Groundwater Monitoring for Pesticides, J. Postle, 1986-1997, DNR, DNR Project #2.

Fate of Aldicarb Residues in A Groundwater Basin near Plover, Wisconsin, G. Kraft, 1986-87, DNR, DNR Project #3.

Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills, M. Friedman, 1985-87, DNR, DNR Project #4a.

VOC Contamination at Selected Wisconsin Landfills - Sampling Results and Policy Implications, J. Battista, 1988-89, DNR, DNR Project #4b.

Volatile Organic Compounds in Small Community Wastewater Disposal Systems Using Soil Absorption, W. Boyle, W. Sonzogni, 1986, DNR, DNR Project #5.

The Use of Groundwater Models to Predict Groundwater Mounding Beneath Proposed Groundwater Gradient Control Systems for Sanitary Landfill Designs, J. Hoopes, 1986, DNR, DNR Project #6.

Evaluation Techniques for Groundwater Transport Models, J. Hoopes, 1986, DNR, DNR Project #7.

West Bend Road Salt Use and Storage Study, M. Sucht, 1986-91, DNR, DNR Project #9.

Barnyard Management Practices: Effect on Movement of Nitrogen Through Soils and Impact on Groundwater Quality, B. Shaw, 1991-92, DNR, DNR Project #9.

The Prediction of Nitrate Contamination Potential Using Known Hydrogeologic Properties, D. Cherkauer, 1986-87, DNR, DNR Project #10.

Nitrate Contamination in West-Central Wisconsin with Emphasis on Mill Run First Edition Subdivision, J. Tinker, 1987-90, DNR, DNR Project #11.

Investigation of Hydrogeology and Groundwater Geochemistry in the Shallow Fractured Dolomite Aquifer in Door County, Wisconsin, K. Bradbury, 1986-1990, DNR, DNR Project #12.

Lead Migration from Contaminated Sites - Door County, Wisconsin, J. Wiersma, R. Stieglitz, 1987-88, DNR, DNR Project #13.

Graphical and Statistical Methods to Assess the Effect of Landfills on Groundwater Quality, K. Potter, 1986-87, DNR, DNR Project #14a.

Methods for Determining Compliance with Groundwater Quality Regulations at Waste Disposal Facilities, K. Potter, 1988-89, DNR, DNR Project #14b.

Groundwater Quality Monitoring - Long Term Effects of Intensive Farming and Sprinkler Irrigation on Groundwater Quality, P. Kammerer, 1986, DNR, DNR Project #15.

The Effect of Construction, Installation and Development Techniques on the performance of Monitoring Wells in Fine-Grained Glacial Till, D. Cherkauer, C. Palmer, 1986, DNR, DNR Project #16.

Field Investigation of Groundwater Impacts from Absorption Pond Systems Used for Wastewater Disposal, J. Hoopes, 1985-86, DNR, DNR Project #17a.

A Case Study of Nitrogen Transformations at a Rapid Infiltration System Used for the Disposal of Food Processing Wastewater, W. Boyle, J Hoopes, 1986, DNR, DNR Project #17b.

The Occurrence of Volatile Organic Compounds in Wastewater, Sludges and Groundwater at Selected Wastewater Treatment Plants in Wisconsin, C. Hunger, 1985-90, DNR, DNR Project #18.

Fate and Mobility of Radium-226 in Municipal Wastewater Sludge Following Agricultural Landspreading, T. Portle, 1986, DNR, DNR Project #19.

Filtration Preservation Study of Groundwater Samples, D. Sauer, 1984, DNR, DNR Project #21a.

Groundwater Survey of Bacterial Contamination Near Rapid Infiltration Wastewater Treatment System, C. Norenberg, J. Standridge, 1987, DNR, DNR Project #21b.

Hydrogeology of the Wisconsin River Valley in Marathon County, Wisconsin, K. Bradbury, 1986, DNR, DNR Project #22.

Treatment of Cheese Processing Wastewater by Ridge and Furrow Disposal - Nitrogen Transformations, W. Boyle 1986, DNR, DNR Project #23.

Environmental Investigation of the City of Two Rivers Landfills, Manitowoc County, Wisconsin, T. Van Biersel, 1986-87, DNR. DNR Project #24,

Hydrogeologic Investigation and Groundwater Quality Assessment (Havenswood Landfill), P. Singh, 1987, DNR, DNR Project #28.

Groundwater Quality and Laundromat Wastewater: Summit Lake, Wisconsin, J. Saltes, 1986-1988, DNR, DNR Project #29.

Flambeau Paper Sulfite Lagoon Site Contamination Study, W. Lantz 1987, DNR, Project #30.

Monitoring of Volatile Organic Compounds in Tomah, Wisconsin, C. Krohn, 1986, 1989, DNR, Project #31a.

Hydrogeological Investigation of VOC Contaminated Private Wells Near Hudson, Wisconsin, J. Anklam, 1986, DNR, DNR Project #31b.

Sealing Characteristics of Sodium Bentonite Slurries for Water Wells, T. Edil, 1988. DNR, DNR Project #34.

Barron County Nitrate Study, D. Hanson, 1986-87, DNR, DNR Project #37.

Mutagenic Effects of Selected Toxicants Found in Wisconsin's Groundwater, L. Meisner, D. Belluck, 1988-89, DNR. DNR Project #38.

Downward Movement of Water Below Barnyard Grass Filter Strips - Case Studies, G. Bubenzer, J. Converse,

1987-1989, DNR, DNR Project #39.

1987 Volatile Organic Compound Testing Project in Rock County, Wisconsin, D. Holman, 1987, DNR, DNR Project #40.

Volatile Organic Compound Contamination of Private Water Supplies Adjacent to Abandoned Landfills in Marathon County, T. Wittkopf, 1986-1989, DNR, DNR Project #41.

Investigation of Large Scale Subsurface Soil Absorption Systems, D. Peerenboom, 1987, DNR, DNR Project #42.

Characterization of Groundwater Impacts at an Above Ground Petroleum Storage Terminal, G. Becker, R. Ham. 1987. DNR. DNR Project #43,

Lead Contamination Study of Door County. R. Stoll. 1988. DNR. DNR Project #44,

Freedman Creek Hydrogeologic Baseline Report. A. Wilson 1988-89. DNR. DNR Project #45.

Analytical Determination of Atrazine, Alachlor and Their Selected Degradation Products in Contaminated Groundwater: Implication for Wisconsin Groundwater Standards. W. Sonzogni, 1988-89, DNR, DNR Project #47.

Plover Area Nitrate Study, F. Bailey, 1987-88, DNR, DNR Project #48.

Assessment of Geologic Controls on Groundwater Flow and Distribution in Precambrian Bedrock, Central Wisconsin, Using Remote Sensing and Geophysical Analysis, B. Brown, D. Davidson Jr. 1988, DNR, DNR Project #49,

A Ground Penetrating Radar Study of Water Table Elevation in a Portion of Wisconsin's Central Sand Plain, M. Anderson, C. Bentley, 1988, DNR, DNR Project #50.

Mineralogical and Geophysical Monitoring Naturally Occurring Radioactive Elements in Selected Wisconsin Aquifers, G. Morsky, R. Taylor, 1988, DNR, DNR Project #51.

Degradation of Atrazine, Alachlor, Metolachlor in Soils and Aquifer Materials, G. Chesters, 1988-1990, DNR, DNR Project #52.

Evaluation of the Effect of Stormwater Disposal on Groundwater, G. Nienke, B. Shaw, 1988-89, DNR, DNR Project #53.

Radionuclides in Drinking Water of North central Wisconsin, B. Dobbins, C. Fitzgerald, 1988-89, DNR, DNR Project #54.

Pesticide Migration Study. Shaw, 1989-90, DNR, DNR Project #55.

Research and Data Analysis of Groundwater Contamination from Municipal Rapid Infiltration Land Disposal Systems, W. Boyle, J. Hoopes, K. Potter, 1987-88, DNR, DNR Project #56.

Digital Simulation of Solute Transport to Green Bay and Lake Michigan by Groundwater from Door County, Wisconsin, D. Cherkauer, 1988-91, DNR, DNR Project #57.

Grade A Dairy Farm Water Well Quality Survey, G. LeMasters, D. Doyle, 1989, DNR, DNR Project #58.

Demo of Low Input Strategies for Potato/Vegetable Production in Irrigated Sands, Shaw, Curwen, Kraft, Osborne, 1989-90, DNR, DNR Project #59.

Groundwater Quality Investigation of Selected Townships in Jefferson County, Wisconsin, F. Madison, 1989. DNR, DNR Project #60.

Effects of Volatile Organic Compounds on Clay Landfill Liner Performance. Edil, Berthouex, Park, Sandstrom. 1989. DNR. DNR Project #61.

Effect of Soil Type, Selected BMPs, and Tillage on Atrazine and Alachlor Movement Through the Unsaturated Zone. Lowery, McSweeny. 1991. DATCP and DNR. DNR Project #62.

Designs for Wellhead Protection in Central Wisconsin. Osborne, Sorenson, Knaak, Mechenich, Travis. 1989. DNR. DNR Project #63.

Atrazine Contamination of Groundwater in Dane County, Wisconsin. Bradbury, McGrath. 1990-91 DNR., DATCP DNR Project #64.

Sources and Extent of Atrazine Contamination of Groundwater at a Grade A Dairy Farm in Dane County, Wisconsin. Chesters, Levy. 1990-91. DATCP, UWS, and DNR. DNR Project #65.

Effect of Soil Type on Atrazine and Alachlor Movement Through Unsaturated Zone. T. Daniel. 1989. DATCP, DNR. DNR Project #66.

Subdivision Impacts on Groundwater Quality. Shaw, Ameson, VanRyswyk. 1989. DNR. DNR Project #67

Incorporation of County Groundwater Inventory Data into the DNR Groundwater Information Network (GIN). M. Bohn. 1990. DNR. DNR Project #68.

DNR and DATCP Rural Well Survey. LeMasters. 1990. DNR, DATCP. DNR Project #69.

Follow Up to the Grade A Dairy Farm Well Water Quality Survey. Cowell, LeMasters. 1990. DATCP, DNR. Project #70.

Optimum Manure Application Rate - Corn Fertility Management and Nitrate Leaching to Groundwater in Sandy Soils. Shaw. 1989-90. DNR. DNR Project #71.

Report on Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells. Hutchinson. 1990-91. DNR. DNR Project # 72.

Volatile Organic Chemical Attenuation in Unsaturated Soil Above and Below an Onsite Wastewater Infiltration System. Tyler, Peterson, Sauer. 1990-91. DNR, UWS. DNR Project #73.

Variation in Hydraulic Conductivity in Sandy Glacial Till: Site Variation Versus Methodology. Mickelson, Bradbury, Rayne. 1990-92. DNR, UWS. DNR Project #74.

A Field Evaluation of Drainage Ditches as Barriers to Contaminant Migration. Bahr, Chambers. 1990-91 DNR. DNR Project #75.

Nitrogen Isotope Monitoring at Unsewered Subdivisions. Tinker. 1990. DNR. DNR Project #76.

Analytical Determination of Pesticide Metabolites and Carrier Chemicals in Wisconsin Wells. Sonzogni, Eldan, Lawrence. 1990. DNR. DNR Project #77.

Integrated Decision Support for Wellhead Protection. Adams, Bensen. 1991. UWS.

Nitrate Movement Through the Unsaturated Zone of a Sandy Soil in the Lower Wisconsin River Valley. Lowery, Kussow. 1991-93. UWS.

In-situ Removal of Fe, Mn, and Ra from Groundwater. Christensen, Cherkauer. 1991. UWS.

Effect of Complex Mixtures of Leachate on the Transport of Pollutants in Groundwater. Grundl, Cherkauer. 1991-92. UWS.

Adsorptive Behavior of Atrazine and Alachlor in Organic-Poor Sediments. Grundl. 1991. UWS.

The Economic Effects of Groundwater Contamination on Real Estate. Page. 1991. UWS.

Near-Source Transport of Contaminants in Heterogeneous Media. Hoopes. 1991-92. UWS.

Chemical Transport Across a Sediment-Water Interface. Green. 1991-92. UWS.

Role of Mobile Colloids in the Transport of Chemical Contaminants in Groundwaters. Armstrong, Shafer. 1991-93. UWS.

Prediction of Organic Chemical Leachate Concentrations from Soil Samples. Park. 1991. UWS.

Using Ground Penetrating Radar to Predict Preferential Solute Movement and Improve Contaminant Monitoring in Sandy Soils. Kung, Madison. 1991. UWS.

A Tracer Technique for Measuring Regional Groundwater Velocities from a Single Borehole. Monkmeier. 1991. UWS.

Tracking Contaminant Pathways in Groundwater Using a Geologically Based Computer Code for Outwash. Mickelson, Anderson. 1991-92. UWS.

Bioremediation of Herbicide-Contaminated Soil and Water. Harris, Armstrong. 1991. UWS.

Renovation of Pesticide Contaminated Rinse Waters. Chesters, Harkin. 1991. UWS.

Contamination Attenuation Indices for Sandy Soils: Tools for Information Transfer. McSweeney, Madison. 1991. UWS.

Reactions of Chlorohydrocarbons on Clay Surfaces. Fripiat. 1991. UWS.

Design of a Small Scale Transportable Mixing/Loading System. Kammel. 1991. DATCP.

Evaluation of Potential Phytotoxicity and Crop Residues when Using Sprayer Rinsate as a Portion of the Diluent in Pesticide Spray Mixtures. Binning. 1991. DATCP.

To Expand Groundwater Sampling in the Lower Wisconsin River Valley. Cates, Madison, Postle. 1991.

DNR. DNR Project #78.

Waupaca County Groundwater Project: Towns of St. Lawrence and Little Wolf. Wilson, Blonde. 1991. DNR. DNR Project #79a.

Waupaca County: Towns of Lebanon and Scandinavia. Wilson, Blonde. 1992. DNR. DNR Project #79b.

Crop Rotations Effects on Leaching Potential and Groundwater Quality. Posner, Bubbenzer, Madison. 1991-92. DNR. DNR Project #80.

A Study of the Response of Nitrate and Pesticide Concentrations to Agricultural BMPs in Sandy Corn Fields. Madison, Cates. 1991-94. DNR. DNR Project #81.

A Comparative Study of Nitrate-N Loading to Groundwater from Mound, In Ground Pressure and at Grade Septic Systems. Shaw, Turyk. 1991-92. DNR. DNR Project #82.

The Biological Impact of Landfill Leachate on Nearby Surface Waters. Geis, Sonzogni, Standridge. 1991. DNR. DNR Project #83.

Dependence of Aldicarb Residue Degradation Rates on Groundwater Chemistry in the Wisconsin Central Sands. Kraft, Helmke. 1991-92. DNR. DNR Project #84.

Municipal Wastewater Project. Kopecky. 1991. DNR. DNR Project #85.

Arsenic as a Naturally Elevated Parameter in Water Supply Wells in Eastern Winnebago and Outagamie Counties. Stoll. 1992. DNR. DNR Project #87.

Spatial Attributes of the Soil-Landscape-Groundwater System of the Lower Wisconsin River Valley. McSweeney, Madison, Attig, Bohn, Falk. 1992-93. DNR. DNR Project #88.

Herbicide and Nitrate Movement in a Sandy Soil in the Lower Wisconsin River Valley. Lowery, McSweeney. 1992-93. UWS, DATCP.

Preliminary Comparison of a Discrete Fracture Model with a Continuum Model for Groundwater Movement in Fractured Dolomite. Bradbury, Muldoon. 1992. DNR. DNR Project #89.

Evaluation of NURE Hydrogeochemical Groundwater Data for Use in Wisconsin Groundwater Studies. Bradbury, Mudrey, Shrawder. 1992. DNR. DNR Project #90.

Distribution of Radionuclides in Wisconsin Groundwater. Bradbury, Mudrey. 1992. DNR. DNR Project #91.

Assessment of Wisconsin's Groundwater Monitoring Plan Program for Active Non-Approved Landfills (1985-1990). Pugh, Gear. 1992. DNR. DNR Project #92.

GIS Mapping of Groundwater Contaminant Sources, Quality and Contamination Susceptibility for Door County. Carlson, Stoll, Hronek. 1992-93. DNR. DNR Project #93.

Effects of Transient Cross-Stratification Flow on Contaminant Dispersion. Bahr. 1992-93. UWS.

Geographical Information System for Subsurface Characterization. Bosscher, Adams. 1992-93. UWS.

Distribution, Transport and Fate of Major Herbicides and Their Metabolites. Chesters. 1992-93. UWS, DATCP.

Use of Tire Chips to Attenuate VOCs. Edil, Park. 1992-93. UWS.

Living Mulch Systems for Nitrate Trapping in Vegetable Production. Harrison. 1992-93. UWS.

New Approaches to Measuring Biologic Effects of Groundwater Contaminants. Porter. 1992. UWS.

Estimating the Spatial Distribution of Groundwater Recharge Rates Using Hydrologic, Hydrogeologic and Geochemical Methods. Potter. 1992-93. UWS, DATCP.

Evaluation of Denitrification Systems for Improving Groundwater from On-Site Waste Disposal Systems. Shaw 1992-93. DNR. DNR Project # 95.

Optimization of Two Recirculating Sand Filters for Nitrogen and Organic Chemical Removal from Domestic Wastewater. Shaw. 1994. DNR. (Continuation of DNR Project #95).

Remediation of Soils Contaminated by Leaking Underground Storage Tanks by Vapor Extraction and *In-situ* Biostimulation. Hickey, Jacobsen, Bubbenzer. 1992-93. DNR. DNR Project #96.

Municipal Wastewater Absorption Pond Renovation for Enhanced Nitrogen Removal. Gilbert. 1992-93. DNR. DNR Project #97.

Investigation of Potential Groundwater Impacts at Demolition Landfills and Deer Pits. Pugh, Connelly. 1992-93. DNR. DNR Project #98a.

Investigation of Potential Groundwater Impacts at Yard Waste Sites. Pugh, Connelly. 1994. DNR. DNR Project #98b.

Dane County Atrazine/Land Management Project. Conners, Bohn, Madison, Muldoon, Richardson. 1992. DNR, DATCP. DNR Project #99.

Facility Plan Amendment for Wastewater Collection for Green Lake Sanitary District, Green Lake, WI. McMahon & Assoc. 1991. DILHR.

On-site Nitrogen Removal Systems Research Demonstration Project: Phase I. Ayers & Assoc. 1991. DILHR.

Nitrogen Removal from Domestic Wastewater in Unsewered Areas. Otis, Converse. 1992-96. DILHR.

Trace Metal Transport Affected by Groundwater Stream Interactions. Bahr. 1993-94. UWS.

Management of Sweet Corn Processing Wastes to Protect Groundwater Quality. Bundy. 1993-94. UWS.

Impact of Tunnel Dewatering on Surface Water Bodies in Milwaukee County. Cherkauer. 1993-94. UWS.

Ultrasonic Verification Technique for Evaluating Well Seals. Edil 1993-94. UWS.

Field Evaluation of Near Source Transport of Contaminants in Heterogeneous Media. Hoopes. 1993-94. UWS.

Variability of Hydraulic Conductivity in Supraglacial Sediments. Mickelson. 1993-94. UWS.

The Impact of Atrazine Management Areas Designation on Weed Control Strategies in Wisconsin Corn Production. Nowak. 1993. DATCP.

Evaluation of Five Groundwater Susceptibility Assessments in Dane County, Wisconsin. Bridson, Bohn. 1993-94. DNR. DNR Project #100.

Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite. Bradbury, Muldoon. 1993-94. DNR. DNR Project #101.

Urban Stormwater Infiltration: Assessment and Enhancement of Pollutant Removal. Armstrong. 1993-94. DNR. DNR Project #102.

Long-Term Transformation and Fate of Nitrogen with Mound Type Soil Absorption Systems for Septic Tank Effluent. Harkin. 1993-94. DNR. DNR Project #103.

A Further Study of Organics at Wisconsin Municipal Solid Waste Landfills. Connelly. 1993-94. DNR. DNR Project #104.

Comparative Evaluation of Biostimulation Approaches for Enhancing in Situ TCE Degradation in Contaminated Aquifers. Hickey. 1994. UWS.

Stratigraphy, Sedimentology and Porosity Distribution of the Silurian Rocks of the Door Peninsula, WI. Harris. 1994. UWS.

Improved Design of Pump and Treat Systems for Heterogeneous Aquifers. Bahr, Anderson. 1994. UWS.

Herbicide Contamination of Soil and Groundwater at a Mixing-Loading site. Chesters. 1994. UWS, DATCP.

Photocatalytic Degradation of Volatile Organic Carbon. Anderson, Marc, Hill. 1994. UWS.

Mineral Phase Sorption of Selected Agrochemicals to Wisconsin Soils. Grundl. 1994. UWS.

Using "Predict" to Reduce Herbicide Usage and Improve Groundwater Quality. Harvey. 1994. UWS.

Leaching Potential of Imazethapyr and Nicosulfuron in Sparta Sand. Lowery. 1994. DATCP.

Integrated Computerized Mapping of Point Source Contaminants and Physical Environmental Characteristics to Protect and Manage Groundwater Quality. Stoll. 1994. DNR. DNR Project #105.

An Investigation of Field-Filtering and Low-Flow Pumping When Sampling for Metals. Connelly. 1994. DNR. DNR Project #106.

Groundwater Hydrogeology of an Agricultural Watershed. Potter 1994-95. DATCP and DNR. DNR Project #109.

The Further Incidence of Native Arsenic in Eastern Wisconsin Water Supply Wells; Marinette, Oconto, Shawno and Brown Counties. Stoll. 1994. DNR. DNR Project #110.

Factors Affecting the Determination of Radon in Groundwater. Sonzogni. 1994. DNR. DNR Project #111.

Groundwater Survey of Alachlor and ESA its Polar Metabolite in Southern Wisconsin. Vanden Brook, Postle. 1994. DNR, DATCP. DNR Project #112.

Cover Crops to Limit Herbicide Use on Sweet Corn. Newenhouse. 1994. DATCP.

The Use of Peat as an Absorptive Medium. Wiersma and Stieglitz. 1994. DATCP.

Photocatalytic degradation of volatile organic carbon. Anderson. 1994-1995. UWS. UWS Project #94REM2B2.

Improved design of pump and treat systems for heterogeneous aquifers. Bahr. 1994-1995. UWS. UWS Project #94REM3B2.

Herbicide contamination of soil and groundwater at a mixing and loading site. Chesters. 1994-1995. UWS and DATCP. UWS Project #94PES2B2.

Mineral phase sorption of selected agrichemicals to Wisconsin Soils. Grundl. UWS. 1994-1995. UWS Project #94PES1B2.

Stratigraphy, sedimentology, and porosity distribution of the Silurian rocks of the Door Peninsula, Wisconsin. Harris. 1994-1995. UWS. UWS Project #94HGE2B2

Using 'PREDICT' to reduce herbicide usage and improve groundwater quality. Harvey, 1994-1995. UWS. UWS Project #94PES6B2.

Comparative evaluation of biostimulation approaches for enhancing *in situ* TCE degradation in contaminated aquifers. Hickey. 1994-1995. UWS. UWS Project #94REM6B2.

Application of a Discrete Fracture Flow Model for Wellhead Protection at Sturgeon Bay, Wisconsin. Bradbury and Muldoon. 1995-1996. DNR. DNR Project #113.

A Comparison of Low Flow Pumping and Bailing for VOC Sampling. Connelly. 1995. DNR Project #114.

An Evaluation of Long-term Trends and a Mineralogical Interpretation of Naturally Occurring Metals Contamination and Acidification of the St. Peter Sandstone Aquifer. Weissbach. 1995-1996. DNR. DNR Project #115.

Agrichemical Impacts to Groundwater Under Irrigated Vegetables in the Central Sand Plain. Kraft. 1995-1996. DNR. DNR Project #116.

Characterization of E. Coli and Total Coliform Organisms Isolated from Wisconsin Groundwater and Reassessment of their Public Health Significance. Sonzogni. 1995. DNR. DNR Project #117.

Collection of Hydraulic and Geologic Data to Improve the Quality of the Wisconsin Groundwater Monitoring Network. Zaporozec. 1995-1996. DNR. DNR Project #118.

Vertical and Horizontal Variability of Hydrogeologic Properties in Glaciated Landscapes. Mickelson. 1995. DNR. DNR Project #119.

Direct and Residual Effects of Land-applied Sweet Corn Processing Wastes on Nitrate Loss to Groundwater.

Bundy. 1995-1996. DNR. DNR Project #120.

A Low-Input Crop Management Plan for Wisconsin Fresh-Market Vegetable Growers. Delahaut. 1995. DATCP.

Tracer Study for Characterization of Groundwater Movement and Contaminant Transport in Fractured Dolomite. Bradbury. 1995-1996. UWS.

Evaluating the Effectiveness of Landfill Liners. Benson. 1995-1996. UWS.

Geologic Constraints on Arsenic in Groundwater with Applications to Groundwater Modeling. Simo. 1995. UWS.

Integration of Hydraulics and Geology into a Hydrostratigraphic Model for the Paleozoic Aquifer of Eastern Dane County, Wisconsin. Cherkauer. 1995. UWS.

Use of Heavy Nitrogen to Study Nitrate Flux from Septic Systems. Harkin. 1995-96. UWS/COMM.

Development and Demonstration of an Accurate Manure Spreading System to Protect Water Quality, Improve Waste Management and Farm Profitability. Shinnars. 1995-96. UWS.

Evaluation of Enzyme-linked Immunosorbent Assay for Herbicide Analysis of Wisconsin Soil in Comparison to Gas Chromatography. Sonzogni. 1995. UWS.

Synergistic Effects of Endocrine Disrupters in Drinking Water. Porter. 1995-96. UWS.

Delineation of Capture Zones for Municipal Wells in Dane County, Wisconsin. Bradbury. 1996. DNR. DNR #121.

Optimum Management of Ground-water Resources in the Lower Fox River Valley. J. Krohelski. 1996-97. DNR. DNR #122.

Variability of Nitrate Loading and Determination of Monitoring Frequency for a Shallow Sandy Aquifer, Arena, Wisconsin. F. Madison. 1996-97. DNR. DNR # 123.

Evaluation of Shallow-soil Absorption Fields Associated with Advanced On-site Disposal System. R. Stieglitz. 1996-97. DNR/UWS/COMM. DNR #125

GIS as a Tool to Prioritize Environmental Releases, Integrate their Management, and Alleviate their Public Threat. R. Stoll. 1996-97. DNR. DNR # 126.

Responses of Biological Toxicity Tests to Mixtures of Pesticides and Metabolites. G. Chesters. 1996-97. UWS.

The Use of Azimuthal Resistivity & Self Potential Measurements to Delineate Groundwater Flow Direction in Fractured Media. R. Taylor. 1996. UWS.

Stratigraphic Controls on the Mobilization and Transport of Naturally Occurring Arsenic in Groundwater: Implication for Wellhead Protection in Northeastern Wisconsin. T. Simo. 1996. UWS.

Characterization of the Role of Evapotranspiration on Groundwater Movement and Solute Chemistry in

Groundwater-fed Wetlands. K. Potter. 1996-97. UWS.

Bioremediation of Hydrocarbons Influenced by Air Sparging: A Multi-model Approach to Assess Contaminant Mass Removal. J. Bahr. 1996. UWS.

Biostimulation of Trichloroethylene Degradation in Contaminated Aquifers. W. Hickey. 1996. UWS.

Evaluation of Well Seals Using an Ultrasonic Probe. T. Edil. 1996. UWS.

An Integrated Approach to the Management of Insects in Sweet Corn Grown for Fresh Market. Wedberg. 1996-97. DATCP.

Land Use Effects on Groundwater and Streamwater Quality in the Little Plover River Watershed. B. Shaw. 1996-97. DATCP.

Iron-based Abiotic Destruction of Chlorinated Solvents and Pesticides in Groundwater. Eykholt. 1996. DATCP.

Ground-water Recharge and Contamination in Wisconsin's Driftless Area. K. Potter. 1996. DATCP.

Evaluation of Shallow-Soil Absorption Fields Associated with Advanced On-site Disposal System. R. Stieglitz. 1996-97. COMM.

A Study of Well Construction Guidance for Arsenic Contamination in Northeast Wisconsin. A. Weissbach 1997-98, DNR # 127.

Stratigraphic Controls on Distribution of Hydraulic Conductivity in Carbonate Aquifers. T. Simo. 1997-98, DNR # 129

Evaluation of the Use of DUMPSTAT to Detect the Impact of Landfills on Groundwater Quality. K. Potter. 1997. DNR # 130

Nitrate-Contaminated Drinking Water Followback Study. W. Kanarek. 1997. DNR # 131

Improved Detection Limits for Ground Water Monitoring. W. Sonzogni. 1997. DNR/UWS. DNR # 128

Groundwater Protection by Application of Modern Portfolio Theory to Microbiotesting Strategies. G. Blondin. 1997. UWS.

Development of a Variable Rate Nitrogen Application Approach for Corn. L. Bundy. 1997-98. UWS.

Experimental Verification of Models Used to Evaluate Landfill Liner Effectiveness. T. Edil. 1997. UWS.

Stratigraphy, sedimentology, and Porosity Distribution of the Silurian Aquifer of Ozaukee County, Wisconsin. M. Harris. 1997. UWS.

Improved Estimation of Groundwater Recharge Rates. Anderson. 1997. UWS.

Hydrogeochemical and Microbiological Studies for Enhanced Ground Water Bioremediation. Bahr. 1997-98. UWS.

Groundwater Bioremediation: Monitoring with MMO Probes. Collins 1997-98. UWS.

Treatment of Groundwater Contaminated with Chlorinated Aliphatics Using a Silicone Tubing Supported Methanotrophic Biofilm Reactor. Park. 1997-98. UWS.

In situ Air Sparging: Air Plume Characterization and Removal Effectiveness. Benson. 1997-98. UWS.

Fate of Nicosulfuron in Sparta Sand. Lowery. 1997. DATCP.

Determining Compatibility Between Herbicide Release and Habitat for Karner Blue Butterfly in Red Pine Plantations. Sucoff. 1997. DATCP.

Molecular Techniques for Detection and Identification of Sewage-Borne Human Pathogens in Soils. W. Hickey. 1997-98. COMM.

Holding Tank Effluent and Fecal-Contaminated Groundwater: Sources of Infectious Diarrhea in Central Wisconsin? M. Borchardt. 1997-98. COMM.

Relationships Between Water Quality in Stream Base Flow and Private Wells and Land use in the Tomorrow/Waupaca River Watershed, B. Shaw, 1998-99, DNR #132

Northeast Region Public Water Supply Location Utilizing Geographic Information Systems and Global Positioning Systems. R. Stoll , 1998, DNR #133

Characterization of the Hydrostratigraphy of the Deep Sandstone Aquifer in Southeastern Wisconsin, T. Eaton, 1998-99, DNR #134

Evaluation of Geology and Hydraulic Performance of Wisconsin Ground-Water Monitoring Wells, A. Zaporozec, 1998, DNR # 135

Further Evaluation of Well Seals Using an Ultrasonic Probe, T. Edil, 1998, DNR #136

Groundwater-Surface Water Interactions in the Nine Springs Watershed. J. Bahr, 1998-99, DNR # 137

Evaluation of the Confining Properties of the Maquoketa Formation in the SEWRPC Region of Southeastern Wisconsin. K. Bradbury, 1998, DNR # 138

Assessment of Impacts on Groundwater/Lake and Wetland Systems Mary Anderson 1998, UWS

Investigation of Air Sparging: Numerical Modeling, Laboratory Verification and Design Guidelines J. Hoopes 1998-99, UWS

Watershed-Scale Nitrate Contamination and Chlorofluorocarbon Ages in the Little Plover Basin: A Study at the Groundwater/Surface Water Interface B. Browne, 1998-99, UWS

Determining Ground-Water Recharge Rates in Southern Washington County D. Cherkauer, 1998-99, UWS

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Natural Attenuation of Fuel and Related Groundwater Contaminants - A Measurement Method. W. Sonzogni. 1999, UWS.

On-line SFE/GC for Improved Detection of Trace Organic Pollutants in Ground Water Monitoring. D. Armstrong. 1999, UWS/DATCP.

Fate of the Herbicides Atrazine, Cyanazine, and Alachlor and Selected Metabolites. D. Stoltenberg. DATCP. 1999.

Using Geographic Information Systems and Soil Landscape Models to Predict Critical Sites for Nonpoint Source Pollution. B. Lowery. DATCP. 1999.

Assessing and Reducing Leaching of Agricultural Chemicals on Silt Loam Soils under Different Farming Systems. K-J. Kung. DATCP. 1999.

WISCONSIN FERTILIZER RESEARCH COUNCIL RESEARCH

The Wisconsin Fertilizer Research Program was a pioneering idea to obtain research support from the private sector which would improve agricultural profitability and, at the same time, protect our natural resources. As state and federal research monies continues to decline, funds from fertilizer sales will become even more important in terms of helping farmers make wise decisions regarding fertilizer use in Wisconsin.

Each year, the State of Wisconsin collects fees from the sale or distribution of fertilizer, pursuant to Chapter 273, State Laws of 1977. This includes a \$0.10 per ton fee that is earmarked for research. At the end of each year, these moneys are forwarded to the University of Wisconsin system to be used for research on soil management, soil fertility, plant nutrition problems and for research on surface water and groundwater problems which may be related to fertilizer usage; for dissemination of the results of the research; and for other designated activities tending to promote the correct usage of fertilizer materials. Research is conducted by investigators within the University of Wisconsin system. These investigators submit proposals for research to the Fertilizer Research Council for funding consideration. If the University of Wisconsin system is unable to carry on the projected research, the Council may recommend other appropriate nonprofit research institutions or agencies for receipt of funds. Projects funded in FY 99 and projects selected in FY 99 for funding in FY 00 are listed in the following tables.

RESEARCH PROJECTS FUNDED BY THE FERTILIZER RESEARCH COUNCIL FOR FY 99

Project Number	Project title	Lead Project Investigator	Affiliation	Objective	Duration
166-98	The Lancaster Experiment: Crop Rotations for the Unglaciaded Soils of the Upper Mississippi Valley	R.Higgs,	UW-Platteville, Agriculture	To evaluate nitrogen contributions from legume crops in rotations compared to N fertilized continuous corn; To provide access to experiment and long-term data for research on long-term crop management effects on crop production, N cycling and environmental issues as well as economic evaluations.	3 years
167-98	Dynamic Simulation of Soil Nitrate for N Fertilizer Management	W.L. Bland	UW-Madison, Soil Science	To create a dynamic simulation model of nitrogen dynamics in the mineral soils used for potato production in Wisconsin.	2 years
168-98	Evaluation of Slow Release Fertilizer to Aid Establishment of Cranburry Vines in Upland Settings.	T. Roper	UW-Madison, Horticulture	To evaluate the effect of various slow release fertilizers for suitability to provide nitrogen to new cranberry vines; To evaluate cranberry vine growth and precocity resulting from nitrogen from slow release sources.	3 years
171-98	Effect of Subsoiling on Soil Physical Properties and Crop Growth in Several Wisconsin Soils	R.P. Wolkowski	UW-Madison, Soil Science	To evaluate crop growth and yield response to subsoiling; To determine the changes in soil physical properties from subsoiling; To evaluate whether subsoiling effects plant nutrient removals.	3 years

RESEARCH PROJECTS FUNDED BY THE FERTILIZER RESEARCH COUNCIL FOR FY 00

Project Number	Project title	Lead Project Investigator	Affiliation	FY 00 Funding
172-99	Effect of Tillage and timing on legume N mineralization and N credit to small grains	Dr. Keith Kelling	UW- Madison Soil Science Dept	\$9,790
173-99	Characterization of nitrogen uptake efficiency of new commercial apple rootstocks and scions	Dr. Teryl Roper	UW- Madison Dept of Horticulture	\$4,000
175-99	Nitrogen application effects on residue decomposition and no-till corn yields	Dr. LG Bundy	UW- Madison Soil Science Dept	\$9,400
177-99	Phosphorus losses in runoff from Wisconsin soils	Dr. LG Bundy	UW- Madison Soil Science Dept	\$8,000
178-99	Using airborne remote sensing to evaluate nutrient stress and crop performance in large crop production fields	Dr. Ronald Schuler	UW-Madison Biological Systems Engineering Dept	\$7,800
180-99	Evaluation of soil test levels in grid sampled fields treated with variable-rate fertilizer applications	Dr. Richard Wolkowski	UW- Madison Soil Science Dept	\$6,325
183-99	Evaluating a standard field method for measuring nitrogen mineralization	Dr. J M Norman	UW- Madison Soil Science Dept	\$8,875
184-99	Interaction of soil pH and rate of topdressed K on alfalfa forage mineral levels, yield and quality	Dr. Keith Kelling	UW- Madison Soil Science Dept	\$10,416
185-99	Investigations into improved nitrogen use efficiency of potatoes	Dr. Keith Kelling	UW- Madison Soil Science Dept	\$8,000

GROUNDWATER EDUCATION ACTIVITIES OF THE DEPARTMENT OF PUBLIC INSTRUCTION

The Department of Public Instruction (DPI), though not a member agency of the GCC does promote and support educational activity related to surface and groundwater quality. DPI is represented on the GCC Education Subcommittee. In FY 99 DPI staff were involved in the following professional development programs:

- During The DPI continues to make available to agricultural teachers, the video entitled “How to fill and seal a well”. Copies of the video were provided by the DNR. This video has been made available since January of 1997 when DPI agricultural education consultants held an in-service workshop for teachers.
- During the 1998 Wisconsin Association of Vocational Agriculture Instructors Summer Conference, a workshop was conducted by CWGC, WGNHS, and DNR staff on the “Groundwater Study Guide” Approximately 20 people attended this session.
- At the same conference, a workshop conducted by DNR staff was offered on well abandonment. The workshop was attended by approximately 15 people

For more information contact Dean Gagnon - Agricultural Education Consultant at the DPI at (608)267-9255.

GROUNDWATER ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY WATER RESOURCES DIVISION - WISCONSIN DISTRICT

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

- * Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- * Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface water and ground water.
- * Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress.
- * Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- * Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.
- * 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 District is currently conducting cooperative projects that have a significant ground-water component with the DNR, WGNHS, Southeast Wisconsin Regional Planning Commission (SEWRPC), the Menominee Tribe of Wisconsin, and the Bad River Band of Lake Superior Chippewa. In addition, several projects are funded by Federal agencies: EPA-Region V, U.S. Fish and Wildlife Service (USFW) and USGS. On going projects and completed projects with reports in preparation or recently published that have a significant ground-water component are listed below.

On going projects with State and local agencies

1. Ground-water observation well network (WGNHS)
2. Wisconsin water-use data file (DNR)
3. Southeast Wisconsin Hydrologic Study (SEWRPC, DNR, WGNHS)
4. Hydrologic studies to mitigate future North Fork Urbanization impacts on the Pheasant Branch Watershed in the Lake Mendota Priority Watershed (DNR)
5. Characterization of part of the aquifer flow system in the vicinity of the Bad River Indian Reservation (Bad River Band)
6. Hydrologic review of proposed zinc-copper mine near Crandon (DNR)
7. Delineation of municipal well zones of contribution in the Lower Fox River Valley (DNR)
8. Delineation of zones of contribution for Zoar (Menominee Tribe)

On going projects with Federal agencies

1. Superfund remedial response support (EPA)
2. Hydrologic and biogeochemical budgets in temperate lakes and their watersheds, Northern Wisconsin (USGS)
3. Western Lake Michigan Drainages National Water-Quality Assessment (USGS)
4. Characterization of groundwater and surface water systems of the Necedah Wildlife Refuge (USFW)
5. Groundwater/surface water Interaction – Mississippi River, Pool 8 (USGS-Biological Resources Division)

Completed projects with reports in preparation or recently published

1. Hydrogeology and simulation of groundwater flow in the sandstone aquifer, Northeastern, Wisconsin (East Central Wisconsin Regional Planning Commission and several Lower Fox River Valley municipalities)
2. Optimum management of groundwater resources in the Lower Fox River Valley (DNR)
3. Numerical simulation of groundwater in Dane County, Wisconsin (Dane County Regional Planning Commission and WGNHS)

A summary of the Wisconsin District projects and listing of publications is published annually in "Water-Resources Investigations in Wisconsin." Copies of the summary are available at the Wisconsin District Office or by calling 608/821-3801. For more information please contact Jim Krohelski, USGS, 8505 Research Way, Middleton, Wisconsin, 53562-3581 (608/821-3850), jtkrohel@usgs.gov or visit the Wisconsin District web page (wi.water.usgs.gov).

Groundwater Activities of the Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is a federal agency within the U.S. Department of Agriculture. The NRCS, formerly the Soil Conservation Service, works with private landowners to promote conservation of natural resources. 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.
- animal waste storage: proper waste storage is imperative to protect groundwater from contamination by nutrients in animal waste.
- Farm*A*Syst Program: a site assessment program to determine areas of possible groundwater contamination on a farm or rural home - enables individuals to apply management practices to their own property. <http://www.wisc.edu/farmasyst>
- Wetland Reserve Program - restores wetlands through permanent or 30-year easements or 10-year contracts.
- Environmental Quality Incentives Program - provides cost sharing for conservation practices on agricultural land. 1999 statewide priorities include groundwater protection practices such as well decommissioning and nutrient and pesticide management and prescribed grazing.
- well decommissioning: proper decommissioning is essential to prevent contaminants from entering groundwater through abandoned wells, which are direct conduits to the groundwater.
- Conservation Reserve Program: participants establish permanent vegetative cover on agricultural lands in return for guaranteed rental payments.

The agency also provides leadership in the following:

- Interagency committee to find improved joint sealers for concrete animal waste storage structures. These sealers are critical to the groundwater protection provided by these structures.
- Interagency Committee to revise NRCS Conservation Practice Standard, Code 313 - Waste Storage Facility. This revision will enhance groundwater protection by increasing the distance between the base of a waste storage structure and the water table, and minimizing the number of joints allowed in concrete structures.

To find out more information about NRCS, go to the home page at <http://www.wi.nrcs.usda.gov> or contact Renae Anderson at 608-276-8732 ext. 227.

STATUTORY LANGUAGE RELATING TO THE GCC

SECTION 2. 15.347 (13) of the statutes is created to read:

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 industry, labor and human relations.
 3. The secretary of agriculture, trade and consumer protection.
 4. The secretary of health and social services.
 5. The secretary of transportation.
 6. The president of the university of Wisconsin.
 7. The state geologist.
 8. One person to represent the governor.
 9. ~~One person who is a member of a local health department under s. 149.09, appointed by the governor to represent local health departments.~~ (Vetoed in part)
- (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 ~~and 9~~ shall be appointed to 4-year terms. (Vetoed in part)
- (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 members of appropriate standing committees of the legislature and the governor, 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.

Non-statutory provisions: Natural Resources

- (9) GROUNDWATER COORDINATING COUNCIL: INITIAL APPOINTMENTS. (a) Notwithstanding section 15.347 (13)(d) of the statutes, as created by this act, the initial member appointed to the groundwater coordinating council under section 15.347 (13) (b) 8 of the statutes, as created by this act, shall be appointed for a term ending on July 1, 1987 ~~and the initial member appointed to the groundwater coordinating council under section 15.347 (13) (b) 9 of the statutes as created by this act, shall be appointed for a term ending on July 1, 1985.~~ (Vetoed in part)
- (b) Following initial appointments under paragraph (a), members appointed to the groundwater coordinating council under section 15.347 (13) (b) 3 and 4 of the statutes, as created by this act, shall serve for the terms prescribed under section 15.347 (13) (d) of the statutes as created by this act.

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.

- (2) **SUBCOMMITTEES.** The groundwater coordinating council may create subcommittees to assist in its work. The subcommittee members may include members of the council, employees of the agencies with members on the council, employees 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... (this act) and report to the legislature concerning the implementation of the act by January 1, 1989.