# Comprehensive planning in Wisconsin: centralizing access to ground-water information for use in comprehensive planning. [DNR-190] 2007

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#190

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## Centralizing Access to Ground-Water Information for Use in Comprehensive Planning


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# BACKGROUND/NEED

Groundwater, lakes, rivers, streams, and wetlands are among Wisconsin's greatest natural resources. Over 95% of Wisconsin's communities and about 75% of Wisconsin residents rely on ground water for their drinking water supply. Ground water is equally vital to industry and agriculture. In order for communities to plan for the future, it is essential that both the quantity and quality of groundwater be protected.

Wisconsin law requires that by January 1, 2010 all communities that make specified land-use decisions must do so consistent with their comprehensive plan. Groundwater is a recognized factor in all nine required elements of comprehensive plans, and much information and data exist to address the role of groundwater in those nine elements. However, many communities, particularly smaller communities, do not have the resources or expertise to locate, evaluate, and incorporate appropriate groundwater information and data in their comprehensive plans.

In many instances it is difficult for a community to know where to begin because Wisconsin groundwater information and data exist in many forms and formats, and it resides with many different state and federal agencies (Wisconsin Department of Natural Resources, Wisconsin Geologic and Natural History Survey, University of Wisconsin System, Wisconsin Department of Administration, Wisconsin Department of Trade and Consumer Protection, Wisconsin Department of Commerce, U.S. Geological Survey, National Resource Conservation Service, and many more). Some information and data are easily accessible, and others are hard to locate and transmit. By providing a means for centralizing access to information and data, it will be easier for those involved in planning to know what is available and how to utilize it. Centralizing web access will also enhance the efficiency of information and data gathering by the users, diminish the needs to expend considerable amount of time and resources to develop a large new web structure, and minimize duplication of providing similar information and data by different agencies and organizations.

If Wisconsin groundwater information and data are made accessible and user-friendly, it is much more likely that it will be used in the comprehensive-planning process. Comprehensive plans that adequately address the range of groundwater issues based on the best information available will play a very important role in protecting the groundwater resources of their communities and the state.

# OBJECTIVES

The objectives of this project were to:

1. identify the range of groundwater information and data useful for addressing groundwater in comprehensive planning,
2. identify means of centralizing world-wide web access to groundwater information and data,
3. establish the chosen centralized access,
4. incorporate characteristics or features believed important for the centralized site,
5. include on the centralized site results of ongoing evaluations of groundwater in adopted comprehensive plans, and
6. ensure that the existence and capabilities of the site are advertised to the broad range of potential users.

These objectives were accomplished by a project team and advisory panel identified in Appendix A.

# METHODS

With the assistance of the project advisory panel, we

1. Surveyed existing websites in Wisconsin that are providing groundwater information relevant to comprehensive planning,
2. assisted three pilot counties in incorporating groundwater information, goals and policies in their comprehensive plans, with the objective of learning what information and layout they found most valuable,
3. spoke with multiple agencies to determine the optimal home for the new website,
4. conducted a survey of intended website users which provided the basis for our design of a user-friendly web structure for displaying groundwater data, maps, and other information,
5. incorporated on centralized web site an outlet for results of current assessment of groundwater in comprehensive plans, and
6. investigated means of long-term support of the web site to allow for maintenance and updating of information, data, and results from analysis of groundwater in comprehensive plans.

# RESULTS AND DISCUSSION

The results section is organized into eight main areas:

1. Groundwater information and data useful for addressing groundwater in comprehensive planning
2. Survey results identifying characteristics or features important for the centralized site
3. Linking of groundwater information and data to centralized website
4. Centralized website
5. Inclusion on the centralized site of results of ongoing evaluations of groundwater in adopted comprehensive plans
6. Description of how the website and capabilities of the site were advertised to the broad range of potential users
7. Project feedback to date
8. Recommendations for future work

1. Groundwater information and data useful for addressing ground water in comprehensive planning

   A. Scientific information

   A search of agencies and websites identified by the investigators and the project advisory panel was undertaken to determine what groundwater information was available from various agencies and organizations. The groundwater information search results are included as Appendix B.

   B. DNR/UWEX groundwater and comprehensive planning fact sheets

   We chose to include three very relevant fact sheets about groundwater and comprehensive planning that were developed by DNR and UW-Extension. These fact sheets were linked to the website and also served as an organizational structure for some parts of the website. They are:

   - *Groundwater and Its Role in Comprehensive Planning: Comprehensive Planning and Groundwater, Fact Sheet 1*, 2002, Wisconsin Groundwater Coordinating Council, 4 pp.
   - *Resources To Help You Protect Your Drinking Water Supply: Comprehensive Planning and Groundwater, Fact Sheet 2*, 2002, Wisconsin Groundwater Coordinating Council, 4 pp.

- *Residential Development and Groundwater Resources: Comprehensive Planning and Groundwater, Fact Sheet 3*, 2002, Wisconsin Groundwater Coordinating Council, 4 pp.

C. Comprehensive planning information

We also considered the following two comprehensive planning publications, but did not find significant information in them about community planning for groundwater.

- *Planning for Natural Resources: A Guide to Including Natural Resources in Local Comprehensive Planning*, 2002, Department of Urban & Regional Planning, University of Wisconsin-Madison/Extension and Wisconsin Department of Natural Resources, >82 pp.
- *Planning for Agriculture in Wisconsin: A Guide for Communities*, 2002, UW Cooperative Extension and Wisconsin Department of Agriculture, Trade and Consumer Protection, >96 pp.

D. Pilot communities assisted with groundwater component of comprehensive plan

We assisted three pilot counties (Portage, Lafayette, and Oconto) in incorporating groundwater information, goals and policies in their comprehensive plans to learn what information and layout they found most valuable. For each pilot county, we prepared a graphic-rich report summarizing groundwater information in the county, and gave well-received presentations to a total of 200 local government officials about our findings. Working with county staff, local government officials and regional planning staff to develop these reports and presentations provided valuable experience in developing reports for the other 69 counties.

The county groundwater reports were prepared and presented to the pilot counties as follows:

- We prepared a 12 page county groundwater report for Portage County to incorporate in their comprehensive plan. This report was largely a summary of the most recent Portage County Groundwater Plan. Lynn Markham presented the findings to approximately 15 members of the Portage County Rural Comprehensive Planning Committee on January 11, 2006. This report was developed in collaboration with the Portage County Planning Department and USGS.
- We prepared a 19 page county groundwater report for Lafayette County to incorporate in their comprehensive plan. Lynn Markham and Dave Johnson (WDNR) presented this report to ~120 plan commissioners in Lafayette County on August 2, 2006. The audience asked many questions and we received multiple positive comments. This report was developed in collaboration with DNR, UWEX, WGNHS, WRWA, USGS, Central Wisconsin Groundwater Center, and Southwest Wisconsin Regional Planning Commission.
- We prepared a 28 page county groundwater report for Oconto County to incorporate in their comprehensive plan – see Appendix C. Lynn Markham and Kevin Masarik

(Central Wisconsin Groundwater Center) presented the findings to approximately 60 local government officials in Oconto County on April 18, 2007. This report was developed in collaboration with Oconto County, DNR, UWEX, WGNHS, WRWA, USGS and the Central Wisconsin Groundwater Center.

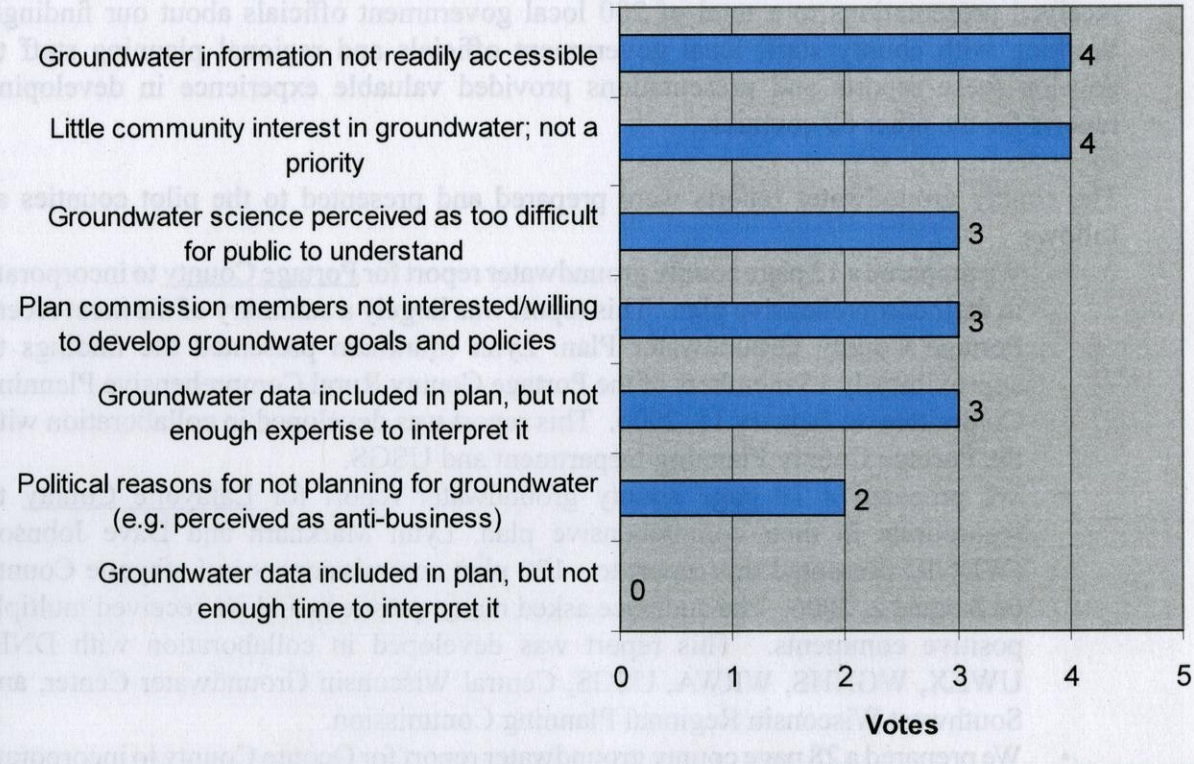
2. Survey results identifying characteristics or features important for the centralized site

This survey was developed by the investigators in collaboration with the project advisory panel, and sent to private consultants, regional planning commission staff, government staff and others who assist communities in developing their comprehensive plans. The survey can be found in Appendix D.

## Respondents

Nine people working for consulting planning firms, regional planning commissions and the government completed our survey. Seven of these people have significant experience assisting communities with comprehensive planning, having helped 113 communities. They have assisted communities in all regions of the state and at all local levels of government (towns, villages, cities and counties). The results presented below reflect the experience of these 7 people.

**Figure 1: Main barriers for including groundwater information in comprehensive plans**



## Main barriers

The respondents identified a diverse set of barriers for including groundwater information in comprehensive plans as shown in Figure 1.

The centralized groundwater planning website can directly address making groundwater data more accessible, and minimizing time necessary to compile it. We will also work to address some of the other barriers including raising community interest in groundwater by providing localized information, providing a primer about groundwater science, and providing example groundwater goals and policies. We also recognize the need to provide training for plan writers to help them interpret groundwater data.

## Preferred methods for receiving on-line groundwater information

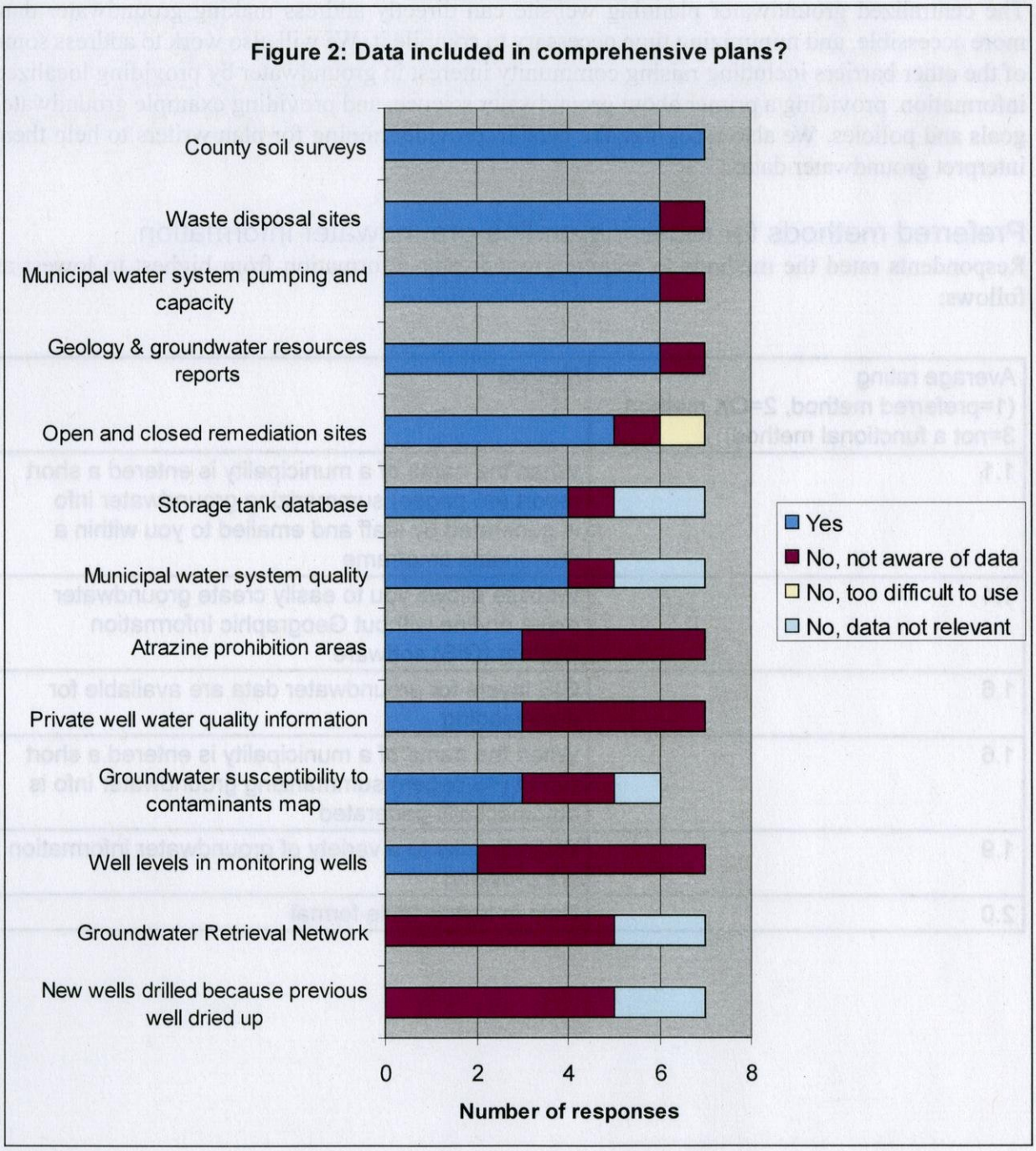
Respondents rated the methods to receive groundwater information from highest to lowest as follows:

| Average rating (1=preferred method, 2=OK method, 3=not a functional method) | Method |
|---|---|
| 1.1 | When the name of a municipality is entered a short report (<5 pages) summarizing groundwater info is generated by staff and emailed to you within a reasonable timeframe |
| 1.4 | Website allows you to easily create groundwater maps on-line without Geographic Information System (GIS) software |
| 1.6 | GIS layers for groundwater data are available for downloading |
| 1.6 | When the name of a municipality is entered a short report (<5 pages) summarizing groundwater info is automatically generated |
| 1.9 | Website links to a variety of groundwater information are provided |
| 2.0 | Data in text or table format |

## Groundwater data included in past comprehensive plans

Figure 2 illustrates which types of data respondents have included in comprehensive plans; and if they have not included a certain type of groundwater data, why this is the case.

**Figure 2: Data included in comprehensive plans?**




Most respondents have included data in comprehensive plans regarding county soil surveys, waste disposal sites, municipal water system pumping and capacity, geology and groundwater reports

and open and closed remediation sites. Data types included in comprehensive plans by less than half of the respondents include: groundwater susceptibility to contaminants, atrazine prohibition areas, private well water quality, well levels in monitoring wells, groundwater retrieval network data and new wells drilled because previous well dried up. The primary reason data were not included was because plan writers were not aware of the data.

3. Linking of groundwater information and data to centralized website

Based on the survey results, we compiled the most recent data from the sources identified earlier and created reports for each county that are included on the website. For each set of data, the source is given and where possible a website link is provided so that users can check for more recent or detailed data.

4. Centralized website

A. Potential locations for website

Multiple locations for the website were explored including WDNR, WGNHS, CLUE and USGS.

B. Chosen location and rationale

Based on the feedback we received from potential host agencies and the capabilities of these agencies to host the site, we chose USGS because they have a dedicated web master and staff who were available to develop the website. WGNHS has recently expressed an interest in "adopting" the website and these discussions continue.

C. Design of website

The website was designed by USGS web design staff to respond to the results of our survey of planners. A visually simple template was chosen to help users easily find the information they seek. The website includes four main sections based on the common needs of potential users. A clickable map of the state helps users quickly find local groundwater information.

D. Content of website

We created a website called *Protecting Wisconsin's Groundwater Through Comprehensive Planning*. The website incorporates data from 16 federal, state and local agencies, and is intended to make Wisconsin groundwater information and data accessible and usable, thereby encouraging government officials and planners to incorporate groundwater into their comprehensive-planning processes. Communities that have already adopted their comprehensive plans will have an opportunity to incorporate additional groundwater data from this website during plan revisions.

This web site is located at http://wi.water.usgs.gov/gwcomp and organized into four sections: Learn, Integrate, Find, and Browse.

The Learn section is to help users learn more about how groundwater is used in Wisconsin and what scientific researchers have found about how groundwater moves and how it can be contaminated. This section also provides links to a number of fact sheets about planning for groundwater, a recent report about many groundwater issues in Wisconsin, and a few key reports about the connections between land, groundwater, and lakes and streams.

The Integrate section is designed to help users integrate groundwater into their comprehensive plan. It includes groundwater-specific recommendations for five steps of the planning process:

Step 1: Review pre-planning actions
Step 2: Inventory groundwater data and analyze trends
Step 3: Develop groundwater goals, objectives and policies
Step 4: Prioritize policies
Step 5: Decide how to monitor progress

Step 3, in particular, includes a number of key components to planning for ground water:

- Topics to consider under each of the nine comprehensive planning elements
- Wisconsin's top 5 groundwater planning and policy recommendations
- Examples of actions taken at the local level that protect groundwater

The Find section provides an executive summary and full report about groundwater in each of Wisconsin's 72 counties including:

- Sources of drinking water
- Groundwater protection policies
- Money spent on cleanup
- Groundwater use
- Susceptibility of groundwater to pollutants
- Groundwater quality
- Potential sources of contaminants

The Browse section contains:

- References for the footnotes in the text
- Links to web resources for data and information
- Links to groundwater programs at state and federal agencies
- Links to assist in locating groundwater and planning expertise

A printout of the website, except for the county reports is included as Appendix E. The Wood County executive summary and full report are included as Appendix F. The reports for all 72 counties are available on the website.

5. Inclusion on the centralized site of results of evaluations of groundwater in adopted comprehensive plans.

The results and recommendations developed from reviewing 79 adopted comprehensive plans are linked to the second portion of the website: Integrate groundwater into your comprehensive plan.

6. Description of how the website and capabilities of the site were advertised to the broad range of potential users

In addition to email announcements to advisory panel members and all contributors to the project, please see the **Related publications** and the **Related presentations** sections on page 15.

7. Project feedback to date

Based on our survey results, pilot county projects and discussions with our wide-ranging project advisory group, we learned that professional planners, citizen plan commissioners, local elected officials and communities were "thirsty" (pardon the pun) for groundwater information relevant to their communities. Measures of this include:

- the eight counties that expressed interest in becoming pilot counties
- approximately 200 local government officials in three counties who attended well-received local groundwater presentations
- additional requests from local groups to present about our findings in their geographical areas
- requests from multiple counties to get access to their specific county information before the website was on-line

While the website has been on-line only a few months, initial feedback is very positive including:

- "*I've started looking through the website you put together and am very impressed! You've done a nice job pulling tons of groundwater information together.*" WDNR groundwater staff
- "*This is a great resource for planning. Thank you for your efforts.*" WDNR land use staff
- "*I've been looking through the new groundwater planning website. I'm really learning a lot and enjoying how nicely laid out the site is. It's very easy to navigate...Thanks very much!*" UW-Extension Educator
- "*Thank you for the opportunity to review the groundwater planning website. I thought it was beautifully organized, very clear, and easy to build on information and resources. This will be an enormously helpful resource!*" Professional planner

8. Recommendations for future work

Users of our website have also stated that they want additional information available in this centralized location. Specifically they have requested

- expanding the groundwater quantity information in Wisconsin and ensuring the website references the latest activities of the Wisconsin Groundwater Advisory Council

- expanding the information available for each county about money spent on groundwater clean-up to include monies spent on brownfield remediation (DNR) and agrichemical spills (DATCP)
- providing additional case studies about water conservation efforts
- providing additional case studies about community groundwater efforts in other states
- enhancing the information about private wells by including the number of private wells in each county and additional water quality parameters
- updating the following three WGNHS publications written over 15 years ago about local governments' legal authority in adopting groundwater policies
    - *Groundwater Protection through Local Land Use Controls*, 1991
    - *Groundwater Quality Regulation: Existing Governmental Authority and Recommended Roles*, 1991
    - *A Guide to Groundwater Quality and Management for Local Governments*, 1987

We have submitted a grant application in response to the to the Groundwater Coordinating Committee's FY 2009 Joint Solicitation to address most of these recommendations.

# PUBLICATIONS, PRESENTATIONS. FUNDING

## Related Publications

Is Your Community Planning to Protect Its Drinking Water? *Land Use Tracker*, Fall 2007

Is Your Community Planning to Protect Your Drinking Water? A New Website Can Help, *Wisconsin Counties Association Magazine*, November or December 2007.

Lisa Gaumnitz with the DNR is drafting a press release for newspapers about this project, and also may write an article for the Wisconsin Natural Resources magazine.

Additional publications are planned with the Wisconsin chapter of the American Planning Association and the Wisconsin Towns Association.

## Related presentations:

In addition to the presentations given for the three pilot counties, presentations about this project were given for:

- Approximately 160 UW-Stevens Point geography students in 2006.
- Approximately 20 members of the Stevens Point Area Rotary Club in 2007.
- Approximately 100 members of the Wisconsin Counties Association (county board members) in 2007.
- Approximately 40 town board members for the Wood County Wisconsin Towns Association in 2007.
- A poster about this project has been accepted for the Association of Natural Resource Extension Professionals 2008 conference in Madison.
- An additional presentation is planned for the 2008 Wisconsin AWRA meeting.

## Funding:

Funding for this project came from the Wisconsin Department of Natural Resources and the University of Wisconsin System through the Joint Solicitation for Groundwater Research & Monitoring of Wisconsin's Groundwater Coordinating Council. Additional funds were provided by the U.S. Geological Survey Cooperative Water Program.

# APPENDIX A: PROJECT TEAM AND ADVISORY PANEL

**Project Team**

The team responsible for developing the web site *Protecting Wisconsin's Groundwater Through Comprehensive Planning* is made up of the following individuals:

| **UW-Extension**<br>**Center for Land Use Education** | **U.S. Geological Survey**<br>**Wisconsin Water Science Center** |
|---|---|
| Lynn Markham | Charles Dunning |
| Christine Mechenich | Anne Moser |
| Raquel Miskowski | Jennifer Bruce |
| | Elizabeth Woodcock |
| | James Rauman |

**Advisory Panel**

An advisory panel was formed early in this project to address groundwater in comprehensive planning. This panel has been consulted at critical points in the development and review of this web site. The authors express their deep appreciation for the involvement of the individuals on the panel in supporting this effort.

Jerry Braatz, UW-Extension
Kenneth Bradbury, UW-Extension, WGNHS
Nancy Eggleston, Wood County
David Hart, WGNHS
Dana Jensen, Vandewalle & Associates
Sally Kefer, WDNR
Tom Larson, Wisconsin Realtors Association
Pam Lazaris, Planning Service & Solutions
David Lindorff, WDNR
Peter Manley, UW-Extension
Kevin Masarik, Central Wisconsin Groundwater Center, UW-Stevens Point
Edward Morse, Wisconsin Rural Water Association
Dave Neuendorf, UW-Extension
Paul Ohlrogge, UW-Extension
Jim Vandenbrook, DATCP

Ray Schmidt, Portage County
Aaron Schuette, City of Green Bay
Larry Ward, Southwestern Wisconsin Regional Planning Commission
Bobbie Webster, UW-Stevens Point

**Other assistance**

The authors have received valuable assistance from other individuals including Jeffery Helmuth, David Johnson, and Timothy Asplund, WDNR ; Jeffery Postle and Bruce Rheineck, WDATCP; Madeline Gotkowitz, UW-Extension, WGNHS; and Cheryl Buchwald, USGS.

# APPENDIX B: GROUNDWATER INFORMATION SEARCH RESULTS

| Where does your community's groundwater come from? | Source of data |
|---|---|
| Aquifers | WGNHS paper reports? |
| Yield from aquifers | Well construction report CD for specific capacity from existing wells |
| Groundwater time of travel maps | Only from consultants? |
| How susceptible is your community's groundwater to contamination from near the land surface? | |
| Groundwater susceptibility (general) | http://www.uwex.edu/wgnhs/gwmap.htm |
| Soils | WGNHS, NRCS on web? |
| Surficial deposits | WGNHS, on web? |
| Type of bedrock | WGNHS, on web? |
| Depth to bedrock | WGNHS, on web? |
| Depth to water table = groundwater flow direction | WGNHS paper reports; list of reports available is online at http://www.uwex.edu/wgnhs/watertable1.htm |
| Water quantity: Is the groundwater level changing? | |
| Municipal wells - current production | Annual municipal water reports from PSC (pdf files) http://psc.wi.gov/apps/wegs/content/criteria.asp?type=water |
| Municipal wells - capacity | Included in annual PSC reports?? |
| # of municipal water systems | http://prodmtex00.dnr.state.wi.us/pls/inter1/pws2$.startup |
| # of municipal water wells | |
| Total # of wells | DNR well construction report CD and number of wells from scanned images (1936-1988) (WGNHS) |
| # of new wells since 1988 | DNR well construction report CD |
| # of wells replaced or reconstructed since 1988 | DNR well construction report CD |
| # of high cap wells | http://prodmtex00.dnr.state.wi.us/pls/inter1/hicap$.startup |
| Water use over time by county (Is GW broken out?) | http://water.usgs.gov/watuse/ |
| Estimated community GW pumping rate | PSC reports (annual reports), database?? DNR has monthly pumping reports that |

| | |
|---|---|
| | are in hardcopy, last entered in 1997 |
| Is the groundwater level changing? | |
| # of wells replaced or reconstructed that were due to "dry well" | DNR well construction report CD, everything since 1988 |
| Water level changes in USGS monitoring wells (1975 to present) | http://wi.water.usgs.gov/public/gw/HISTORICAL/historical.html |
| Municipal water level differences (compares when well was drilled to 2000) | Special DNR report in 2000, Dave Johnson created and has map and data |
| What are the existing and potential contaminant sources that could impact your wells? | |
| Water quality (inorganics) | http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup |
| Inorganic contaminants (As, Fe, Pb, Mn, NO3 – GRN data) | http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup |
| % of county samples >10ppm nitrate on map and over time | Upcoming DNR statewide nitrate publication |
| Pesticides (Groundwater Retrieval Network (GRN) data) | http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup |
| Atrazine prohibition areas (atrazine levels in wells were above the drinking water standard) | http://www.legis.state.wi.us/cr_final/00-119.pdf has statewide map in pdf file. Previously more detailed maps were available at http://datcp.state.wi.us/arm/agriculture/pest-fert/pesticides/accp/contact.html |
| Volatile Organic Compounds (VOCs) including benzene, tetrachloroethylene, and chloroform (GRN data) | http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup |
| Bacteria (coliforms, fecals? – GRN data) | http://prodmtex00.dnr.state.wi.us/pls/inter1/grn$.startup |
| Toxic releases (Toxic release inventory – EPA) | http://epamap20.epa.gov/tri/emtri.asp |
| Closed remediation sites on statewide map (groundwater contamination, soil contamination, groundwater and soil contamination) | http://dnr.wi.gov/org/aw/rr/gis/index.htm |
| DNR's Bureau for Remediation and Redevelopment Tracking System (BRRTS) | http://botw.dnr.state.wi.us/botw/SetUpBasicSearchForm.do |

| | |
|---|---|
| open and closed remediation sites, searchable by county or municipality | |
| Storage tank database (WI Dept of Commerce) – searchable by county and municipality; includes what was/is stored and quantity | http://www.commerce.state.wi.us/ER/ER-EN-tanks-info.html |
| Landfills - all licensed landfills and many that are not licensed. Registry updated in 1999, pdf doc organized by county** | Registry of waste disposal sites: http://dnr.wi.gov/org/aw/rr/archives/pubs/RR108.pdf<br><br>Active landfills: http://dnr.wi.gov/org/aw/wm/faclists/WisLic_SWLandfills.pdf<br><br>General info: http://dnr.wi.gov/org/aw/rr/brrts/databases.htm |
| Solid and Hazardous Waste Information Management System (SHWIMS – DNR) | http://sotw.dnr.state.wi.us/sotw/Welcome.do |
| Superfund sites | DNR: http://dnr.wi.gov/org/aw/rr/archives/pubs/RR005.pdf<br><br>EPA: http://www.epa.gov/region5/superfund/index.html |
| Concentrated animal feeding operations with greater than 1000 animal units | http://dnr.wi.gov/org/water/wm/nps/rules/nr243/NR243.htm |
| Large quantity hazardous waste generators | http://www.epa.gov/reg5rcra/wptdiv/hazardous/index.html<br><br>http://www.epa.gov/epahome/commsearch.htm |
| Leaking Underground Storage Tank and other spills sites | GIS registry: http://dnr.wi.gov/org/aw/rr/gis/index.htm<br><br>BRRTS: http://dnr.wi.gov/org/aw/rr/brrts/index.htm |
| Wisconsin Pollutant Discharge Elimination System permitted outfalls (groundwater and surface water) | http://dnr.wi.gov/org/water/wm/ww/index.htm |
| Manure storage facilities other than CAFOs | http://dnr.wi.gov/org/water/wm/nps/animal.htm |
| Does the groundwater from municipal wells meet drinking water standards? | |
| Consumer confidence reports (accuracy?) | http://prodmtex00.dnr.state.wi.us/pls/inter1/pws2$.startup |

# APPENDIX C: OCONTO COUNTY GROUNDWATER REPORT

# Oconto County groundwater information for comprehensive planning

*March 21, 2007*

**Executive summary**

Maintaining the quality AND quantity of groundwater is vital to safeguarding the economy and quality of life in Oconto County, and protecting the health of its residents.

The following table summarizes the findings of this report.

| GROUNDWATER FINDINGS |
|---|
| Susceptibility of groundwater to pollutants |
| • Susceptibility varies throughout county.<br>• The majority of highly susceptible groundwater areas are in the north part of county. |
| Sources of drinking water |
| • 26% of county residents get drinking water from five municipal water utilities.<br>• 74% of county residents get drinking water from private wells. |
| Groundwater quality |
| • 97% of 941 private well samples met the health standard for nitrate.<br>• 92% of 203 private well samples met the health standard for arsenic.<br>• 80% of private well samples met the health standard for bacteria.<br>• Limited testing for pesticides.<br>• Public wells have consistently met health standards with the exception of arsenic in two of the Village of Suring wells. |
| Potential contaminants |
| • 3 confined animal feeding operations (large dairies).<br>• 40 sites with contaminated groundwater and/or soil.<br>• Naturally occurring contaminants such as arsenic, radium, radon and chloride.<br>• No currently licensed landfills and no Superfund sites. |
| Groundwater quantity |
| • Water use in 2000 is ~25% less than in 1979.<br>• No regional effects of pumping are observed, but there is always the possibility of local effects from high capacity wells. |
| Money spent on cleanup |
| • Over $12 million has been spent on petroleum cleanup from leaking underground storage tanks which works out to $332 per county resident. |
| Groundwater protection policies |
| • Of 5 municipal water utilities, only Suring has a wellhead protection plan. Gillett, Lena and Oconto Falls have one in progress or plan to start soon.<br>• Of 5 water utilities, only Suring has a wellhead protection ordinance.<br>• County has manure management ordinance for areas outside of cities and villages. |

**Recommended groundwater policies**

Based on the facts in the table above, the authors of this report recommend the following policies to protect groundwater in Oconto County.

## GROUNDWATER POLICY RECOMMENDATIONS

1. Adopt county approved wellhead protection plans and wellhead protection ordinances for municipal wells that don't currently have them. These plans and ordinances are used to avoid locating petroleum and other potential groundwater contaminants in areas where contaminants could enter drinking water supplies. These areas often include land within the city/village and land in the towns which are under county zoning. See the *Goals and Policies* section for a table summarizing where plans and ordinances are needed.

2. Identify and properly seal unused wells. Unused wells can act as a direct conduit for contaminants to quickly travel from the land surface to the groundwater. Portage County Groundwater Specialist Ray Schmidt (715-346-1334) has developed a program to seal unused wells which may serve as a useful model. Unused wells may be identified using the Farm-A-Syst program or by driving around to look for abandoned farmsteads and old wind mills. Soon the DNR will have well abandonment forms scanned that could be crossed with the well construction report files to identify unused wells which have not been properly abandoned/sealed.

3. Provide educational programs for private well users about the responsibilities and protection measures that come with private wells. 74% of county residents get their drinking water from private wells. Water testing and drinking water programs are available through UW-Extension. In addition, the Wisconsin Groundwater Directory contains a section listing organizations and resources for groundwater education at www.uwsp.edu/cnr/gndwater/info/WI%20Groundwater%20Directory%202006.pdf

4. Encourage farmers to adopt nutrient management planning, integrated pest management and rotational grazing practices which all reduce use of potential groundwater contaminants. These practices are particularly valuable near or in recharge areas for public wells, regions where there are a high density of private wells and around karst areas. For a description of karst and recommended actions to prevent groundwater contamination in karst areas see http://basineducation.uwex.edu/rockriver/documents/2005karst.pdf.

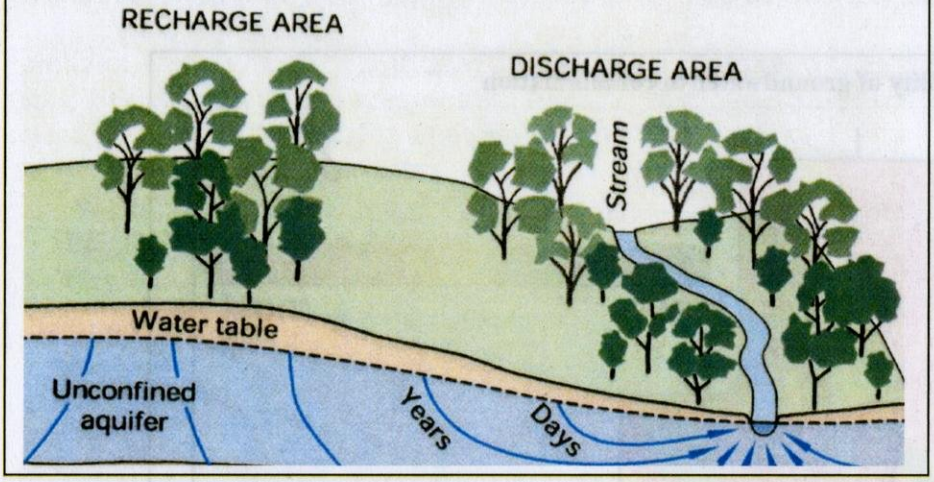
5. Encourage water conservation for businesses and residents on municipal water systems to avoid the increased expenses incurred when additional wells are needed.

**Introduction**

This report provides a county-wide look at groundwater resources. Site specific planning is necessary to analyze specific proposals.

Groundwater is the water that occupies the spaces in between soil particles and rocks below the earth. As shown in Figure 1, groundwater, lakes and rivers are all connected because water commonly flows between them. So if a substance gets in the groundwater it will eventually spread to nearby lakes and rivers and vice-versa. Groundwater is also connected to the surface of the land by rain and melted snow which carry substances from the surface of the land down to the groundwater and nearby drinking water wells.

**Figure 1: Groundwater, lakes and streams are all connected**




One hundred percent of water used by municipalities and in homes in Oconto County comes from groundwater. Industrial water users in Oconto County use surface water and groundwater.

Fertilizers, manure, land application of sewage, pesticides, on-site sewage disposal systems, chemical spills, leaking underground storage tanks, landfills, existing land uses and landowner practices are all potential pollutants for drinking water wells.

The remainder of this paper is organized as follow:

1) Groundwater inventory and analysis
    a. Groundwater susceptibility to contaminants
    b. Sources of drinking water
    c. Groundwater quality
    d. Potential sources of groundwater contaminants
    e. Groundwater quantity
    f. Geology and aquifers
    g. Money spent on cleanup
2) Groundwater goals and policies
    a. Goals
    b. Policies
    c. Next steps

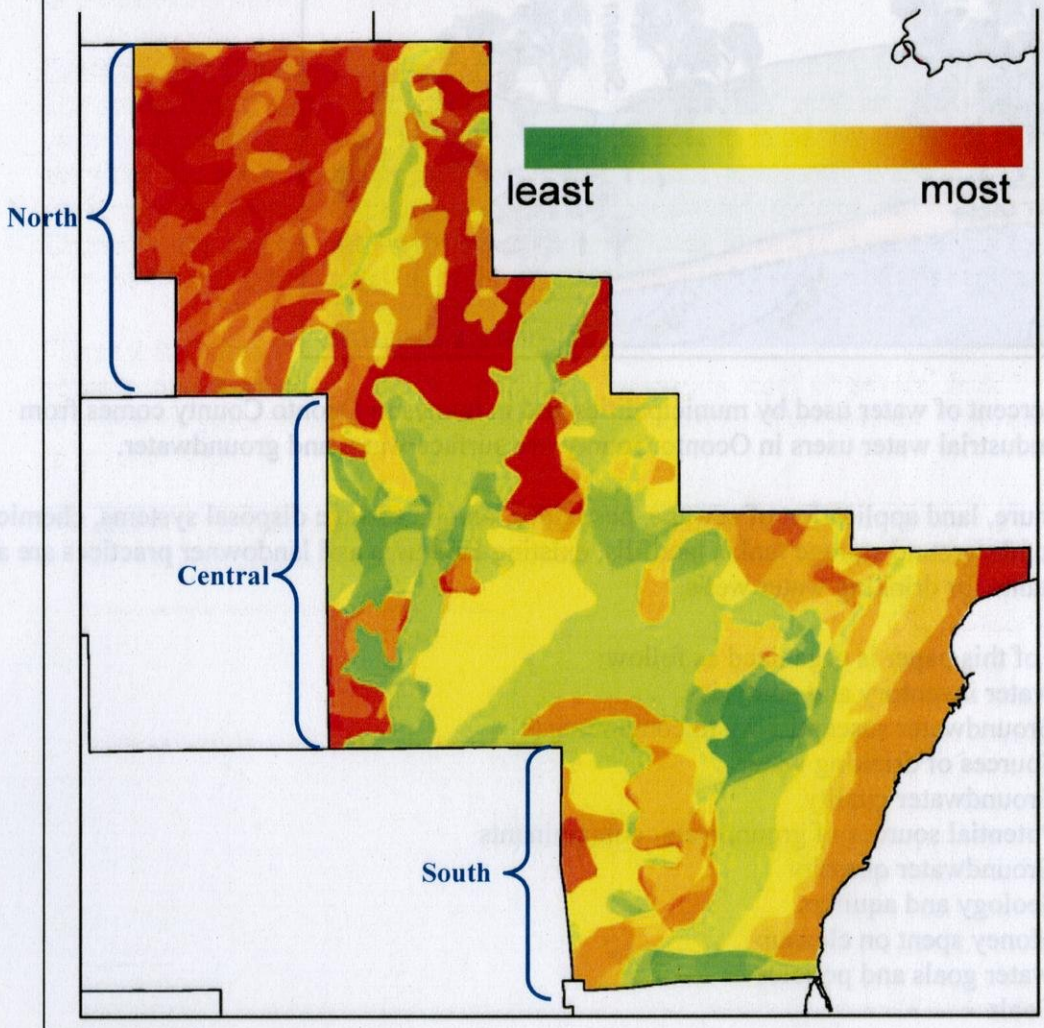
**Groundwater Inventory and Analysis**

Susceptibility of groundwater to contamination

The susceptibility of groundwater to contamination from land-use activities can be highly variable depending on location. It is important to keep in mind that the types of land use activities that are allowed, where they are located, and how carefully those activities are performed ultimately determine whether the groundwater resource becomes contaminated. Currently, the groundwater in the county that has been impacted most heavily by humans is in the central area as detailed in the groundwater quality section of this report.

Figure 2 indicates the relative susceptibility of groundwater to contamination from sources located on or near the land surface. The map is based on several factors thought to influence susceptibility, including depth to bedrock, aquifer type, soil type, and depth to groundwater.

**Figure 2: Susceptibility of groundwater to contamination**



The majority of highly susceptible groundwater areas are in the north part of the county with scattered highly susceptible areas elsewhere. Groundwater is generally less susceptible in the central and south parts of the county. For further information about the groundwater susceptibility factors, see the geology section of this paper.

Sources of drinking water

*Municipal wells*

As shown in Figure 3, five municipalities in Oconto County have 15 municipal wells that provide drinking water to 9,939 residents, or 26% of county residents.

**Figure 3: Municipal drinking water systems**[1]

| Water system | Wells and aquifers | Population served |
|---|---|---|
| Gillett | 3 wells in sand & gravel; 1well planned in sand & gravel | 1,356 |
| Lena | 2 wells in bedrock | 585 |
| Oconto | 3 wells in bedrock | 4,505 |
| Oconto Falls | 3 wells in bedrock | 2,892 |
| Suring | 2 wells in gravel; 1 well in sandstone | 601 |
| **All municipal systems** | **15 wells + 1 well planned** | **9,939** |

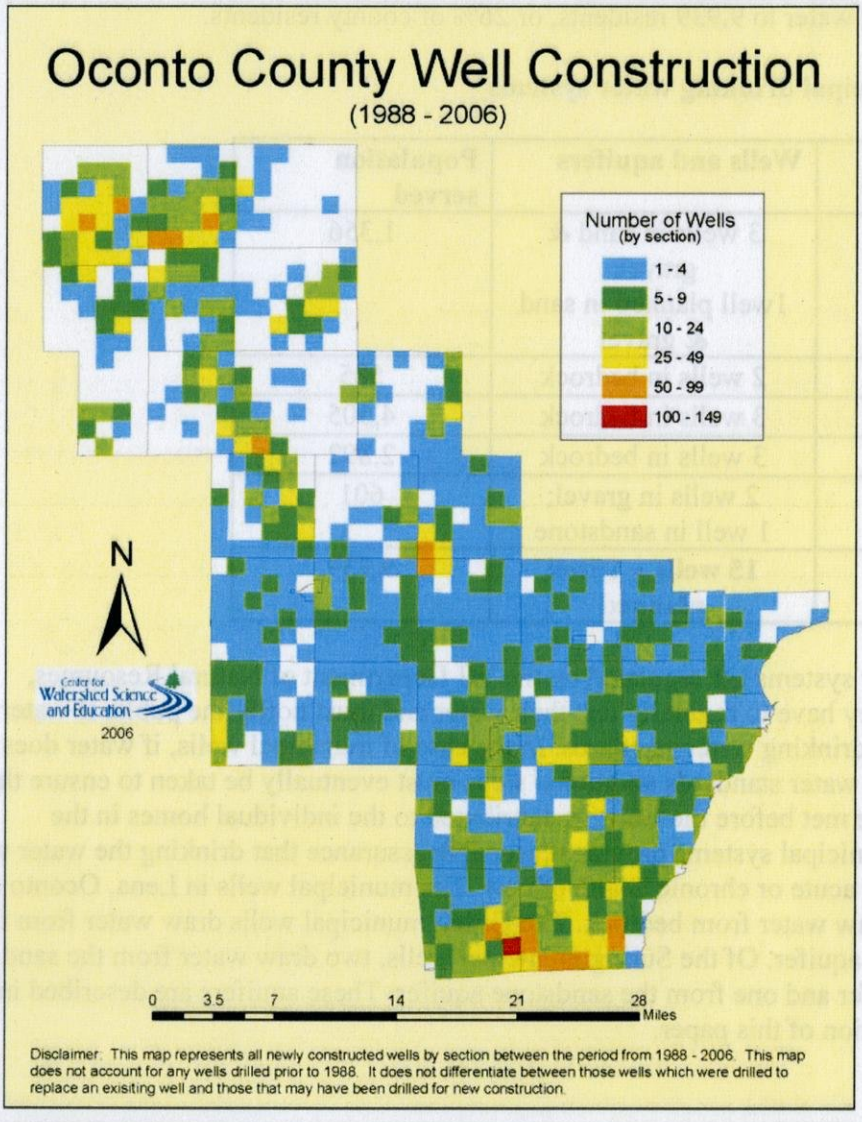
Municipal water systems are regulated by the WI Department of Natural Resources, meaning that they have to regularly test their water and must notify the public if water exceeds certain drinking water standards. In the case of municipal wells, if water does exceed drinking water standards additional steps must eventually be taken to ensure that the standards are met before the water is distributed to the individual homes in the community. Municipal systems provide reasonable assurance that drinking the water will not result in any acute or chronic health effects. The municipal wells in Lena, Oconto and Oconto Falls draw water from bedrock. The Gillett municipal wells draw water from the sand and gravel aquifer. Of the Suring municipal wells, two draw water from the sand and gravel aquifer and one from the sandstone aquifer. These aquifers are described in the geology section of this paper.

[1] DNR well data base, compiled by Ed Morse, Wisconsin Rural Water Association.

*Private Wells*

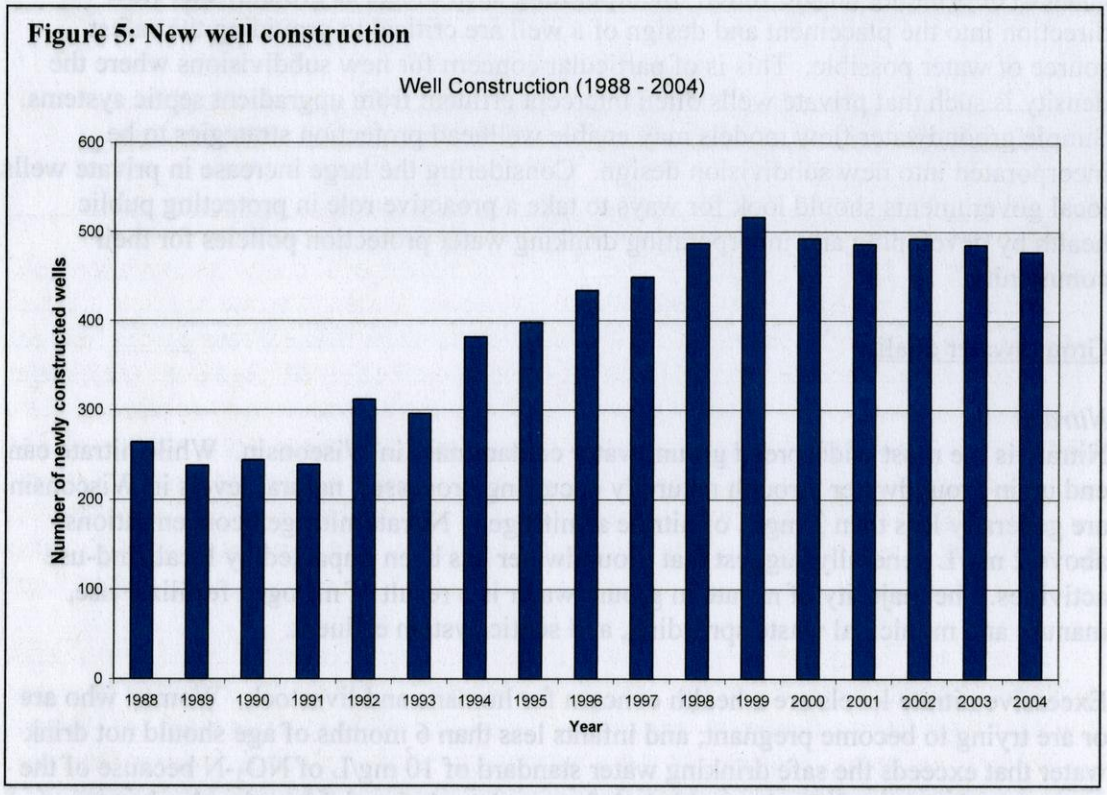
There have been over 12,000 wells constructed in Oconto County alone, the vast majority of which are private wells. Approximately 27,700 county residents, or 74%, get their drinking water from private wells. Figure 4 shows that from the period from 1988-2004 over 7,000 wells have been constructed, many of those newly constructed wells are concentrated in certain parts of the county.

**Figure 4**



The number of wells constructed each year in Oconto County has increased since 1988 as shown in Figure 5.

**Figure 5: New well construction**




Well construction which is regulated by the WI DNR (NR 812) is based on the premise that if a well and water system is properly located, constructed, installed and maintained the well should provide safe water continuously without the need for treatment. These regulations have specific guidelines regarding materials and methods used to construct a well, in addition to separation distances from potential sources of contamination. A coliform bacteria test is also required on all newly constructed private wells to ensure that the well is sanitary. This is a one time initial test and the only test that is required for private wells. While the majority of private wells in the state do produce high quality safe drinking water, some private wells may provide contaminated water to unsuspecting families."

After a well is drilled most homeowners are unaware of their responsibilities when it comes to owning a private well. The decision to test, and which contaminants to test for, is solely the responsibility of the individual well owner. If there is something wrong with the water supply it is the individual well owner's responsibility to determine what the risks are and whether those risks are great enough to correct the problem or find an alternative source of drinking water.

Unlike municipal wells, private wells are not required to have a wellhead protection plan. The recharge area for private wells is generally local and discrete. Therefore, it is

important for homeowners and well drillers to evaluate potential contamination sources when placing and deciding on the depth of a new well and casing in order to reduce the chances of drinking unsafe water. Incorporating such things as groundwater flow direction into the placement and design of a well are critical to providing the safest source of water possible. This is of particular concern for new subdivisions where the density is such that private wells often intercept effluent from upgradient septic systems. Simple groundwater flow models may enable wellhead protection strategies to be incorporated into new subdivision design. Considering the large increase in private wells, local governments should look for ways to take a proactive role in protecting public health by developing and incorporating drinking water protection policies for their community.

Groundwater quality

*Nitrate*

Nitrate is the most widespread groundwater contaminant in Wisconsin. While nitrate can end up in groundwater through naturally occurring processes, natural levels in Wisconsin are generally less than 2 mg/L of nitrate as nitrogen. Nitrate-nitrogen concentrations above 2 mg/L generally suggest that groundwater has been impacted by local land-use activities. The majority of nitrate in groundwater is a result of nitrogen fertilizer use, manure and municipal waste spreading, and septic system effluent.

Excessive nitrate levels are a health concern for humans and livestock. Women who are or are trying to become pregnant; and infants less than 6 months of age should not drink water that exceeds the safe drinking water standard of 10 mg/L of $NO_3$-N because of the concerns related to miscarriages, birth defects and methemoglobinemia, also known as "blue baby disease". High nitrate levels in feedstocks combined with high nitrate levels in water can be a lethal combination for livestock. In addition to health concerns, nitrate is also an environmental concern since it may be toxic to aquatic life and can cause excessive vegetative growth in aquatic systems. Nitrate is also considered an indicator of other health related contaminants such as pesticides if the source is fertilizer use or contaminants like pharmaceuticals or viruses if the source is septic system effluent.[2]

The ideal solution to high nitrate levels and other water quality problems caused by human activity is to eliminate the contamination source. In cases where the source of contamination is obvious, such as fertilizers or a nearby septic system, it may be easy to eliminate the source. However, identifying contamination sources can often be difficult or challenging, especially when dealing with non-point pollutants like nitrate. In addition, eliminating the contamination source may not result in a change in water quality for a long time since it may take years for newer uncontaminated water to replace the contaminated groundwater within the aquifer. While improving land management practices to reduce contamination or taking additional steps to eliminate groundwater contamination should be a goal of everyone in the community, it is important to realize

[2] Kevin Masarik, Central Wisconsin Groundwater Center.

that temporary solutions also often have to be implemented to avoid drinking unsafe drinking water in the short-term.[3]

Drilling deeper wells is sometimes a way to reduce nitrate levels because shallow wells are more susceptible to contamination from the surface of the land. However, it is important to note that drilling a deeper well does *not* guarantee lower nitrate levels. Nitrate levels can also be reduced by home water treatment systems that are certified specifically for nitrate removal and are capable of removing the amount of nitrate present.

Nitrate levels in Oconto County are generally low compared to other parts of the state. Of the 941 nitrate samples that have been collected in the county, 82 samples (11%) were above 2 mg/L and indicate that land use has likely affected groundwater quality; only 26 samples (3%) exceeded the safe drinking water standard.[4] Much of the information about nitrate in the county is due to information, education and water testing services provided by the Oconto County UW-Extension Office over the years. Residents of Oconto County should be encouraged by the low levels of nitrate in groundwater; however there are areas for improvement. As shown in Figure 6, most of the samples where nitrate levels were elevated were located in the central part of the county.[5] This may be because karst areas (limestone outcroppings and sink holes) are more common in the central part of the county than in the south. These out crops are farmed around and may act as conduits from the land's surface to the groundwater.[6] While some nitrate leaching is expected under agricultural lands and septic systems, extra precautions should be taken or encouraged to ensure that nitrate does not reach problem levels in other parts of the county.

[3] Kevin Masarik, Central Wisconsin Groundwater Center.
[4] WI DNR groundwater retrieval network.
[5] Map created by Kevin Masarik, Central Wisconsin Groundwater Center. The land use layer is from WISCLAND Land Cover created from satellite imagery collected in 1991 – 1993.
[6] Oconto County Planning and Zoning.

**Figure 6: Nitrate and land use**

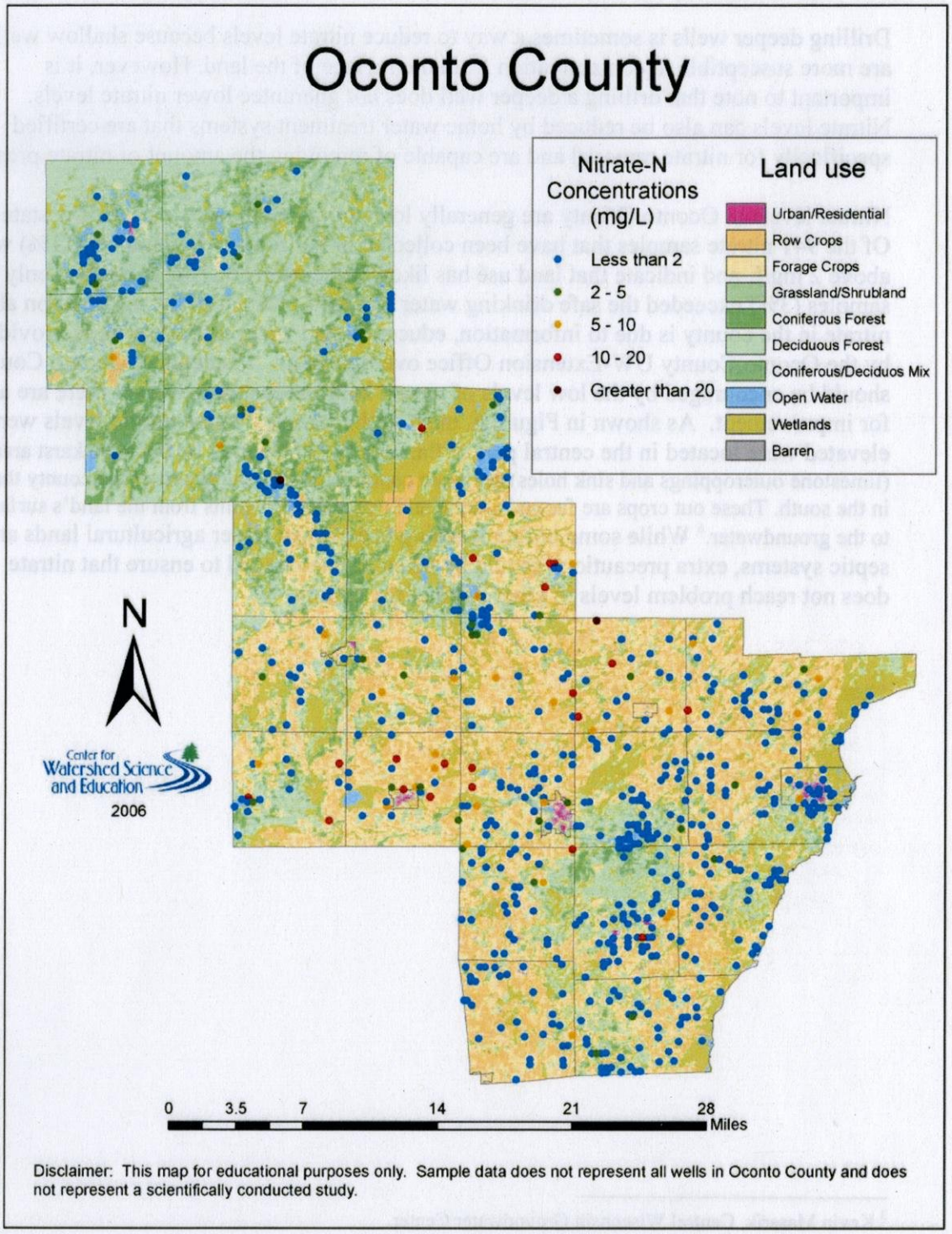
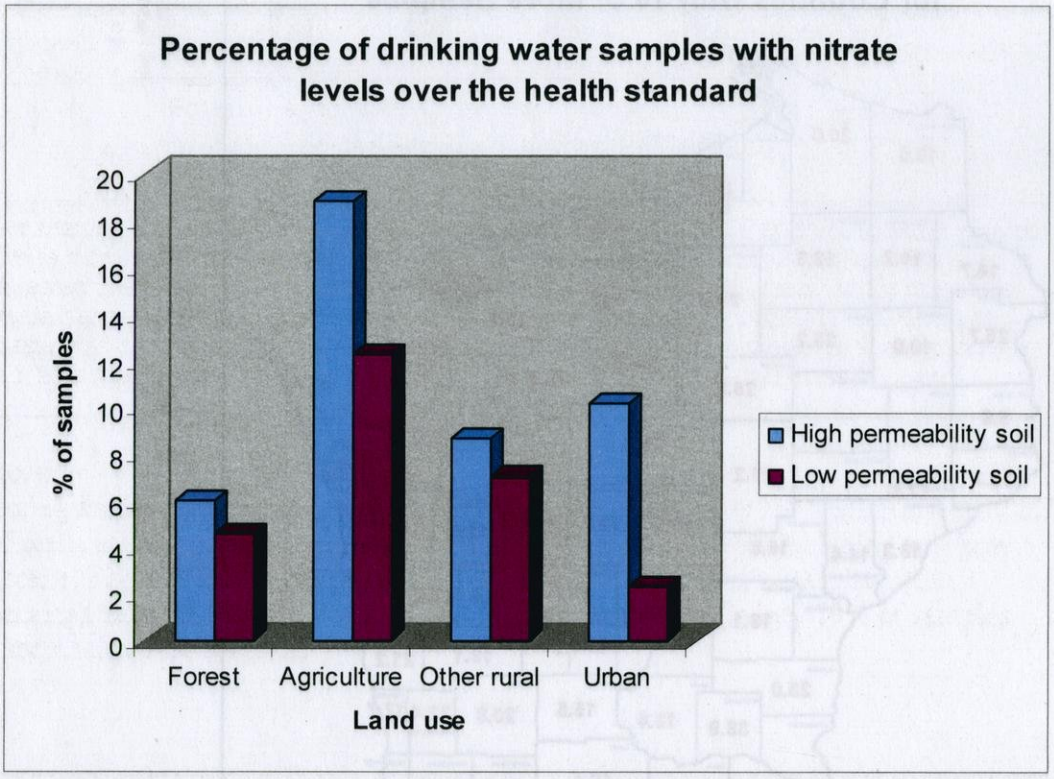


Figure 7 explains how the forest land use in the northwest part of the county probably protects the water quality despite its high susceptibility to contamination.[7]

**Figure 7: Land use – nitrate connection**



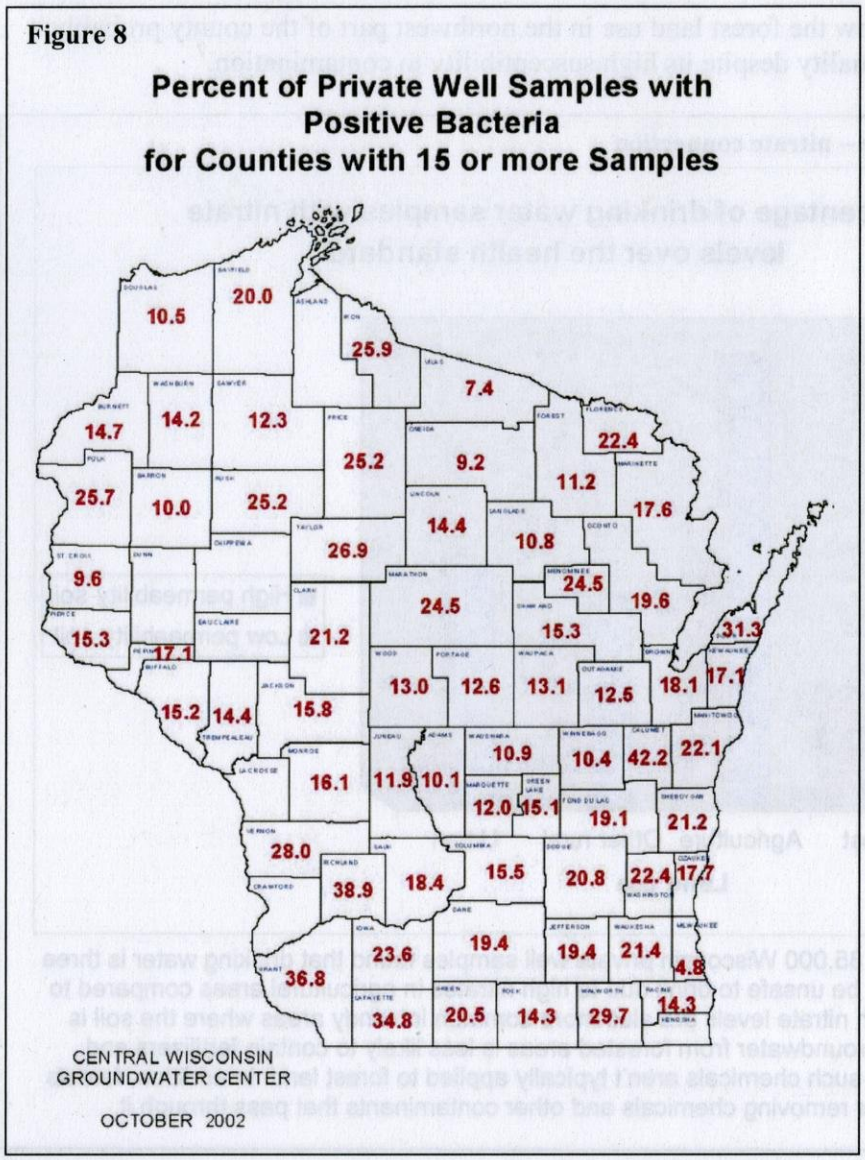

An analysis of over 35,000 Wisconsin private well samples found that drinking water is three times more likely to be unsafe to drink due to high nitrates in agricultural areas compared to forested areas. High nitrate levels are also more common in sandy areas where the soil is more permeable. Groundwater from forested areas is less likely to contain fertilizers and pesticides because such chemicals aren't typically applied to forest land. In addition, forests act as a natural filter removing chemicals and other contaminants that pass through it.

*Bacteria*

Testing for coliform bacteria helps to determine if a private well is bacterialogically safe. All wells that supply drinking water should be absent of bacteria including coliform bacteria. Figure 8 shows the percentage of sampled private wells that have been contained bacteria for each county in Wisconsin. In Oconto County 19% of samples tested positive for bacteria.

[7]Sample results compiled by David Mechenich at the Central Wisconsin Groundwater Center.

**Figure 8**




In most cases a properly constructed well (Well Construction is regulated by NR 812) will prevent bacteria and other disease causing organisms from entering a well. Soils are usually able to filter bacteria out of water before it reaches the saturated zone. Unfortunately in areas with thin soils or in karst regions, bacteria can more easily contaminate the groundwater aquifer. Under these conditions even a properly constructed well may become contaminated with bacteria. Installing wells according to required distances from septic systems, animal feedlots and manure pits should help in avoiding potential bacteria problems. Also, ensuring that pets are not allowed in the area directly surrounding the well is a good precaution. Bacteria can also enter wells through sanitary defects such as compromised well caps or well casings.[8]

[8] Kevin Masarik, Central Wisconsin Groundwater Center.

*Pesticides*
Pesticides include compounds used to kill weeds, insects, nematodes and fungi. When pesticides are spilled, disposed of, or applied on the soil, some amount can be carried into the surrounding surface water or groundwater. These products move with water and can eventually enter nearby drinking water wells. In a recent study of pesticides in Wisconsin groundwater the following commonly used herbicides (weed killers) and their metabolites were detected in varying percentages of private drinking water wells: alachlor (28% of wells), metolachlor (25% of wells), atrazine (5% of wells), and acetochlor (3% of wells).[9] The occurrence of pesticides in groundwater is more common in agricultural regions, although it can occur anywhere pesticides are stored or applied.

Very little information exists about pesticides in groundwater in Oconto County.[10] More information is needed regarding pesticides especially in areas near agriculture and where nitrate levels are elevated.

*Arsenic*
While there are some human sources of arsenic, the source of most arsenic in groundwater is naturally occurring arsenic in bedrock and glacial deposits. Of 203 water samples analyzed for arsenic in Oconto County, 96 have detectable arsenic and 17 samples (8%) are greater than the recently reduced safe drinking water standard of 10 parts per billion (ppb).[11] Most private wells in the county have unknown arsenic levels. In the Village of Suring Municipal Well #2 was taken off line in October 2006 because the three samples collected from the well in 2006 and analyzed for arsenic had levels at 13-14 ppb.[12] This well cannot be used unless emergency conditions arise. The Village installed Well #3 with arsenic removal equipment and will blend water from Well #1 and Well #3 to stay below the standard.[13] More information is needed to identify the extent of arsenic in the county and help people who may have elevated levels of arsenic to improve their drinking water quality.

*Other potential groundwater contaminants originating from land uses*
The following three groups of chemicals have the potential to contaminate groundwater.

*Volatile organic compounds* (VOCs) are a group of common industrial and household chemicals that evaporate, or volatilize, when exposed to the air. Sources of VOCs include a variety of everyday products such as gasoline, fuel oil, solvents, degreasers, and dry cleaning solutions. When chemicals containing VOCs are spilled or disposed of on or below the land surface some of the chemicals can be carried down into the groundwater where they may pose a threat to nearby wells. Some VOCs are quite toxic while others pose little risk. Health risks vary depending on the type of VOC, but effects of long-term

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[9] Agricultural chemicals in Wisconsin groundwater. Final report May 2002. DATCP
[10] Of ~30 samples recorded in the WI DNR groundwater retrieval network and the Central Wisconsin Groundwater Center database, the majority showed undetectable levels of triazine.
[11] Data from WI DNR groundwater retrieval network. The new safe drinking water standard for arsenic went into effect on January 23, 2006. Based on health study results, the USEPA lowered the standard from 50 to 10 ppb.
[12] WI DNR groundwater retrieval network and Central Wisconsin Groundwater Center.
[13] Personal communication with Robert Barnum, WDNR, 12/20/06.

exposure can include cancer, liver damage, spasms, and impaired speech, hearing and vision.[14] VOC contamination of groundwater and soils is included in Figure 9.

*Pharmaceuticals and personal care products.* The list of pharmaceuticals is long and includes such medications as tranquilizers, pain killers, antibiotics, birth control, hormone replacement, lipid regulators, beta blockers, anti-inflammatories, chemotherapy, antidiabetics, seizure control, veterinary drugs, antidepressants and other psychiatric drugs. There is a related category of chemicals referred to as "personal care products" that includes cosmetics, perfumes, soaps, sunscreens, insect repellants and so forth. The volume of pharmaceuticals and personal care products entering the environment each year is about equal to the amount of pesticides used.

In 2000 the U.S Geological Survey conducted a nationwide assessment of drugs in streams and groundwater. They picked locations likely to be contaminated, but found pharmaceuticals in about 60% of groundwater samples. Sources of discharge of pharmaceuticals to the environment include wastewater treatment plants, septic systems, landfills, sludge and manure spreading and livestock feedlots. Why be concerned about traces of chemicals that were designed to be consumed? We're only beginning to understand the health effects. Because of the low concentrations, any effects are likely to appear only after years of exposure. A real concern is that some of the drugs are endocrine disruptors. Endocrine glands, such as the thyroid, pituitary or thymus send hormones, such as adrenaline, estrogen or testosterone to specific cells stimulating certain responses. There are hundreds of different hormones and they are messengers that regulate a multitude of normal biological functions, such as growth, reproduction, brain development and behavior. The delivery of hormones to various organs is vital and when the delivery, timing or amount of hormone is upset, the results can be devastating and permanent. Chemicals that are similar to hormones ("hormone mimics") can fit onto the receptor sites on the target cells and either block the real hormones or trigger abnormal responses in the cells. Scientific studies have indicated links between endocrine disruptors and reproductive disorders, immune system dysfunction, certain types of cancer, congenital birth defects, neurological effects, attention deficit, low IQ, low sperm counts and early onset of puberty in girls.[15]

*Chloride* at levels greater than 10 parts per million (ppm) usually indicate contamination by septic systems including from regeneration of water softeners, road salt, fertilizer, animal waste or other wastes. Chloride is not toxic in concentrations typically found in groundwater, but some people can detect a salty taste at 250 ppm. Levels of chloride that are above what is typical under natural conditions indicate that groundwater is being affected and extra care should be taken to ensure that land use activities do not further degrade water quality.[16]

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[14] Kevin Masarik, Central Wisconsin Groundwater Center.
[15] *Drugs in Our Water?* by Ed Morse, Wisconsin Rural Water Association, October 2005.
[16] Kevin Masarik, Central Wisconsin Groundwater Center.

Sources of potential contaminants

Groundwater contaminants can come from a wide variety of sources. This report does not deal with these in detail, but does provide some references for further investigation.

*Landfills*

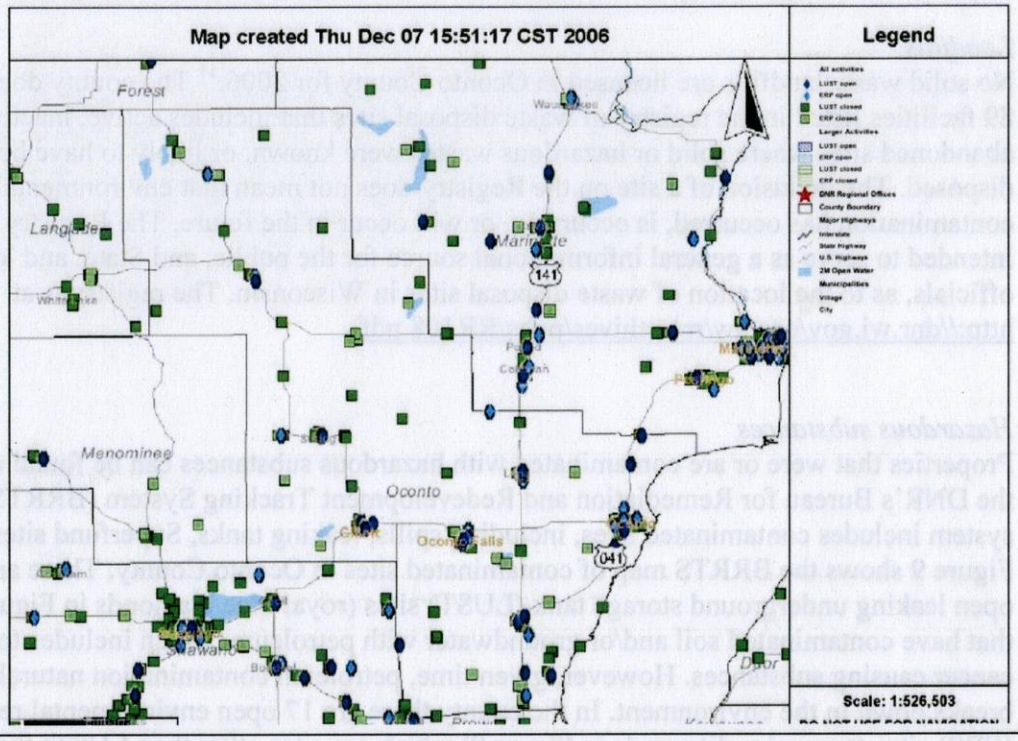
No solid waste landfills are licensed in Oconto County for 2006.[17] The county does have 89 facilities listed in the registry of waste disposal sites that includes active, inactive, and abandoned sites where solid or hazardous wastes were known, or likely to have been disposed. The inclusion of a site on the Registry does not mean that environmental contamination has occurred, is occurring, or will occur in the future. The Registry is intended to serve as a general informational source for the public, and State, and local officials, as to the location of waste disposal sites in Wisconsin. The registry is at http://dnr.wi.gov/org/aw/rr/archives/pubs/RR108.pdf

*Hazardous substances*

Properties that were or are contaminated with hazardous substances can be found using the DNR's Bureau for Remediation and Redevelopment Tracking System (BRRTS). This system includes contaminated sites, including spills, leaking tanks, Superfund sites, etc. Figure 9 shows the BRRTS map of contaminated sites in Oconto County. There are 23 open leaking underground storage tank (LUST) sites (royal blue diamonds in Figure 9) that have contaminated soil and/or groundwater with petroleum, which includes toxic and cancer causing substances. However, given time, petroleum contamination naturally breaks down in the environment. In the county there are 17 open environmental repair (ERP) sites (turquoise diamonds in Figure 9) which are sites other than LUSTs that have contaminated soil and/or groundwater. Examples include industrial spills or dumping, buried containers of hazardous substances and closed landfills that have caused contamination. More information for the sites on Figure 9 is available at http://botw.dnr.state.wi.us/botw/Welcome.do

[17] http://dnr.wi.gov/org/aw/wm/faclists/WisLic_SWLandfills.pdf

**Figure 9: BRRTS map**




Wells to be constructed on or near properties shown on the map in Figure 9 may require special well construction features. Residual soil contamination may need to be treated or disposed of if excavated, and should be avoided during well construction. Precautions may be needed during excavation, or for construction on such properties due to residual contamination. Some of these sites have deed restrictions or land use controls associated with them.

*Agriculture*

Oconto County has three concentrated animal feeding operations (CAFOs), all dairies. They are Dads Farms Inc. (Suring address), Suring Community Dairy LLC (Suring address) and Zahns Farms LLC (Gillett address).[18] By definition, these facilities each have greater than 1000 animal units. Other potential groundwater contaminants from agriculture include fertilizers and pesticides. Large amounts of nitrogen fertilizers are used when fields are planted in continuous corn, and can leach into groundwater as nitrates.

*Superfund Sites*

Oconto County has no Superfund sites.[19]

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[18] Wisconsin's WPDES Permitted Animal Feeding Operations (map) http://www.dnr.state.wi.us/ORG/WATER/WM/nps/ag/cafo_map.pdf

[19] Superfund Sites in Wisconsin http://dnr.wi.gov/org/aw/rr/archives/pubs/RR005.pdf

Groundwater quantity

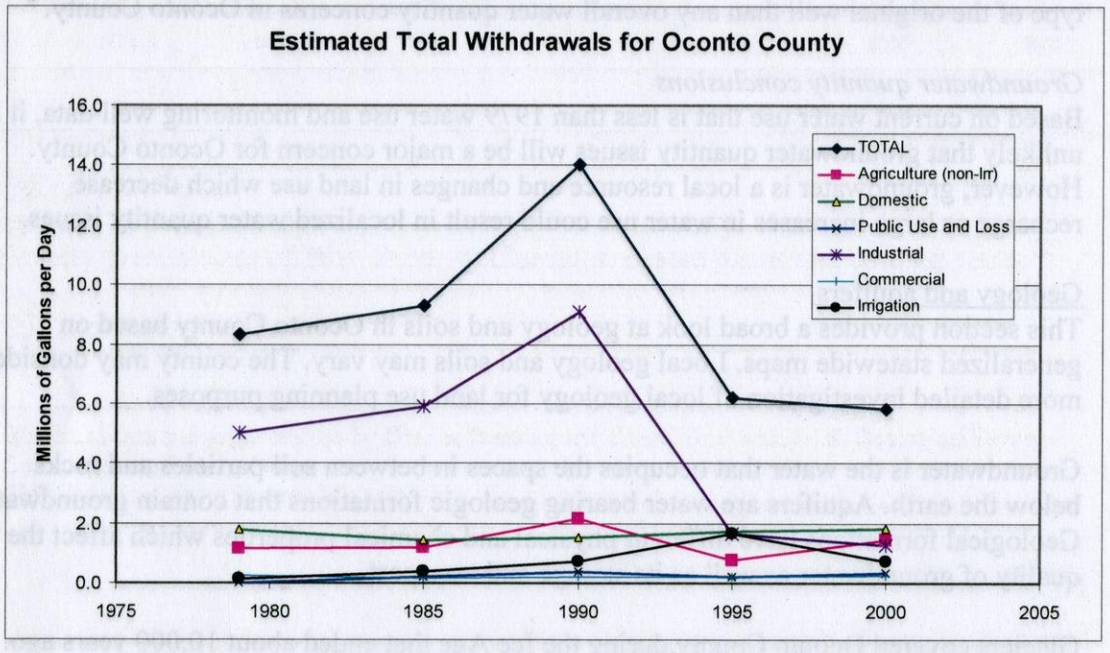
Despite relatively abundant precipitation in Wisconsin, some regions of the state have falling groundwater levels (southeast, Fox cities and Dane County). In some areas of Wisconsin, but not documented in Oconto County, lowered groundwater levels due to a combination of drought and increased water usage have caused portions of streams to go dry.

*Water use*

Figure 10 shows water use in Oconto County from 1979-2000.[20] Notable trends include:

- Total water use increased from 1979-1990 and then decreased from 1990-1995.
- The largest water users were industrial users which use both groundwater and surface water. Their use also accounted for the majority of the rise and fall in water use. This may be due to the closings of the Oconto Falls paper mill pulp plant and the plywood company in Mosling.[21]

**Figure 10: Water use**




*High capacity wells*

There are 76 permitted high capacity wells in Oconto County. These wells belong primarily to municipal utilities, farms, golf courses, cheese plants and bottling plants.[22]

*USGS monitoring well*

[20] Water use data and graph created by Charles Dunning and Cheryl Buchwald, U.S. Geological Survey.
[21] Oconto County Zoning Office.
[22] DNR Drinking Water System: High Capacity Wells http://prodoasext.dnr.wi.gov/inter1/hicap$.startup

The groundwater level in one U.S. Geological Survey monitoring well in Oconto County, located near Bonita has varied within about a three-foot range from 1985-2005 with no defined trend.[23] This well is shallow at 46 feet deep and is located near a river and dam which stabilizes water levels compared to surrounding areas.

*Dry wells*

Of more than 7,000 well that have been drilled since 1988, 147 wells indicated that the reason for constructing the well was to replace an existing well that had gone dry or was not able to produce enough water to meet the household water demands. The majority of the dry wells that needed replacement happened to be driven point wells. Driven point wells are generally shallower than drilled wells and are more susceptible to fluctuations in the water table during dry years. Driven point wells generally do not have the same pumping capacity as a drilled well and may not have been adequate to meet any increases in water use. In addition, driven points are also more likely to become plugged or encrusted over time which reduces yield and can lead to water quantity problems for well owners. It appears from this information that the well replacement was due more to the type of the original well than any overall water quantity concerns in Oconto County.

*Groundwater quantity conclusions*

Based on current water use that is less than 1979 water use and monitoring well data, it is unlikely that groundwater quantity issues will be a major concern for Oconto County. However, groundwater is a local resource and changes in land use which decrease recharge or large increases in water use could result in localized water quantity issues.

Geology and aquifers

This section provides a broad look at geology and soils in Oconto County based on generalized statewide maps. Local geology and soils may vary. The county may donsider more detailed investigation of local geology for land use planning purposes.

Groundwater is the water that occupies the spaces in between soil particles and rocks below the earth. Aquifers are water bearing geologic formations that contain groundwater. Geological formations have different physical and chemical properties which affect the quality of groundwater as well as its storage and transport.

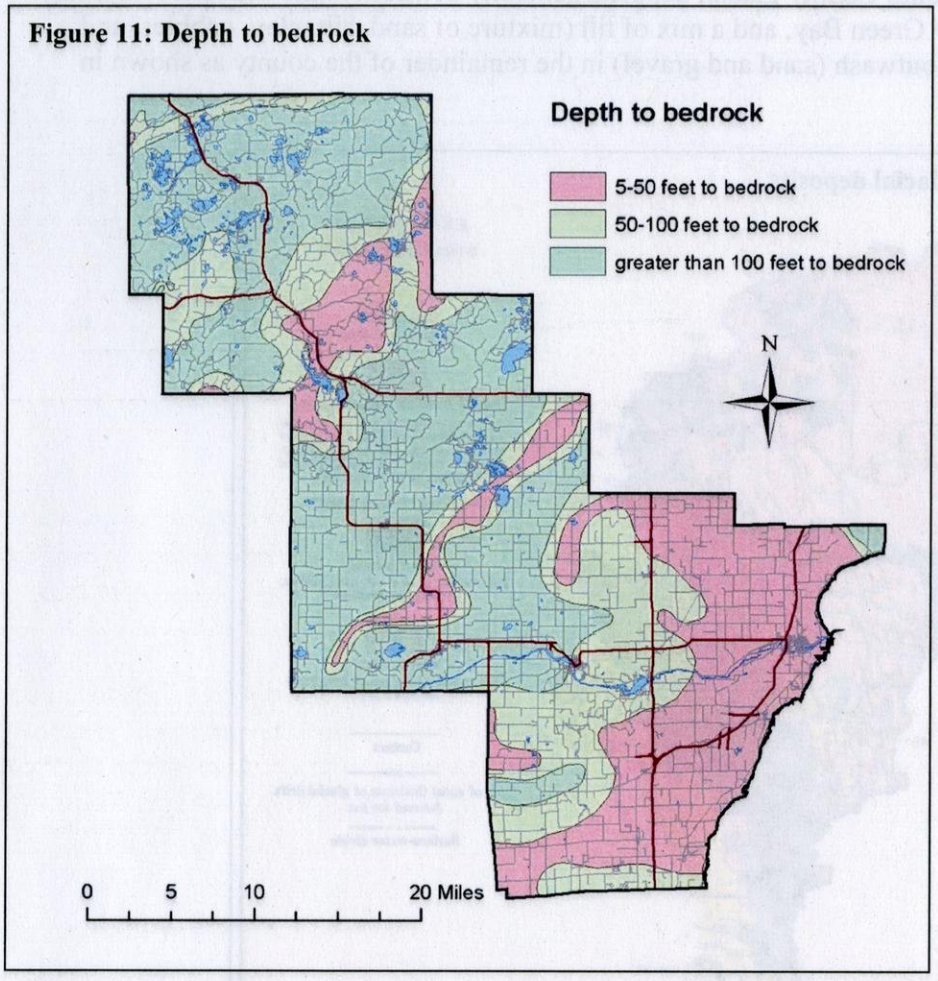
Glaciers covered Oconto County during the Ice Age that ended about 10,000 years ago. These glaciers left behind thick deposits of sand, gravel, till (a mixture of sand, gravel, silt, and clay), and lake sediment over most of the county. These deposits cover the bedrock.

[23] Monitoring well location and hydrograph at http://wi.water.usgs.gov/public/gw/HISTORICAL/OC-0179.html

*Depth to bedrock*

See Figure 11 for the depth to bedrock in Oconto County.

**Figure 11: Depth to bedrock**



*Glacial deposits*

Glacial deposits are the soil and loose rocks located between the surface of the land and the bedrock. In Oconto County glacial deposits generally consist of lake deposits (clay, silt, and sand) near Green Bay, and a mix of till (mixture of sand, silt, clay, cobbles, and boulders) and outwash (sand and gravel) in the remainder of the county as shown in Figure 12.

**Figure 12: Glacial deposits**

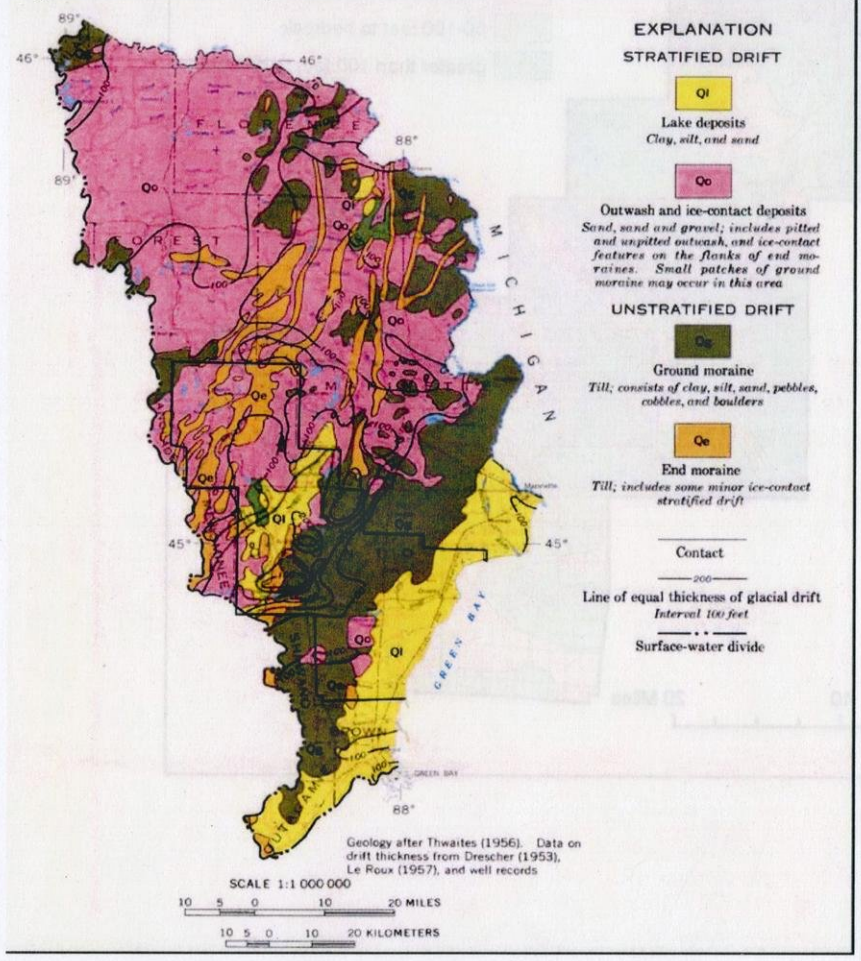



Figure 12 is from Oakes and Hamilton, and includes the entire Menominee-Oconto-Peshtigo River basin.[24] We currently do not have a glacial map for all of Oconto County. Attig and Ham prepared a detailed glacial map for the northern part of the county.[25]

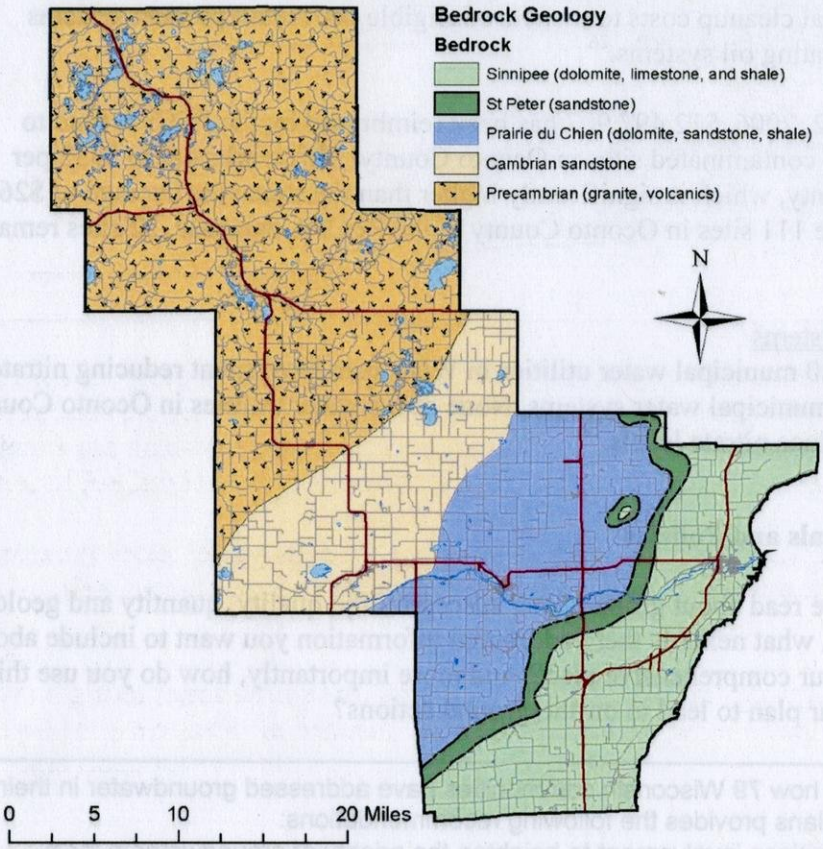
[24] Oakes, E.L., and L.J. Hamilton, 1973. Water resources of the Wisconsin-Menominee-Oconto-Peshtigo River Basin. US Geological Survey, Hydrologic Atlas HA-470.

[25] Attig, J.W., and N.R. Ham. 1999. Quaternary geology of Northern Oconto County, Wisconsin. Wisconsin Geological and natural History Survey, Bulletin 97. 13 p and 1 map

*Bedrock geology*

Oconto County straddles the boundary between Paleozoic sedimentary rocks and the much older PreCambrian rocks of the Canadian Shield.

**Figure 13: Bedrock geology**




As shown in Figure 13, moving northwest from the shore of Green Bay, the sedimentary bedrock units are the Sinnipee dolomite, St Peter sandstone, Prairie du Chien Group (dolomite and sandstone), and Cambrian sandstone. West of the Cambrian sandstone lie a series of PreCambrian crystalline rocks such as granite, basalt, and rhyolite.

Sedimentary rocks form good aquifers, while crystalline rocks do not generally form good aquifers because in these rocks groundwater occurs mostly in cracks and fractures.

*Aquifers*

Sand and gravel forms an important shallow aquifer in Oconto County, especially in the north part of the county. In contrast, bedrock aquifers are present only in the south part of Oconto County.

**Money spent on cleanup**

Money spent by Petroleum Environmental Cleanup Fund Award (PECFA)
The PECFA program was created in response to enactment of federal regulations requiring release prevention from underground storage tanks and cleanup of existing contamination from those tanks. PECFA is a reimbursement program returning a portion of incurred remedial cleanup costs to owners of eligible petroleum product systems including home heating oil systems.[26]

As of December 12, 2006, $12,497,907 has been reimbursed by the PECFA fund to cleanup petroleum contaminated sites in Oconto County. This works out to $332 per resident in the county, which is significantly higher than the statewide average of $264 per resident. Of the 111 sites in Oconto County in the PECFA database, 22 sites remain open.[27]

Nitrate removal systems
As of 2005, over 20 municipal water utilities in Wisconsin have spent reducing nitrate concentrations in municipal water systems. None of the water utilities in Oconto County have needed to reduce nitrate levels.[28]

**Groundwater Goals and Policies**

So now that you've read about groundwater susceptibility, quality, quantity and geology in Oconto County, what next? Is there additional information you want to include about groundwater in your comprehensive plan? And more importantly, how do you use this information in your plan to lead to on-the-ground actions?

A recent study of how 79 Wisconsin communities have addressed groundwater in their comprehensive plans provides the following recommendations:

- Increase citizen involvement to heighten the priority of groundwater in local communities
- Hire local government staff and consultants that value groundwater
- Provide education about the costs of groundwater contamination and depletion
- Provide education to help plan writers better interpret and use groundwater information
- Improve the accessibility of groundwater data to plan writers
- Provide funding to support further groundwater studies

The complete results of the study which includes five case studies about communities who are protecting or cleaning up their groundwater are available at http://www.uwsp.edu/cnr/landcenter/groundwater/index.html

[26] http://commerce.wi.gov/ER/ER-PECFA-Home.html
[27] Wisconsin Department of Commerce
[28] Kevin Masarik and WDNR

To move toward action, we recommend that the county involve as many people and interests as possible to develop groundwater goals and policies. Plans are as strong as the people who are involved in creating them. The more people who are involved and believe in the plan, the more people who will help make it happen.

Goals

Goals describe what you want to accomplish. Here are some example groundwater goals. Use these as starting points to develop goals that fit Oconto County.

- Protect groundwater quality in private and municipal wells in the county.
- Determine what pesticides are being used and where. Test wells in these areas for pesticides and their metabolites.
- For pesticides with established drinking water standards, keep concentrations below the drinking water standard.
- For nitrates, keep concentrations below the drinking water standard of 10 parts per million.
- Avoid human-caused lowering of the county's lakes, streams, wetlands, and groundwater.

Policies

Policies describe courses of action used to ensure plan implementation and to accomplish goals. Often one goal will have two or more policies listed under it, which help achieve that goal. For instance, if a community goal is "protect groundwater quality," two associated policies could be "develop a manure management ordinance" and "adopt wellhead protection ordinances for each municipal well."

*Existing policies to protect groundwater in Oconto County*

The following policies are in place to protect groundwater quality in Oconto County:

1) Wellhead protection plans and ordinances – Wellhead protection plans are developed to achieve groundwater pollution prevention measures within public water supply wellhead areas. A wellhead protection plan uses public involvement to delineate the wellhead protection area, inventory potential groundwater contamination sources and manage the wellhead protection area. All new municipal wells are required to have a wellhead protection plan. A wellhead protection ordinance is a zoning ordinance that implements the wellhead protection plan by controlling land uses in the wellhead protection area.[29] The table below summarizes which water utilities in Oconto County have wellhead protection plans and ordinances.[30]

[29] Wisconsin Wellhead Protection Program Summary
http://www.dnr.state.wi.us/org/water/dwg/gw/whp/WHP-sum.html

[30] Ed Morse, Wisconsin Rural Water Association, personal communication 10/31/06.

| Water system | Wellhead protection plan | Wellhead protection ordinance |
|---|---|---|
| Gillett | In progress | No |
| Lena | In progress | No |
| Oconto | No | No |
| Oconto Falls | No. Plan to start in 2007. | No |
| Suring | Yes | Yes. They plan to revise and update it. |

2) Animal waste storage ordinance – In 2001 Oconto County adopted an animal waste management ordinance that applies to all unincorporated areas of the county (areas outside of city and village boundaries). The intent of the ordinance is to protect the groundwater and surface water resources of Oconto County by regulating:

1. Permitting of Storage Facilities
2. Nutrient Management practices
3. Enforcement of the following prohibitions
4. No overflow of manure storage structures
5. No unconfined manure stacking (piling) within water quality management areas (adjacent to stream banks, lakeshores, and in drainage channels.)
6. No direct runoff from feedlots or stored manure to waters of the state.
7. No unlimited livestock access to waters of the state where high concentrations of animals prevent adequate sod cover maintenance.
8. Permit new and expanding feedlots
9. Required removal of feed piles.[31]

The local governments in Oconto County may also have additional policies for groundwater protection in place. Common approaches to protect groundwater in rural areas include:

- Wellhead protection plans and ordinances
- Offering educational opportunities and incentives for groundwater-friendly types of agriculture such as nutrient management planning, rotational grazing and integrated pest management
- Zoning ordinances separating housing from land uses likely to contaminate groundwater and/or providing standards to contain potential contaminants
- Subdivision ordinances providing adequate space for private sewage systems and/or encouraging community sewage treatment systems

Below is a fairly expansive list of potential groundwater policies sorted into 11 categories.[32] Choose, modify and develop new policies that will help achieve your county

[31] Oconto County Animal Waste Management Ordinance
http://www.co.oconto.wi.us/upload/images/LCD/OrdinanceTotal.pdf

goals. *A draft list of recommended groundwater policies developed specifically for Oconto County was developed by the authors of this report and is included on page 2 of this document.* Once you have developed a list of groundwater policies for the county with input from as many local people as possible, see the recommendations after the list for next steps.

[32] Webster, Bobbie; Tang, ChinChun; Markham, Lynn and Chuck Dunning. 2005. Comprehensive Planning in Wisconsin: Are Wisconsin Communities Planning to Protect Their Groundwater? 2005. Center for Land Use Education and U.S. Geological Survey.

| | |
|---|---|
| 1 | Water supply |
| 1.1 | Long-term planning to determine if enough water is available for future development |
| 1.2 | Water conservation measures |
| 1.3 | Quantity standards for new or existing high capacity wells |
| 2 | Wellhead protection |
| 2.1 | Wellhead protection plan |
| 2.2 | Identify potential contaminant sources |
| 2.3 | Adopt a wellhead protection ordinance that prohibits uses with the potential to contaminate municipal wells or prescribes BMPs for these uses |
| 2.4 | Identify and/or protect areas for new municipal wells |
| 2.5 | Well construction standards (quality) |
| 2.6 | Seal unused wells |
| 2.7 | Limits on new development and/or uses allowed in groundwater recharge areas if recharge areas are separate from the wellhead protection zone |
| 3 | Stormwater management |
| 3.1 | Stormwater plan |
| 3.2 | Promote infiltration - limit impervious surfaces and/or encourage raingardens |
| 3.3 | Treatment of stormwater runoff to remove contaminants before discharge to ground or surface water. |
| 4 | Agricultural practices |
| 4.1 | Incentives for groundwater-friendly crops allowed in designated areas |
| 4.2 | Nutrient management plans |
| 4.3 | Integrated pest management |
| 4.4 | Education and incentives for rotational grazing |
| 4.5 | Manure management ordinances |
| 5 | Waste management |
| 5.1 | Wastewater plan (facilities) |
| 5.2 | Group septic system standards |
| 5.3 | Locate new development or specific types of new development in areas with sewer service |
| 5.4 | Encourage advanced wastewater treatment systems. Local communities are not allowed to require more protective standards than COMM 83, but may encourage them. |
| 5.5 | Hazard waste collection - Clean Sweep or other programs |

| | |
|---|---|
| 5.6 | Landfills siting - located and designed to protect surface and groundwater |
| 5.7 | Urban service or sewer service areas |
| 6 | Land Conservation |
| 6.1 | Land acquisition to protect groundwater |
| 6.2 | Limit road salt use (usually sodium chloride = NaCl) or use alternative forms of salt to decrease groundwater contamination |
| 6.3 | Encourage/require low groundwater impact land covers such as forest/woods, prairie, native vegetation (MFL, CRP, CREP, EQIP, local programs) |
| 6.4 | Conservation subdivision standards that require a portion of the land to be maintained in low groundwater impact land cover. |
| 6.5 | Encourage conservation easements that protect groundwater through maintaining native vegetation or other means |
| 7 | Development Restriction/land regulation |
| 7.1 | Large lot sizes to protect groundwater for areas with private on-site wastewater disposal systems |
| 7.2 | Limit/prevent new residential development in areas with contaminated groundwater. Land division ordinances may require test results demonstrating the groundwater is suitable for human consumption before a lot split is approved. |
| 7.3 | Encourage land uses that have the potential to pollute groundwater to locate in areas with already contaminated groundwater |
| 7.4 | Limit residential and commercial fertilizer and pesticide use (one option is through limiting lawn area) |
| 8 | Educational programs |
| 8.1 | Drinking water testing program |
| 8.2 | Other groundwater monitoring program |
| 8.3 | Groundwater Guardian program |
| 8.4 | Other groundwater education program |
| 9 | Remediation |
| 9.1 | A contingency plan for immediate cleanup to avoid/mitigate groundwater contamination |
| 9.2 | Long-term groundwater clean up (brownfields) |
| 10 | Intergovernmental cooperation |
| 10.1 | Coordination on any of these issues with other local governments |
| 11 | Mining |
| 11.1 | Water quality measures |
| 11.2 | Water quantity measures |

**Next steps**

After local people tweak the list of recommended groundwater policies at the beginning of the document as they see best for the county we recommend the following steps:

Prioritize the policies. The best way of prioritizing is to develop a systematic approach based on the item's importance, its dependency on other actions and consequently the timing of implementation.

Identify a responsible party for each policy. To ensure that policies are ultimately put in place, it is recommended that a responsible party be identified for each policy, program or other initiative your county expects to complete. Identifying responsible parties has two big benefits: there is a person or organization to take ownership of the action and make sure it is completed; and it helps manage workload so that too many responsibilities are not placed on too few people. Responsible parties may include volunteer organizations, civic groups, commissions, boards, consultants, and other stakeholders.

Consider "milestone dates." It is important to set realistic timeframes for implementation of the items. For regular business items, such as reviewing development proposals, you may include an "ongoing" timeline. However, broad timelines are generally not very useful for specific, one-time types of activities such as preparing an ordinance. When figuring out appropriate milestone dates for completion of tasks, you will need to take into consideration funding and length of time to accomplish the activity. You should also consider how much public input is necessary and whether the recommended activity will be controversial to implement. These all add to total length of a particular activity and the timeline should reflect those considerations. It is important to realize that these milestone dates will likely change as the plan is implemented and updated.[33]

We hope that this summary of groundwater data and potential groundwater goals and policies is helpful. The most important steps are to begin the conversation about groundwater in your community and to get started on a few actions to take care of it for future generations.

Report prepared by the interagency team of:

- Ken Bradbury, Wisconsin Geological and Natural History Survey
- Jamie Broehm, Oconto County Assistant Planner
- Cheryl Buchwald, U.S. Geological Survey
- Charles Dunning, U.S. Geological Survey
- Dave Hart, Wisconsin Geological and Natural History Survey
- Dave Johnson, Wisconsin Department of Natural Resources
- Dave Lindorff, Wisconsin Department of Natural Resources
- Lynn Markham, Center for Land Use Education
- Kevin Masarik, Central Wisconsin Groundwater Center
- Ed Morse, Wisconsin Rural Water Association

[33] Adapted from *Implementation Guide*. Center for Land Use Education. 2006

# APPENDIX D: SURVEY AND COVER LETTER



May 26, 2006

Hello,
Some Wisconsin communities that want to plan for the future of groundwater in their community do not have the resources or expertise to locate, evaluate, and incorporate appropriate groundwater information. To make it easier to include groundwater information in comprehensive plans, the Center for Land Use Education and U.S. Geological Survey are developing a centralized website to provide easy access to Wisconsin groundwater information in a user-friendly format.

***Please help us by taking a few minutes to complete the short survey enclosed and return it by June 15th. Thank you!***

Brief summary of project results to date
We reviewed and evaluated 79 adopted Wisconsin comprehensive plans to understand and measure the extent of efforts to protect and manage groundwater in comprehensive plans. As expected the *Agricultural, natural, and cultural resources* element contains the most extensive coverage of groundwater, followed by the *Utilities and community facilities* element. Conversely, the *Housing* and *Transportation* elements contain little and no mention of groundwater, respectively. Four of the adopted plans did not mention groundwater at all. The most common groundwater-related policies focused on waste and stormwater management, groundwater-related issues that are regulated by the state. Eight recommendations were developed to help communities do community groundwater planning more effectively, and four community case studies of exemplary groundwater protection and remediation programs are included. Detailed results from this portion of the project can be found at http://www.uwsp.edu/cnr/landcenter/groundwater.

Projected timetable moving forward
By July 2006 we plan to have the survey results compiled and be moving ahead on pulling together the groundwater data for the website as well as developing the website framework. The second year of the grant will be devoted to completing the groundwater planning website, testing it, and getting the word out to communities.

Sincerely,

Lynn Markham, CLUE and Chuck Dunning, USGS

## Survey about website for community groundwater planning

1. Name and employer (optional):

2. Your role related to planning
   - ☐ Consulting planner
   - ☐ Local government staff
   - ☐ Local government official

3. How many communities have you helped with comprehensive planning?

4. What type of communities have you helped with planning? Check all that apply.
   - ☐ Towns. Approximate population:_____
   - ☐ Counties. Approximate population:_____
   - ☐ Villages. Approximate population:_____
   - ☐ Cities. Approximate population:_____

5. Where in Wisconsin are these communities located?
   - ☐ Southeast
   - ☐ Southwest
   - ☐ Central
   - ☐ Northeast
   - ☐ Northwest

6. What do you consider to be the main barrier(s) for including groundwater information in comprehensive plans? Check up to 3 items.
   - ☐ Little community interest in groundwater; not a priority
   - ☐ Groundwater information not readily accessible
   - ☐ Groundwater information available, but not enough time to compile it
   - ☐ Groundwater data included in plan, but not enough time to interpret it
   - ☐ Groundwater data included in plan, but not enough expertise to interpret it
   - ☐ Plan commission members not interested/willing to develop groundwater goals and policies
   - ☐ Groundwater science perceived as too difficult for public to understand
   - ☐ Political reasons for not planning for groundwater (e.g. perceived as anti-business)

7. Rate the following methods according to how you would prefer to have groundwater information provided on-line? (1=preferred method, 2=OK as a method, 3=not a functional method)

   ___ When the name of a municipality is entered a short report (<5 pages) summarizing groundwater info is automatically generated (We may be dreaming here ☺)
   ___ When the name of a municipality is entered a short report (<5 pages) summarizing groundwater info is generated by staff and emailed to you within a reasonable timeframe (e.g. 2 weeks)
   ___ A website allows you to easily create groundwater maps on-line without Geographic Information System (GIS) software
   ___ GIS layers for groundwater data are available for downloading
   ___ Data in text or table format
   ___ Website links to a variety of groundwater information are provided
   ___ Other:_____

8. Please complete the following table by checking the appropriate boxes and jotting down your suggestions.
   - Please circle the three types of data in the table that you feel are the MOST important for groundwater planning.
   - Please place a star next to 3 types of data in the table that you want to be more accessible than they currently are.

| Groundwater data | Did you include this data in comp plans? Please check one box for each type of data | | | | Suggestions for making this data easier to use |
|---|---|---|---|---|---|
| | Yes | No, not aware of data | No, too difficult to use | No, data not relevant | |
| **Geology, hydrogeology and soils** | | | | | |
| Geology & groundwater resources reports | | | | | |
| County soil surveys | | | | | |
| Groundwater susceptibility to contaminants map | | | | | |
| **Water quantity** | | | | | |
| Municipal water system pumping and capacity | | | | | |
| Well levels in monitoring wells | | | | | |
| New wells drilled because previous well dried up | | | | | |
| **Water quality** | | | | | |
| Private well water quality information | | | | | |
| Municipal water system quality | | | | | |
| Groundwater Retrieval Network | | | | | |
| **Potential and known groundwater contamination areas** | | | | | |
| Atrazine prohibition areas | | | | | |
| Open and closed remediation sites | | | | | |
| Waste disposal sites | | | | | |
| Storage tank database | | | | | |

| Groundwater data | Did you include this data in comp plans? | | | | Suggestions for making this data easier to use |
|---|---|---|---|---|---|
| **Other** | | | | | |
| County land conservation department, specify data type:_____ | | | | | |
| County planning & zoning department, specify data type:_____ | | | | | |
| Other:_____ | | | | | |
| Other:_____ | | | | | |

9. Would you like to be notified when the centralized groundwater website is completed? It will be finished by June 2007.
   - ☐ Yes. Name and email address:_____
   - ☐ No

10. Would you be interested in attending a workshop focused on planning for groundwater?
   - ☐ Yes. Name and email address:_____
   - ☐ No

11. Would you be interested in helping to plan a workshop focused on planning for groundwater?
   - ☐ Yes. Name and email address:_____
   - ☐ No

*If you have any questions about this survey, contact Lynn Markham at lmarkham@uwsp.edu or 715-346-3879.*

***Thanks for your help!***

*Enclosed is a list of existing websites that provide groundwater information that you may find helpful.*

# APPENDIX E: *PROTECTING GROUNDWATER THROUGH COMPREHENSIVE PLANNING* WEBSITE, EXCEPT FOR COUNTY REPORTS

Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Learn more about groundwater

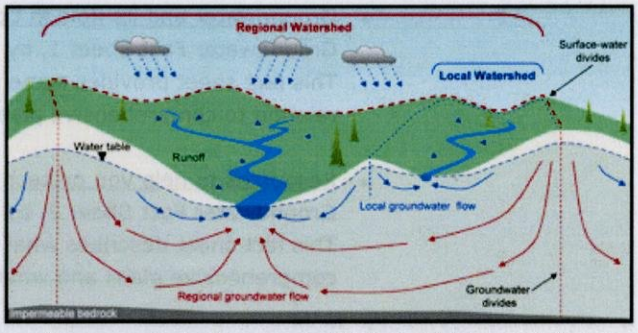
In Wisconsin, 70% of residents and 97% of communities rely on groundwater as their drinking water source. Protecting groundwater from contamination and overuse is vital to the health of Wisconsin's people, ecosystems, communities, and economy.

Many Wisconsin communities are facing groundwater stress in various forms and can benefit or have benefitted from groundwater planning. For example:

- Private well testing and drinking water education programs in Iowa County led to greater awareness, installation of household water filters, greater use of the county's well abandonment program and participation in a comprehensive groundwater study to guide local land use planning.
- Chemical contamination of a municipal well in the City of Waupaca by a dry cleaning business led to reduced pumping capacity and the city council and local businesses adopted multiple water conservation measures.
- To facilitate the economic revival of its rural communities by providing incentives for young farmers to engage in high-margin organic farming businesses, Woodbury County, Iowa provides a full rebate of real property taxes for five years to anyone that converts to organic farming techniques that comply with the USDA standards.
- High nitrate levels in a municipal well in the City of Chippewa Falls led the county board to adopt a county-wide wellhead protection ordinance.
- Rapid population growth in Washington County led the Town of Richfield to develop a water budget for the town and then adopt a groundwater protection ordinance that applies to water use of new development.

Groundwater originates as precipitation that soaks into the land until it reaches a saturated zone underground called the water table.

As the first figure shows, it then generally moves toward surface water bodies, such as lakes, streams, and wetlands. In some places, however, the system works the other way around, and groundwater is recharged from surface water sources.




***How groundwater is connected to the land, lakes and rivers.***

CLICK TO SEE FULL SIZE IMAGE

Wisconsin has abundant quantities of high-quality groundwater, but its quality and quantity depend on our actions on the land surface. Most groundwater contaminants originate on the land surface and are carried downward by rain and melting snow. As the second figure shows, numerous everyday activities can contaminate groundwater, and contaminated groundwater is expensive and difficult or impossible to clean. In addition, paving over or otherwise covering groundwater recharge areas can lead to groundwater quantity problems in the future.

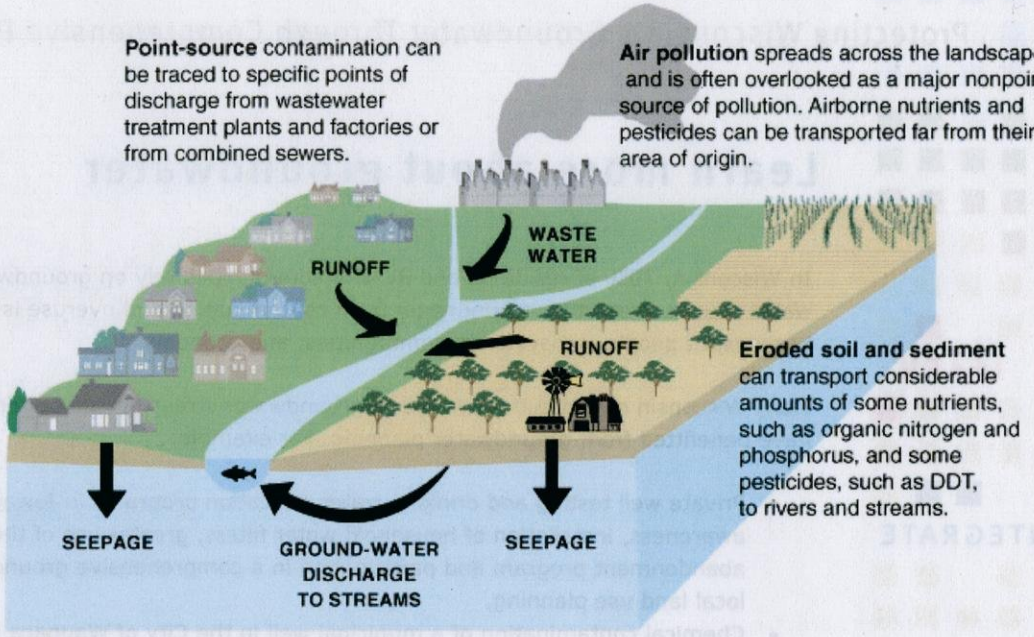



*Figure showing potential sources of groundwater contamination. Image provided by USGS.*

Good planning can separate possible polluting sources from groundwater resources, protect recharge areas, and ensure a safe and abundant supply of groundwater for your community's future.

## MORE INFORMATION ON GROUNDWATER

### GROUNDWATER IN COMPREHENSIVE PLANNING

- Groundwater and its Role in Comprehensive Planning, Comprehensive Planning and Groundwater Fact Sheet 1, by the Wisconsin Groundwater Coordinating Council, 4 pp. This fact sheet provides some background information on groundwater and discusses its relation to comprehensive planning.

- Resources to help you protect your drinking water supply, Comprehensive Planning and Groundwater Fact Sheet 2, by the Wisconsin Groundwater Coordinating Council, 4 pp. This fact sheet describes what information is needed to address groundwater in comprehensive plans and where to go to find that information.

- Residential Development and Groundwater Resources, Comprehensive Planning and Groundwater Fact Sheet 3, by the Wisconsin Groundwater Coordinating Council, 4 pp. This fact sheet examines the relationship between residential development, particularly development of new subdivisions, and the groundwater resource. It also discusses ways in which impacts can be minimized.

### WISCONSIN GROUNDWATER BASICS

- Groundwater: Wisconsin's Buried Treasure by Wisconsin Department of Natural Resources, 2006.
  This web site provides easy-to-read information about Wisconsin's groundwater aquifers, groundwater use, groundwater threats, groundwater protection and sources of additional

information.

- A Water Science Primer, in Wisconsin's waters, A confluence of perspectives by R.J. Hunt 2003. Wisconsin Academy of Sciences, Arts, and Letters, Transactions Volume 90, Edited by Curt Meine, 178 pp.
  This primer discusses overarching concepts about water resources including their unique properties, limits, connectedness with one another and the landscape, and moving and changing nature.

- Groundwater quantity resources by the Groundwater Coordinating Council.
  This list of reports and electronic documents related to groundwater quantity was developed to address the current focus and awareness of groundwater quantity issues in Wisconsin. A good place to begin learning about groundwater quantity concerns in Wisconsin is the two-page publication Groundwater Drawdown.

- Wisconsin's Groundwater Directory, by the Center for Watershed Science and Education, UW Stevens Point, 2006, 17 pp.
  This web site describes groundwater activities of state and federal agencies and provides contact information.

- Groundwater and Surface Water: A Single Resource by U.S. Geological Survey, 1998, 87 pp.
  This document describes the interaction of groundwater and surface water, in terms of both quantity and quality, as applied to a variety of landscapes across the Nation. Its intent is to help other Federal, State, and local agencies build a firm scientific foundation for policies governing the management and protection of aquifers and watersheds.

## GEOLOGIC AND HYDROLOGIC MAPS

- Geologic maps by county, region and entire state, by the UW Extension, Wisconsin Geological and Natural History Survey.
  This web site identifies publications containing geologic maps of areas of Wisconsin.

- Water table maps by the UW Extension, Wisconsin Geological and Natural History Survey.
  This web site identifies publications containing water-table maps by county.

- Hydrologic Investigations Atlas series by the US Geological Survey, 12 atlases.
  This series uses colored maps, figures, and diagrams to show the hydrologic systems in the major river basins of the state. Subjects include the general physical setting, the availability and natural quality of groundwater and surface water, stream flows, water use, and other hydrologic information. These atlases are not available electronically, but most are available from the WGNHS. See page 45 at the link above.

## GEOLOGIC AND HYDROLOGIC DATA AND INFORMATION

- Ground Water Observation Network for Wisconsin, by the USGS Wisconsin Water Science Center and the UW Extension, Wisconsin Geological and Natural History Survey.
  The Ground-Water Observation Network monitors water levels in approximately 100 wells throughout Wisconsin, and archives their historical water-level data.

- USGS Ground-Water Data for Wisconsin, by the U.S. Geological Survey.
  The USGS National Water Information System (NWIS) contains extensive water data for the Nation. Public access to many of these data is provided via NWISWeb.

- Geology of Wisconsin, Survey of 1873-1879, by T.C. Chamberlin, in the Ecology and Natural Resources Collection of the University of Wisconsin Digital Collections, 4 volumes.
  The Wisconsin Legislature mandated a fifth incarnation of the state geological survey in 1873 to conduct a "complete geological, mineralogical and agricultural survey of the state". The results of this survey is contained in these 4 volumes.

## HYDROLOGIC RESEARCH AND MODELING

- Current hydrologic research projects, by the UW Extension, Wisconsin Geological and Natural History Survey.
  This web site describes recent and current hydrologic research projects and available products.

- Current hydrologic research projects, by the USGS Wisconsin Water Science Center.
  This web site describes recent and current hydrologic research projects and available products.

- Current hydrologic research projects, by the University of Wisconsin Water Resources Institute.
  This web site provides access to publications based on research supported by or through the Wisconsin Water Resources Institute.

- Current hydrologic research projects, by the Wisconsin Groundwater Coordinating Council.
  This web site provides information about the Groundwater Coordinating Council and access to results of research supported by participating state agencies.

## WATER QUANTITY LEGISLATION

- Summary of Wisconsin's New Groundwater Quantity Legislation, 2003 Wisconsin Act 310, by Tim Asplund, WDNR Bureau of Drinking Water and Groundwater, 3 pp.

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For more information about this site, its contributors, and the data contained herein, click here.

For assistance concerning comprehensive planning, please contact Lynn Markham, UW-Stevens Point.

For assistance concerning groundwater, please contact Charles Dunning, USGS.

Page contact: Webmaster, USGS

Page last updated: January 14, 2008

Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Integrate groundwater into your comprehensive plan

5 STEPS FOR INTEGRATING GROUNDWATER INTO YOUR PLAN:

1. Review pre-planning actions
2. Inventory groundwater data and analyze trends
3. Develop groundwater goals, objectives and policies
4. Prioritize policies
5. Decide how to monitor progress

## 1 REVIEW PRE-PLANNING ACTIONS

Before starting, we suggest you take a quick look through the recommendations below for groundwater planning that come from a recent study of how 79 Wisconsin communities have addressed groundwater in their comprehensive plans:

- Increase citizen awareness (using the county information in the **FIND** section of this web site) and involvement to heighten the priority of groundwater in local communities;
- Hire local government staff and consultants that value groundwater;
- Provide education to plan commissioners about the costs of groundwater contamination and depletion;
- Provide education to help plan writers better interpret and use groundwater information;
- Improve the accessibility of groundwater data to plan writers;
- Provide funding to support further groundwater studies.

The complete results of the study which includes five case studies about communities who are protecting or cleaning up their groundwater are available at:

http://www.uwsp.edu/cnr/landcenter/groundwater/

If you are not familiar with the Wisconsin planning law and the nine required elements you can learn about them in this report. Guides for each element of the comprehensive plan are available to assist Wisconsin communities.

Now that you have an outline for how to integrate groundwater into your comprehensive plan, sections 2 through 5 in the menu above will provide the details necessary to get it done.

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Integrate groundwater into your comprehensive plan

5 STEPS FOR INTEGRATING GROUNDWATER INTO YOUR PLAN:

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5. Decide how to monitor progress

## 2 INVENTORY GROUNDWATER DATA AND ANALYZE TRENDS

Significant groundwater data are available for Wisconsin communities. We recommend sorting the data into the following categories:

- Susceptibility of groundwater to pollutants
- Sources of drinking water
- groundwater quantity and use
- Current groundwater quality
- Potential sources of groundwater contaminants
- Geology and aquifers
- Money already spent on groundwater cleanup
- Existing groundwater protection policies

Visit our **FIND pages** to find basic groundwater data for your county compiled from state-wide sources in 2007. While there are limitless ways that groundwater data and analysis could be included in your comprehensive plan, we recommend the following two approaches:

- Include all groundwater data and analysis in the *natural resources element* of the plan OR
- Include all groundwater data except that about municipal wells in the *natural resources element* of your plan. Include the municipal well information in the *community utilities and facilities element* of your plan.

groundwater goals, objectives and policies, however, might relate to and be included in any, or all, of the nine elements of the comprehensive plan.

**Oconto County provides an example of a completed groundwater inventory and analysis.**

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

# Integrate groundwater into your comprehensive plan

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5 STEPS FOR INTEGRATING GROUNDWATER INTO YOUR PLAN:

1. Review pre-planning actions
2. Inventory groundwater data and analyze trends
3. Develop groundwater goals, objectives and policies
4. Prioritize policies
5. Decide how to monitor progress

## 3 DEVELOP GROUNDWATER GOALS, OBJECTIVES AND POLICIES

Now that you've inventoried groundwater data and analyzed it, what's next? How do you use this information to lead to on-the-ground actions?

To move toward action we recommend that the community involve as many people and interests as possible to develop groundwater goals, objectives and policies. Plans are as strong as the people who are involved in creating them. The more people who are involved and believe in the plan, the more people who will help make it happen.

To help you start thinking about groundwater goals, consider the table below that describes the relationship of groundwater to other elements of comprehensive planning.

### Tips for writing goals, objectives & policies

- Focus on writing succinct language - keep it simple and brief.
- Avoid writing too many goals and too few objectives and policies.
- Remember there are often multiple objectives and policies under one goal.

**Comprehensive Planning Elements and their Relationship to Groundwater**

**Issues and Opportunites**

*Important issues may include:*

- the amount of water needed for future homes, farms & businesses;
- whether the needed water is available, how it will be provided and at what cost;
- how growth will affect the future quality and quantity of available groundwater;
- the need for community wellhead protection planning

**Housing**

- Additional houses increase the demand for clean water and other services;
- Paved areas may reduce the amount of groundwater recharge;
- More homes may mean more fertilizer and pesticide use;
- The potential for household chemicals or used oil to be dumped on the ground or into septic systems increases.
- Decisions must be made on whether new houses will have public sewers or private on-site wastewater disposal systems. See WDNR Fact Sheet 3

### Transportation

*New roads needed to serve growing areas may mean:*

- more runoff of water off impervious surfaces that might have recharged groundwater to an increase in impervious surface, leading to more runoff of water that might otherwise have recharged groundwater
- more salt to keep the new streets safe in winter, which may seep into groundwater;
- more chemicals leaking from automobiles & entering storm sewers or seeping into the ground.

### Utilities and Community Facilities

- Communities must assess future water needs and the ability of existing systems to meet future needs, including the infrastructure and any environmental limitations to the siting of new wells or reservoirs. See also Economic development below.

### Agricultural, Natural and Cultural Resources

- Groundwater provides the majority of the water in many Wisconsin lakes, streams and wetlands;
- Pumping municipal, industrial, agricultural or other high-capacity wells may reduce flow to surface water bodies;
- Agricultural land use may increase potential for groundwater contamination from fertilizers and pesticides;
- Groundwater information is important in assessing the ability of the resource to sustain growth over the long term.

### Economic Development

- Water demand may increase from new residences and businesses.
- Water costs may increase due to pumping from deeper aquifers or adding new wells to the system to meet demand
- New high capacity wells could affect groundwater quantity and sensitive surface water resources.
- New businesses may have facilities, operations or land use practices that could cause accidental spills or other groundwater contamination.

### Intergovernmental Cooperation

- Because groundwater impacts go beyond political boundaries, a coordinated effort is important to avoid potential problems down the road. Working together can maximize the use and protection of the available water resources.

### Land Use

- Many land uses (agricultural, urban, residential, commercial, industrial) have the potential to impact groundwater quality;
- Impermeable areas such as buildings, roads, houses and parking lots prevent precipitation from infiltrating into the subsurface, increasing runoff and potential flooding;

- Water and sewer service plans, subdivision plans, and wellhead or source water protection plans are all forms of land use planning that can mitigate groundwater impacts.

**Implementation**

- As communities develop a schedule to implement the comprehensive plan, communities need to make sure that protection of the groundwater resource is considered.
- Developing a wellhead protection plan is one way to accomplish this important step. It is important to have information on groundwater resources to make sound planning decisions.

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## GOALS

Goals describe what you want to accomplish. They are realistic and relate to key issues. Here are some example groundwater goals to use as starting points to develop goals that fit your community.

- Protect groundwater quality in private and municipal wells.
- Decrease pesticide use in all areas (agricultural, residential, commercial, and industrial).
- Keep nitrate concentrations below the drinking water standard.
- Avoid human-caused lowering of the water table.

## OBJECTIVES

Objectives are more specific statements that relate to a goal. They set measurable performance targets in a given time frame. Examples include:

- The Village of Trent develops a wellhead protection ordinance covering their three municipal wells by June 2009.
- Fifty private well owners have their water tested through the UW-Extension office by January 2010.
- Twenty farmers attend integrated pest management courses by June 2011.
- Residential water customers reduce county water use 10% below 1998 water use by 2012.

**Groundwater goal # 1 - Protect water quality in public and private wells**

| Supporting Objectives | Champion | Potential Funding Source | Milestone Date |
|---|---|---|---|
| 1. Adopt wellhead protection ordinance | Village of Trenton | Village budget | June 2009 |
| 2. Encourage organic certification of 100 acres of farmland with tax incentives | County land conservation office | County budget | 2012 |
| 3. Purchase 20 acres of land or conservation easements in wellhead protection area | Southwest Land Trust | State stewardship program | 2015 |
| 4. Develop groundwater festival to be attended by 100 people | Trout Unlimited and UW- | Trout Unlimited | Summer 2009 |

Extension

## POLICIES

Policies describe actions and approaches used to accomplish goals and objectives.

A common groundwater policy is to adopt wellhead protection plans and ordinances for all municipal wells. **Click here** to find out which municipal wells in your county have wellhead protection plans and ordinances.

In Wisconsin, some groundwater policies are assigned to certain levels of government. For instance, the DNR regulates high capacity wells while county governments administer manure management ordinances. Therefore, it is important to know what groundwater policies local governments are authorized to adopt. The following reports provide this information:

- Groundwater Protection through Local Land-Use Controls (1991)
- Groundwater Quality Regulation: Existing Governmental Authority and Recommended Roles (1991)
- A Guide to Groundwater Quality and Management for Local Governments (1987)

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Below is a fairly expansive list of potential groundwater policies sorted into 11 categories. Use and modify these policies to help develop community objectives to achieve your groundwater goals.

### Groundwater Protection Policies

**Wisconsin's top 5 groundwater planning and policy recommendations**

1. Adopt wellhead protection plans and ordinances for municipal wells.
   READ MORE

2. Identify and properly seal unused wells.
   READ MORE

3. Educate private well users.
   READ MORE

4. Encourage farmers to reduce inputs of potential groundwater contaminants.
   READ MORE

5. Examine groundwater quantity issues and encourage water conservation practices.
   READ MORE

**More groundwater planning and policy recommendations**

Wastewater management, solid waste management, stormwater management, land conservation, development restrictions or land use regulations, remediation and redevelopment, road salt use, mining, intergovernmental cooperation.
READ MORE

**Examples of actions taken at the local level that protect groundwater**

Sometimes actions intentionally protect groundwater, and sometimes they do so

inadvertently.

The first five examples below describe actions taken by local governments to intentionally protect groundwater. The last three examples describe economic decisions that had serendipitous outcomes for groundwater.

1. Payments to farmers to grow low nitrogen input crops near municipal well.
   READ MORE - CITY OF WAUPACA

2. Groundwater education about water quality of private wells and associated policy development.
   READ MORE - IOWA COUNTY AND TOWNS THEREIN

3. Municipal well remediation and wellhead protection ordinance.
   READ MORE - CITY OF CHIPPEWA FALLS & CHIPPEWA COUNTY

4. Municipal well remediation and water conservation.
   READ MORE - CITY OF WAUPACA

5. Groundwater study included in comprehensive plan and groundwater ordinance addressing future development adopted.
   READ MORE - TOWN OF RICHFIELD, WASHINGTON COUNTY

6. Property tax rebates to farmers who switch to organic methods.
   READ MORE - WOODBURY COUNTY, IOWA

7. Organic farms and food processors in Wisconsin.
   READ MORE

8. Community Supported Agriculture in Wisconsin.
   READ MORE

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For assistance concerning groundwater, please contact Charles Dunning, USGS.

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Page last updated: January 14, 2008

# Organic Food Production and Processing in Wisconsin

*Strong sales driven by health concerns*

Center *for* Land Use Education www.uwsp.edu/cnr/landcenter/ *July 2007*

## Organic Food Sales are Strong

Organic food sales in the U.S. have grown about 20% annually throughout the last decade and remain strong.[1] This compares to annual growth of only two to four percent for non-organic foods.[2] In 2002, $20,828,000 worth of organic products was sold by Wisconsin farms.[3] Organic products are now available in 73% of supermarkets nationwide, particularly in urban and suburban regions. As of 2005, organic sales account for less than 3% of total food sales in the U.S., although organic sales are stronger in European markets. Sales growth for organic products has caught the eye of business giants such as Dole, General Mills, Dean Foods, Del Monte, Birds Eye, and Unilever.[4] At the same time, small, local organic food outlets such as Community Supported Agriculture farm subscriptions are experiencing rapid expansion.[5]

## More People are Choosing Organic Food Because of Health Concerns

A 2004 study found that seven in ten Americans express at least moderate concern about the health risks of pesticides and antibiotics in food production.[10] Is this concern based in science?

## Scientific Studies Have Found Health and Environmental Risks of Using Pesticides in Food Production

Approximately 13 million pounds of pesticides are applied to major agricultural crops in Wisconsin each year.[11] A number of scientific studies have found pesticide-based health risks for children based on what they eat, where they live, and their parents' pesticide exposure. Specifically, here are a few of the research findings:

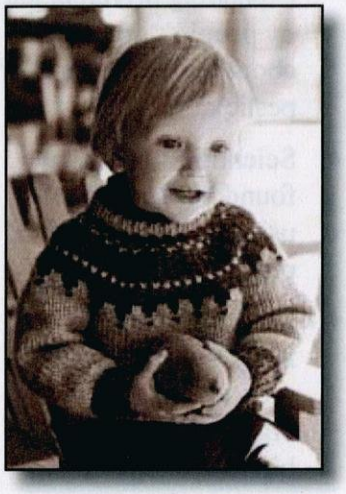
- In 2003, University of Washington researchers found that children who ate organic fruits, vegetables and juices had nine-fold lower pesticide levels in their urine than children who ate conventional food.[12]
- In 1996, University of Minesota researchers did a long-term study of over 200,000 births in Minnesota comparing children of certified agricultural pesticide applicators to children of the general population and found three things:

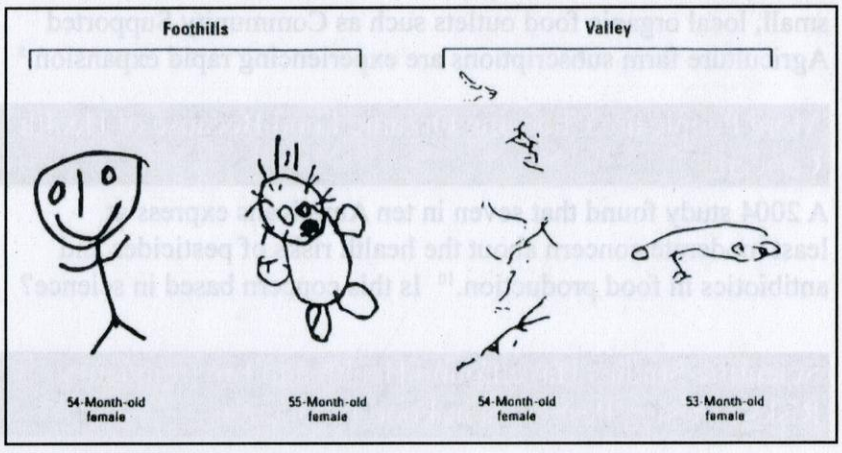
## In a Nutshell

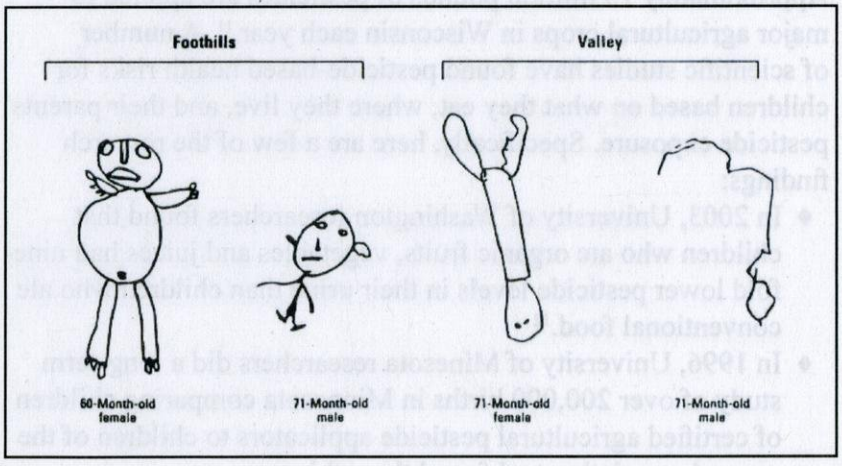
- Organic food sales are strong and rapidly expanding driven in part by people's concerns about the health risks of pesticides.
- Scientific studies have found health risks of using pesticides in food production.
- Wisconsin farmers are leaders in organic food production. Certified organic farmers report higher average net incomes than other farmers.
- Organic food processing is on the rise.
- Increasing consumer demand and educational opportunities suggest a bright future for organic agriculture, and Wisconsin is striving to capture its part of the pie.

1. Pesticide applicators' children had a significantly higher rate of birth defects;
2. Birth defect rates were significantly higher in the western agriculture region of the state: and,
3. A significant majority of children with birth defects were born nine months after spring, suggesting that whatever was causing the birth defects was happening at a very early stage in fetal development.[13]

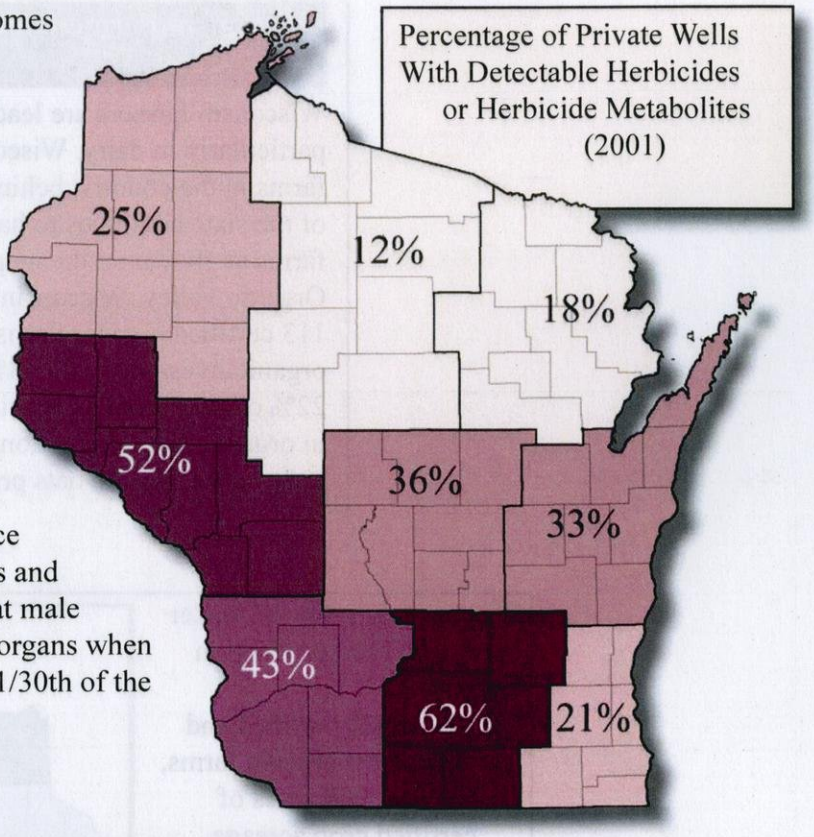
- In 1998, University of Arizona researchers studied children in the Yaqui Valley in Sonora, Mexico. They compared pre-school-aged children living in the foothills where pesticide use was avoided with children living in the valley where agricultural pesticides were frequently used. Although no differences were found in growth patterns, the exposed children demonstrated decreases in stamina, gross and fine eye-hand coordination, 30-minute memory, and the ability to draw a person as shown below. The drawings show striking differences between the exposed and unexposed children. The children from the foothills drew figures of humans with features that are characteristic of four and five year olds, whereas the children from the valley lacked the ability to draw humans with any such detail.[14]





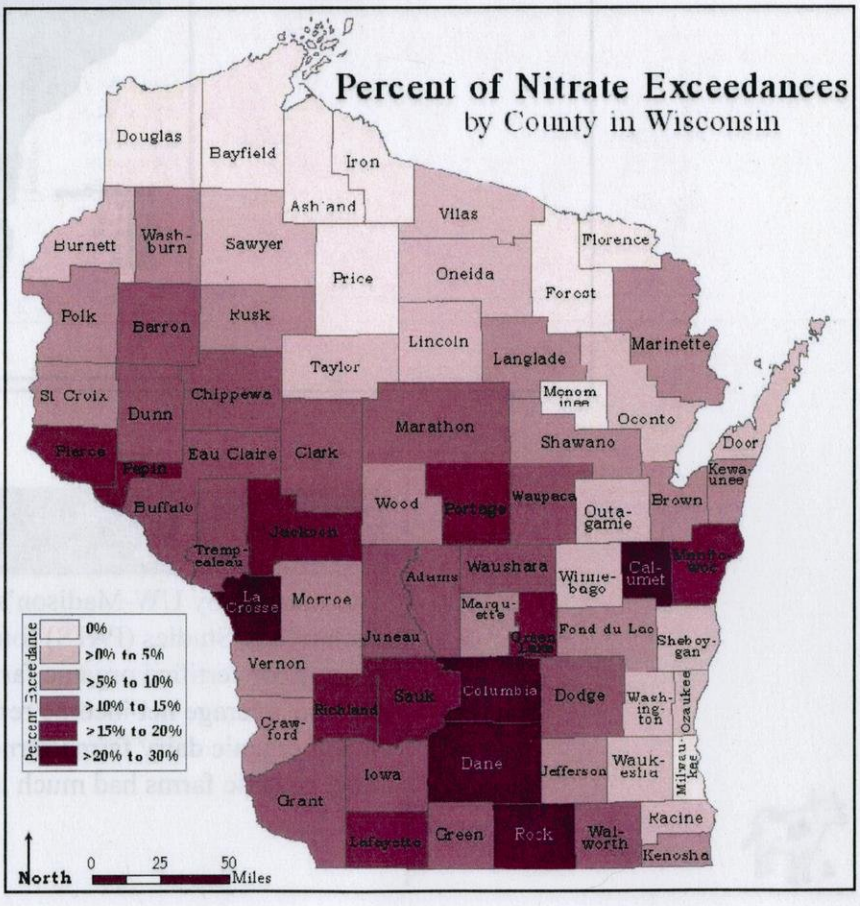
Not all agricultural pesticide exposure comes from food. In some cases pesticides seep into groundwater, as illustrated in a recent study that estimates that 37.7% of private drinking water wells in Wisconsin contain a detectable level of an herbicide or herbicide metabolite.[15] Herbicides are a type of pesticide used to kill or control weeds. The map at the right shows the geographical pattern of herbicide-contaminated wells.




Atrazine, an herbicide used on corn for over 30 years in Wisconsin, is a source of significant health concerns for humans and wildlife.[16] Recent studies have found that male frogs develop both male and female sex organs when exposed to concentrations of atrazine at 1/30th of the current drinking water limit.[17]

## Organic Farming May Lower Nitrate Losses to the Environment

Nitrate, a plant nutrient, is the most widespread groundwater contaminant in Wisconsin and is increasing in extent and severity. Currently 11.6 % of private wells exceed the health-based drinking water limit with geographical distribution shown in the map at the right. Since 80% of nitrate inputs into Wisconsin's groundwater originate from manure spreading, agricultural fertilizers, and legume cropping systems, it makes sense that nitrate-contaminated wells are found to be more prevalent in agricultural districts.[18] In general, well-managed organic farming practices lower nitrate inputs to ground water,[19,20] but at times, leaching from organic systems may also exceed the drinking water limit for nitrate.[21]

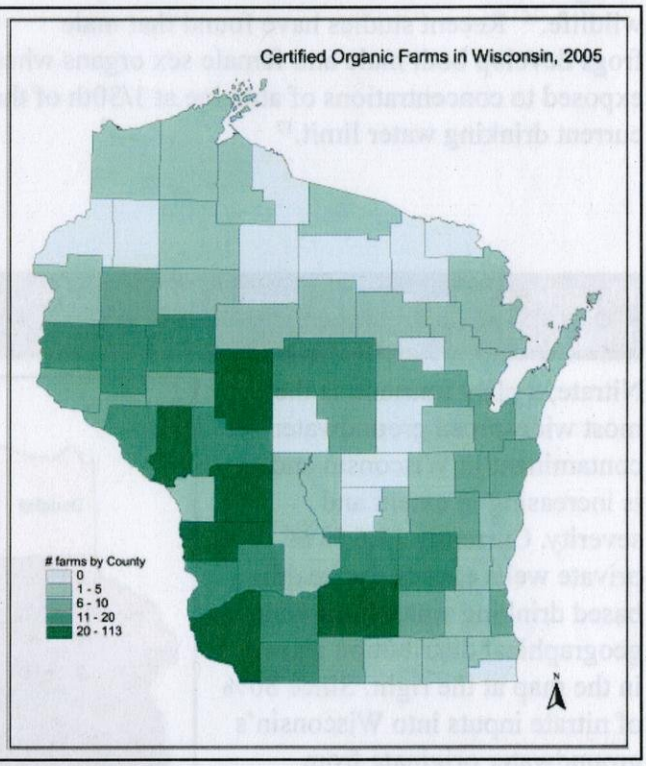


## Wisconsin Farmers are Leaders in Organic Food Production

Wisconsin farmers are leaders in organic food production, particularly in dairy. Wisconsin boasts the second-most organic farms in the country, behind only California. The southwest corner of the state continues to have the greatest concentration of organic farms as shown on the map on the below. Vernon County, home of Organic Valley, Wisconsin's largest organic food cooperative, has 113 certified organic farms. Wisconsin leads the U.S. in certified organic livestock, with 33% of the nation's organic milk cows, and 22% of the nation's organic layer hens. Wisconsin is also a leader in organic crop production, growing 18% of the organic corn and 16% of the organic oats produced in the U.S.[6]

Wisconsin is a natural leader in organic food production with

- About 880 certified and uncertified organic farms,
- Over 91,000 acres of certified crop acreage
- Over 28,000 acres of certified pasture.[7]




## Certified Organic Farmers Report Higher Average Net Incomes Than Other Farmers

Two surveys by UW-Madison's Program for Agricultural Technology Studies (PATS) found that the average 2004 net farm income for certified organic farmers in Wisconsin was 25% higher than the average net income reported for all Wisconsin farms.[8] While organic dairy farms earned average revenues of $150,000, other organic farms had much lower revenues.[9]

## Organic Food Processing is on the Rise

In keeping with growth figures for the organic industry as a whole, organic food processing is on the rise in Wisconsin, representing a significant area of opportunity for entrepreneurial business development. Exact numbers are difficult to obtain because many of the food processing businesses are small, and organic operations are not identified separately in census data. According to organic certifiers and the national trade group, there are at least 70 certified organic processors in Wisconsin.[22]

Wisconsin's most prominent organic food cooperative is the Coulee Region Organic Producer Pools (CROPP), which markets products under the Organic Valley label. CROPP also sells some milk to other companies.[23] Organic Valley Family of Farms™ formed in 1988 with seven Wisconsin farms and has grown to over 1000 family farms from across the country that are organized as regional farmer-owned cooperatives. Organic Valley contracts with existing processors for all of their products including milk, cheese, butter, eggs, vegetables, juices, meats and soy beverages.[24]

There are at least five different grain merchants in the state that handle organic grains either exclusively or as part of their business. DeLong Company of Clinton, Wisconsin – one of the Midwest's largest grain handlers – currently devotes around 5% of its business share to organic corn and soybeans, or well over 100,000 bushels in total.[25]

## Increasing Consumer Demand and Educational Opportunities Suggest a Bright Future for Organic Food Production and Processing in Wisconsin

Consumer demand for organic food is growing at a fast pace, and the U.S. organic market is projected to reach a value of $30.7 billion by 2007. International markets also present opportunities. As a result of this increased demand, there is currently an opportunity for more farmers to enter the organic market.[26]

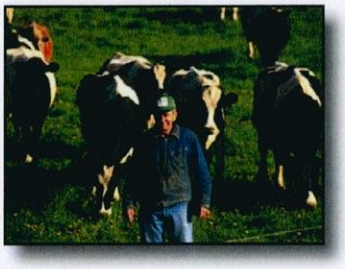
While the infrastructure for organic dairy production, processing and marketing is in place, Wisconsin needs to develop this infrastructure for organic produce and other products.[27]

Educational opportunities in organic agriculture are increasing in Wisconsin. In 2006 Agriculture Secretary Rod Nilsestuen appointed the Wisconsin Organic Agriculture Advisory Council to provide leadership and vision for the future of organic agriculture in Wisconsin.[28]

UW-Madison is home to the Center for Integrated Agricultural Systems (CIAS), a sustainable agriculture research center,[29] and also offers a master's degree in agroecology. CIAS also houses the

## Two Counties in Iowa Offer Tax Rebates for Converting Land to Organic

In 2005 Woodbury County, Iowa adopted an *Organics Conversion Policy* that provides a full rebate of real property taxes associated with land that has been converted from conventional farming to organic farming. The rebate will be provided for 5 years to anyone that converts to organic farming techniques that comply with the USDA National Organic Program Standards and Guidelines. Woodbury County adopted this policy to facilitate the economic revival of its rural communities by providing incentives for young farmers to engage in high-margin organic farming businesses on smaller farm acreages, thus supporting small family farm operations and the re-emergence of local ag-based economies.[30] In 2006, Cherokee County, which borders Woodbury County, passed a similar *Ogranics Conversion Policy*.[31]



Wisconsin School for Beginning Dairy and Livestock Farmers, a curriculum offered in conjunction with the UW-Madison Farm and Industry Short Course that emphasizes grazing based livestock production systems and includes organic production practices. UW-River Falls offers a bachelor's degree in sustainable agriculture. In addition, Lakeshore Technical College in Manitowoc County began offering a five-course technical degree designed for current farmers in 2006 which focuses on farm business and production management and includes a sustainable agriculture option.[32] UW-Extension has offered seminars for farmers and federal, state and county agency staff on organic certification standards since 1994. Extension agents have also followed the lead of the state's grazing networks and organized local organic discussion groups for experienced, novice and aspiring growers. The discussion groups provide an opportunity to share production ideas and explore ways of procuring organic inputs and marketing products.[33]

A number of non-profit organizations also play a large role in organic agriculture education. Midwest Organic & Sustainable Education Service (MOSES), located in Pierce County, helps agriculture make the transition to a sustainable organic system of farming by providing publications, field days, an annual organic farming conference, and a program to recruit new organic farmers called "Help Wanted: Organic Farmers Campaign."[34] Michael Fields Agricultural Institute in Walworth County offers a garden student program exploring biodynamic and organic agriculture through theoretical and experiential learning.[35] Taken together, these trends suggest a bright future for organic agriculture, and Wisconsin is striving to capture its part of the pie.

## Endnotes:


[1] Becoming a Certified Organic Producer. UW-Madison Center for Integrated Agricultural Systems www.cias.wisc.edu/archives/2007/06/18/becoming_a_certified_organic_producer/index.php

[2] Organic Trade Association's 2006 Manufacturer Survey. http://www.ota.com/pics/documents/short%20overview%20MMS.pdf

[3] Organic Agriculture in Wisconsin: 2005 Status Report (OAW 2005) http://www.cias.wisc.edu/pdf/organic05.pdf

[4] OAW 2003; Birds Eye processes organic green beans, broccoli and corn in Darien, WI http://www.mosesorganic.org/umord/brokerscoops.htm; Del Monte http://www.starkist.com/DlmPmt/healthypantry/default.aspx?page=newfromdelmonte

[5] MACSAC. www.macsac.org/csahistory.html

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[7] OAW 2005

[8] OAW 2005

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[10] OAW 2005

[11] Wisconsin Agricultural Statistics Service. 2006. Wisconsin Pesticide Use. www.nass.usda.gov/Statistics_by_State/Wisconsin/Publications/Miscellaneous/pest_use_06.pdf

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[16] Wisconsin Groundwater Coordinating Council Report to the Legislature. 2006. p.70 www.dnr.state.wi.us/org/water/dwg/gcc/rtl/2006report.pdf

[17] Hayes, T., et al. 2002 Feminization of male frogs in the wild. Nature, 419:895-896. Hayes, T., et al. 2003 Atrazine-Induced Hermaphroditism at 0.1 ppb in American Leopard Frogs (Rana pipiens): Laboratory and Field Evidence. Environmental Health Perspectives 111:568-575. www.ehponline.org/members/2003/5932/5932.html

[18] Wisconsin Groundwater Coordinating Council Report to the Legislature. 2006. pp.73-74 www.dnr.state.wi.us/org/water/dwg/gcc/rtl/2006report.pdf

[19] Pimentel, D., P. Hepperly, J. Hanson, D. Douds, and R. Seidel. 2005. Environment, energy, and economic comparisons of organic and conventional farming systems. Bioscience 55(7): 573-582.

[20] U.S. Department of Agriculture. 2006. CSREES Research Results: Organic and Integrated Farming Key to Lowering Nitrogen Leaching. www.csrees.usda.gov/newsroom/news/2006news/nitrogen_organic.html

[21] McIsaac, G.F., and R. A. Cooke. (no date). Evaluation of Water Quality from Alternative Cropping Systems Using a Multiple-Paired Design. University of Illinois at Urbana-Champaign. asap.aces.uiuc.edu/research/stew_farm/home.html

[22] OAW 2003. The Midwest Organic Services Association (MOSA), Wisconsin's largest organic certifying agency, has currently certified 41 organic processors in 32 cities, while international certifying agency Quality Assurance International lists 16 more Wisconsin processors in 12 cities. The Organic Trade Association, a Massachusetts organization, lists 15 additional organic processors operating in 13 communities around Wisconsin.

[23] OAW 2003

[24] Organic Valley website www.organicvalley.coop

[25] OAW 2003

[26] OAW 2005

[27] OAW 2005

[28] Organic Agriculture in Wisconsin, DATCP www.datcp.state.wi.us/mktg/business/marketing/val-add/organic/index.jsp

[29] CIAS www.cias.wisc.edu

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departments/economicdevelopment/press.asp Interview with OCA on Breaking the Chains www.woodburyiowa.com/departments/EconomicDevelopment/Interview%20OCA.pdf

[31] Cherokee County Offers Tax Incentives for Organic Farming www.siouxcityjournal.com/articles/2006/09/20/news/local/54322a2cf28dd753862571ef000a6c3a.txt

[32] Lakeshore Technical College Farm Business and Production Management program www.gotoltc.com/programs/farmbusiness_index.shtml; personal communication 6/20/07

[33] Cadwallader, Tom. Personal communication, 6/26/07.

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[35] Michael Fields Agricultural Institute www.michaelfieldsaginst.org/programs/garden

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Integrate groundwater into your comprehensive plan

5 STEPS FOR INTEGRATING GROUNDWATER INTO YOUR PLAN:

1. Review pre-planning actions
2. Inventory groundwater data and analyze trends
3. Develop groundwater goals, objectives and policies
4. Prioritize policies
5. Decide how to monitor progress

## 4 PRIORITIZE POLICIES

Naturally, there are priorities that surface during the process of developing goals, objectives and policies. To implement goals through objectives and policies, your community will need to prioritize. We recommend the following steps:

1. **Prioritize the goals.** The best way of prioritizing is to develop a systematic approach based on the item's importance, its dependency on other actions and consequently the timing of implementation.

2. **Identify a responsible party for each policy**. To ensure that policies are ultimately put in place, it is recommended that a responsible party be identified for each policy, program or other initiative your county expects to complete. Identifying responsible parties has two big benefits: there is a person or organization to take ownership of the action and make sure it is completed; and it helps manage workload so that too many responsibilities are not placed on too few people. Responsible parties may include volunteer organizations, civic groups, commissions, boards, professional teams, consultants, or agencies and other stakeholders.

3. **Consider "milestone dates."** It is important to set realistic timeframes for implementation of the items. For regular business items, such as reviewing development proposals, you may include an "ongoing" timeline. However, broad timelines are generally not very useful for specific, one-time types of activities such as preparing an ordinance. When figuring out appropriate milestone dates for completion of tasks, you will need to take into consideration funding and length of time to accomplish the activity. You should also consider how much public input is necessary and whether the recommended activity will be controversial to implement. These all add to total length of a particular activity and the timeline should reflect those considerations. It is important to realize that these milestone dates will likely change as the plan is implemented and updated.

Adapted from Implementation Element Guide. Center for Land Use Education. 2006.

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Integrate groundwater into your comprehensive plan

5 STEPS FOR INTEGRATING GROUNDWATER INTO YOUR PLAN:

1. Review pre-planning actions
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5. Decide how to monitor progress

## 5 DECIDE HOW TO MONITOR PROGRESS

A part of good planning practice is monitoring progress. Tracking objectives is a way for your community to know whether it is successfully implementing the comprehensive plan that your community spent hundreds of hours and financial resources to develop. Typically the plan commission and other interested community members track progress over time. The idea is to accomplish the objectives the community set for itself.

Setting up a simple chart that includes goals, objectives, and policies is one easy way to track progress. Including a time line for action is also important as shown here.

| Groundwater goal # 1 - Protect water quality in public and private wells | | | |
|---|---|---|---|
| **Supporting objectives** | **Champion** | **Potential funding source** | **Milestone date** |
| 1. Adopt wellhead protection ordinance | Village of Trenton | Village budget | June 2009 |
| 2. Encourage organic certification of 100 acres of farmland with tax incentives | County land conservation office | County budget | 2012 |
| 3. Purchase 20 acres of land or conservation easements in wellhead protection area | Southwest Land Trust | State stewardship program | 2015 |
| 4. Develop groundwater festival to be attended by 100 people | Trout Unlimited and UW-Extension | Trout Unlimited | Summer 2009 |

We hope that this summary of groundwater data and potential groundwater goals, objectives and policies is helpful. The most important steps are to begin the conversation about groundwater in your community and to get started on a few actions to take care of it for future generations.

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Find data and policies in your area

**CLICK ON THE MAP OR COUNTY NAME TO ACCESS DATA AND POLICIES.**
The *Find Section* provides the most current information and data found as of **May 2007**, unless otherwise noted.


| | | | | |
|---|---|---|---|---|
| Adams | Douglas | Kewaunee | Ozaukee | Taylor |
| Ashland | Dunn | La Crosse | Pepin | Trempealeau |
| Barron | Eau Claire | Lafayette | Pierce | Vernon |
| Bayfield | Florence | Langlade | Polk | Vilas |
| Brown | Fond du Lac | Lincoln | Portage | Walworth |
| Buffalo | Forest | Manitowoc | Price | Washburn |

| | | | | |
|---|---|---|---|---|
| Burnett | Grant | Marathon | Racine | Washington |
| Calumet | Green | Marinette | Richland | Waukesha |
| Chippewa | Green Lake | Marquette | Rock | Waupaca |
| Clark | Iowa | Menominee | Rusk | Waushara |
| Columbia | Iron | Milwaukee | St. Croix | Winnebago |
| Crawford | Jackson | Monroe | Sauk | Wood |
| Dane | Jefferson | Oconto | Sawyer | |
| Dodge | Juneau | Oneida | Shawano | |
| Door | Kenosha | Outagamie | Sheboygan | |

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For more information about this site, its contributors, and the data contained herein, click here.

For assistance concerning comprehensive planning, please contact Lynn Markham, UW-Stevens Point.

For assistance concerning groundwater, please contact Charles Dunning, USGS.

Page contact: Anne Moser, USGS

Page last updated: September 30, 2007

Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Browse additional resources

This list of links should not be considered comprehensive; other very useful information may be found by browsing the internet on your own.

## ADDITIONAL WEB RESOURCES FOR DATA AND INFORMATION

Wisconsin's Groundwater Directory
This web site provides details about which state agencies offer services related to individual groundwater related issues.

Wisconsin's Water Library (University of Wisconsin Water Resources Library)
Established in 1964 by the UW Water Resources Institute, the Water Resources Library is unique among UW-Madison's many libraries for its collection of almost 30,000 volumes of water-related information including a curriculum collection, dozens of educational videos, a children's collection, and more than 60 journals and 100 newsletters.

Research Reports and Publications (University of Wisconsin Water Resources Institute)
Publications are based on research supported by or through the Wisconsin Water Resources Institute. Both WRI publications and publications from other sources are listed.

Water Resources Publications and Educational Materials (University of Wisconsin Extension)
UW-Extension Water Resources Education is hosted by the Environmental Resources Center to provide a gateway to educational programs and publications.

Guide to Finding Water-Related Information (University of Wisconsin Water Resources Library)

Water Data for Wisconsin (U.S. Geological Survey Wisconsin Water Science Center)

## LINKS TO GROUNDWATER PROGRAMS

Wisconsin Department of Natural Resources - Division of Water
The statewide water program promotes the balanced use of Wisconsin's waters to protect, maintain and enhance them in full partnership with the public. Includes the Drinking Water and Groundwater Program.

U.S. Geological Survey - Wisconsin Water Science Center
The USGS is the Nation's largest water, earth, and biological science and civilian mapping agency and has the principal responsibility within the Federal government for providing hydrologic information and for appraising the Nation's water resources. Water-resource activities in Wisconsin are done by hydrologists, hydrologic technicians, and others in the Science Center office in Middleton and in field offices in Middleton, Merrill, and Rice Lake.

Wisconsin Geological and Natural History Survey

University of Wisconsin Water Resources Institute

Wisconsin State Government Water Programs (from the University of Wisconsin Water Resources Institute)

Wisconsin Groundwater Programs (from the University of Wisconsin Water Resources Institute)

U.S. Environmental Protection Agency - Ground Water and Drinking Water

## LINKS TO ASSIST IN LOCATING GROUNDWATER AND PLANNING EXPERTISE

Areas of interest and contact persons (Wisconsin Geological and Natural History Survey)

Ground Water Systems Team (USGS Wisconsin Water Science Center)

Groundwater Staff Directory (Wisconsin Department of Natural Resources)

American Planning Association - Wisconsin Chapter

Association of Natural Resource Extension Professionals

Community Groundwater Planning and Implementation (Center for Land Use Education)

## RESOURCES CITED IN THE "FIND DATA AND POLICIES IN YOUR AREA" SECTION

### SOURCES OF DRINKING WATER

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**A4.** Wisconsin Department of Natural Resources, Public Well Diagram. Last accessed October 1, 2007.

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**F2.** Figure created by Raquel Miskowski, University of Wisconsin-Stevens Point, Center for Land Use Education.

Nitrate-nitrogen data are from sampling conducted during 1985-2004 as reported by the Wisconsin Department of Natural Resources, the Wisconsin Department of Agriculture, Trade and Consumer Protection, and the Central Wisconsin Groundwater Center. Data collected at other times or by other sources are not included.

Land cover data: Wisconsin Department of Natural Resources, 1998, WISCLAND land cover (WLCGW930) 1991-1993.

**F3.** Wisconsin Groundwater Coordinating Council, 2006, Report to the Legislature: Madison, Wis., Groundwater Coordinating Council, 199 p.

**F4.** Shaw, B., 1994, Nitrogen Contamination Sources: A Look at Relative Contributions in Conference Proceedings – Nitrate in Wisconsin's Groundwater: Strategies and Challenges: Stevens Point, Wis., University of Wisconsin-Stevens Point, Central Wisconsin Groundwater Center, p. 23.

**F5.** Wisconsin Groundwater Coordinating Council, 2002, Residential Development and Groundwater Resources (fact sheet): Madison, Wis., Groundwater Coordinating Council, 4 p.

**F6.** Figure is based on the results of over 35,000 Wisconsin private well samples compiled by David Mechenich at the Central Wisconsin Groundwater Center, University of Wisconsin-Stevens Point. "Other rural" land-use category is composed of grassland, water, wetlands, barren land and shrub land. High permeability soils are defined as having infiltration rates greater than 6 inches per hour, while low permeability soils have infiltration rates less than 6 inches per hour.

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**G3**. Wisconsin Department of Natural Resources, Wisconsin's WPDES Permitted Confined Animal Feeding Operations (map). Last accessed October 1, 2007.

**G4.** Wisconsin Department of Natural Resources, Solid Waste Landfills Licensed in Wisconsin, Licensed for Year 2007 (Oct. 1, 2006-Sept. 30, 2007). Last accessed October 1, 2007.

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For more information about this site, its contributors, and the data contained herein, click here.

For assistance concerning comprehensive planning, please contact Lynn Markham, UW-Stevens Point.

For assistance concerning groundwater, please contact Charles Dunning, USGS.

Page contact: Webmaster, USGS

Page last updated: January 14, 2008

# APPENDIX F: WOOD COUNTY EXECUTIVE SUMMARY AND FULL REPORT

Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Find data and policies in your area

## Wood County

The *Find Section* provides the most current information and data found, as of **May 2007**, unless otherwise noted.

EXECUTIVE SUMMARY | FULL REPORT

GROUNDWATER FINDINGS

### SOURCES OF DRINKING WATER

- Wisconsin has nearly 11,500 public water systems which meet the daily water needs of about 4 million people. Public water systems that are owned by a community are called municipal water systems. Wood County has 8 municipal water systems. FIGURE

### GROUNDWATER PROTECTION POLICIES FIGURE

- 5 of 8 municipal water systems in Wood County have a wellhead protection plan: Biron, Marshfield, Milladore, Pittsville and Wisconsin Rapids.
- 1 of 8 municipal water systems in Wood County has a wellhead protection ordinance: Pittsville.
- Wood County has adopted an animal waste management ordinance.

### MONEY SPENT ON CLEANUP

- Over $28 million have been spent on petroleum cleanup in Wood County from leaking underground storage tanks, which equates to $379 per county resident.
- No municipal water systems in Wood County have spent money to reduce nitrate levels.

### GROUNDWATER USE FIGURE

- From 1979 to 2005, total water use in Wood County has increased from about 100.0 million gallons per day to about 139.0 million gallons per day.*
- The increase in total water use over this period is due almost entirely to an increase in industrial use.
- The proportion of county water use supplied by groundwater has varied from about 8% to about 16% during the period 1979 to 2005.*
- Water use in Wisconsin is generally estimated for the following categories:
  - Domestic
  - Livestock
  - Aquaculture
  - Irrigation
  - Industrial
  - Commercial
  - Public use and losses
  - Thermoelectric or mining*

* Thermoelectric and mining data are not considered in water-use tables or figures on this web site. Thermoelectric-power water use is the amount of water used in the process of generating thermoelectric power. The predominant use of water is as non-contact cooling water to condense the steam created to turn the turbines and generate electricity.

## SUSCEPTIBILITY OF GROUNDWATER TO CONTAMINANTS MAP

- Wisconsin has abundant quantities of high-quality groundwater, but once groundwater is contaminated, it's very expensive and often not technically possible to clean.
- An evaluation of the susceptibility of groundwater to contamination in Wood County can be seen in the FULL REPORT or accessed through the map link above.

## GROUNDWATER QUALITY

- 89% of 532 private well samples collected in Wood County from 1990-2006 met the health-based drinking water limit for nitrate-nitrogen. MAP
- A 2002 study estimated that 36% of private drinking water wells in the region of Wisconsin that includes Wood County contained a detectable level of an herbicide or herbicide metabolite. Pesticides occur in groundwater more commonly in agricultural regions, but can occur anywhere pesticides are stored or applied. MAP
- 2,256 acres of land in Wood County are in atrazine prohibition areas. MAP
- 100% of 4 private well samples collected in Wood County met the health standard for arsenic.

## POTENTIAL SOURCES OF CONTAMINANTS

- There are 120 open-status sites in Wood County that have contaminated groundwater and/or soil. These sites include 51 Leaking Underground Storage Tank (LUST) sites, 44 Environmental Repair (ERP) sites and 25 spill sites. MAP
- There is 1 concentrated animal feeding operation in Wood County.
- There are 3 licensed landfills in Wood County.
- There are no Superfund sites in Wood County.

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Protecting Wisconsin's Groundwater Through Comprehensive Planning

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# Find data and policies in your area

## Wood County

The *Find Section* provides the most current information and data found, as of **May 2007**, unless otherwise noted.

EXECUTIVE SUMMARY | FULL REPORT

GROUNDWATER FINDINGS

### SOURCES OF DRINKING WATER

Wisconsin enjoys a generally clean and abundant groundwater resource.[A2] This resource is present because of the state's geologic history and climate; this resource is protected through strong state and federal regulations, and the cooperative efforts of water systems, trade associations, individual operators, planning commissions, and state and federal science agencies.

Drinking water in Wisconsin is provided by either public water systems or private wells. A public water system is defined as a system that provides public water for human consumption, if such a system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. Wisconsin has nearly 11,500 public water systems which meet the daily water needs of about 4 million people.[A1] The Wisconsin Department of Natural Resources (WDNR)[A3] oversees these public systems, and additional information can be found online.

Public water systems that are owned by a community are called municipal water systems.[A4] Wood County has 8 municipal water systems. FIGURE

In addition to the public water systems, about 850,000 private wells provide drinking water to Wisconsin's population. Unlike public water systems, protection and maintenance of a private well is largely the responsibility of homeowners. Information on how to build and protect your private water supply can be found on the WDNR web site.[A5] The USGS is finalizing the "Summary of Water Use in Wisconsin for 2005." When released, this summary will show the percentage of the Wood County population whose drinking water comes from private wells versus municipal systems.

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### GROUNDWATER PROTECTION POLICIES

#### WELLHEAD PROTECTION PLANS AND ORDINANCES FIGURE

- 5 of 8 municipal water systems in Wood County have a wellhead protection plan: Biron, Marshfield, Milladore, Pittsville and Wisconsin Rapids.[B1]
- 1 of 8 municipal water systems in Wood County has a wellhead protection ordinance:

Pittsville.[B1]

Wellhead protection plans are developed to achieve groundwater pollution prevention measures within public water supply wellhead areas. In some areas of the state, sophisticated groundwater flow modeling techniques were used to delineate source water areas for municipal wells. A wellhead protection plan uses public involvement to delineate the wellhead protection area, inventory potential groundwater contamination sources, and manage the wellhead protection area. All new municipal wells are required to have a wellhead protection plan. A wellhead protection ordinance is a zoning ordinance that implements the wellhead protection plan by controlling land uses in the wellhead protection area.[B2]

**For recommendations of groundwater protection policies and some outstanding examples of innovative groundwater protection policies adopted by other communities see Groundwater Protection Policies.**

Of those municipal water systems that have wellhead protection (WHP) plans, some have a WHP plan for all of their wells, while others only have a plan for one or some of their wells. Similarly, of those municipal water systems that have WHP ordinances, some ordinances apply to all of their wells and others just one or some of their wells.

### ANIMAL WASTE MANAGEMENT ORDINANCES

- Wood County has adopted an animal waste management ordinance.[B3]

Most Wisconsin counties have adopted an animal waste management ordinance that applies to all unincorporated areas of the county (areas outside of city and village boundaries). While the purposes of such ordinances vary among counties, a key purpose is often to protect the groundwater and surface water resources. This is accomplished by regulations such as:

- Permitting of animal waste storage facilities;
- Permitting of new and expanding feedlots;
- Nutrient management;
- Prohibiting:
  - Overflow of manure storage structures;
  - Unconfined manure stacking or piling within areas adjacent to stream banks, lakeshores, and in drainage channels;
  - Direct runoff from feedlots or stored manure to waters of the state;
  - Unlimited livestock access to waters of the state where high concentrations of animals prevent adequate sod cover maintenance.

More information is available from the WDATCP.

### ADDITIONAL GROUNDWATER PROTECTION POLICIES

Your county may have additional policies in place for groundwater protection. A good way to find out is to check with the county conservationist and local zoning administrators.

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## MONEY SPENT ON CLEANUP

### PETROLEUM ENVIRONMENTAL CLEANUP FUND AWARD

- Over $28 million have been spent in Wood County on petroleum cleanup from leaking underground storage tanks, which equates to $379 per county resident.[C2]

The Petroleum Environmental Cleanup Fund Award (PECFA) program was created in response to enactment of federal regulations requiring release prevention from underground storage tanks and cleanup of existing contamination from those tanks. PECFA is a reimbursement program returning a portion of incurred remedial cleanup costs to owners of eligible petroleum product systems, including home heating oil systems.[C1]

As of May 31, 2007, $28,349,050 have been reimbursed by the PECFA fund to clean up 206 petroleum-contaminated sites in Wood County. This equates to $379 per county resident, which is greater than the statewide average of $264 per resident.[C2]

### NITRATE REMOVAL SYSTEMS

- No municipal water systems in Wood County have spent money to reduce nitrate levels.

As of 2005, over 20 municipal water systems in Wisconsin have spent over $24 million reducing nitrate concentrations in municipal water systems.[C3]

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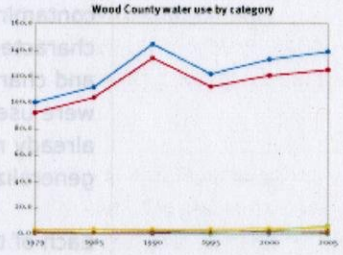
## GROUNDWATER USE

- From 1979 to 2005, total water use in Wood County has increased from about 100.0 million gallons per day to about 139.0 million gallons per day.*
- The increase in total water use over this period is due almost entirely to an increase in industrial use.
- The proportion of county water use supplied by groundwater has varied from about 8% to about 16% during the period 1979 to 2005.*




***Water use in Wood County***
CLICK FOR FULL SIZE

As part of the National Water-Use Information Program, the USGS stores water-use data in standardized format for different categories of water use. In 1978, the USGS entered into a cooperative program with the WDNR to inventory water use in Wisconsin. Since that time, five reports summarizing water use have been published (Lawrence and Ellefson, 1982[D2]; Ellefson and others, 1987[D3]; Ellefson and others, 1993[D4]; Ellefson and others, 1997[D5]; Ellefson and others, 2002[D6]; Buchwald and others, 2008[D7]).

Water use in Wisconsin in these summary reports is reported in the following categories: domestic, livestock, aquaculture, industrial, commercial, public use and losses, thermoelectric or mining. References describing the methods for collecting data and estimating water use are provided in the summary reports.

* Thermoelectric and mining data are not considered in water-use tables or figures on this web site. Thermoelectric-power water use is the amount of water used in the process of generating thermoelectric power. The predominant use of water is as non-contact cooling water to condense the steam created to turn the turbines and generate electricity. [D1]

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## SUSCEPTIBILITY OF GROUNDWATER TO CONTAMINANTS

In Wisconsin, 70% of residents and 97% of communities rely on groundwater as their drinking water source. Wisconsin has abundant quantities of high-quality groundwater, but once groundwater is contaminated, it's expensive and often not technically possible to clean. Because of these factors, we need to be careful to protect our groundwater from contamination. Our activities on the land can contaminate groundwater - most contaminants originate on the land surface and filter down to the groundwater. In some cases however, groundwater can become contaminated from natural causes such as radioactivity due to the presence of radium in certain types of rocks.

READ MORE ABOUT SUSCEPTIBILITY

"Susceptibility of Groundwater to Pollutants" is defined here as the ease with which a contaminant can be transported from the land surface to the top of the groundwater called the "water table". Many materials that overlie the groundwater offer good protection from contaminants that might be transported by infiltrating waters. The amount of protection offered by the overlying material varies, however, depending on the materials. Thus, in some areas, the overlying soil and bedrock materials allow contaminants to reach the groundwater more easily than in other areas of the state.

In order to identify areas sensitive to contamination, the Wisconsin Department of Natural Resources, in cooperation with the University of Wisconsin-Extension, Wisconsin Geological and Natural History Survey and the USGS, has evaluated the physical resource characteristics that influence this sensitivity.

Five physical resource characteristics were identified as important in determining how easily a contaminant can be carried through overlying materials to the groundwater. These characteristics are depth to bedrock, type of bedrock, soil characteristics, depth to water table and characteristics of surficial deposits. Existing statewide maps of these five characteristics were used whenever possible. New maps were compiled when existing information wasn't already mapped. The resource characteristic maps used in this project were compiled from generalized maps at a scale of 1:250,000 or 1:500,000.

Each of the five resource characteristic maps was put into digital form using a Geographic Information Systems (GIS) program. All of the information contained in the five maps were overlaid and combined into one composite map. A numeric rating scheme developed for each map was used to score the maps and the five resource map scores were added together within GIS. The composite map shows the scores for each area – low scores represent areas that are more susceptible to contamination and high scores represent areas that are less susceptible to contamination.

The method described above is a subjective rating method; specifically an index method. An index method assigns a subjective ratings or score to physical resource characteristics of an area to develop a range of contamination susceptibility categories (ranging, in this case, from more susceptible to less susceptible). Index methods are fairly popular approaches to groundwater susceptibility, because they are quick and straightforward, and they use data that are readily available. However, the mapped distribution of susceptibility categories produced by an index method is typically fraught with uncertainty, primarily due to the subjectivity in the approach. The susceptibility categories include little quantifiable or statistical information on uncertainty and this limits their use for defensible decision making. So while susceptibility maps produced using index methods can be useful, their inherent uncertainty must be kept in mind. (National Research Council, 1993[E1]; Focazio and others, 2002[E2]).

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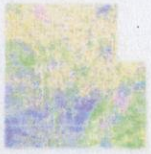
## GROUNDWATER QUALITY

### NITRATE

- 89% of 532 private well samples collected in Wood County from 1990-2006 met the health-based drinking water limit for nitrate-nitrogen.



*Nitrate-nitrogen concentrations in Wood County*
CLICK FOR FULL SIZE

Of the 532 samples that have been collected in the county, 205 samples (39%) contained between 2 and 10 mg/L (milligrams per liter, or parts per million) nitrate-nitrogen, and serve as indicators that land use has likely affected groundwater quality. An additional 61 samples (11%) exceeded the health-based drinking water limit of 10 mg/L nitrate-nitrogen.[F1]

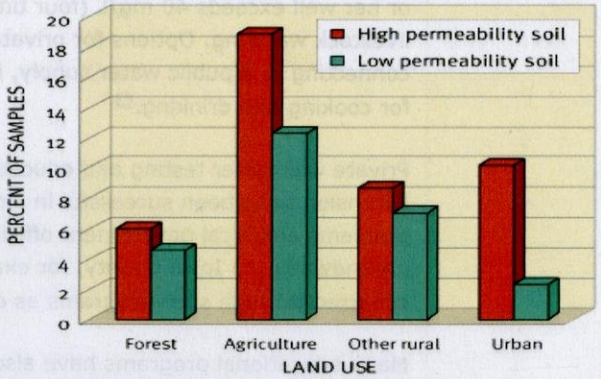
As shown in the map on the right, the samples where nitrate-nitrogen levels were elevated are located throughout the county.[F2]

**Introduction and Sources of Nitrate**

In 2006, the WDNR and the Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP) reported that nitrate-nitrogen ($NO_3$-N) is the most widespread groundwater contaminant in Wisconsin, and that the nitrate problem is increasing both in extent and severity.[F3] In Wisconsin's groundwater, 80% of nitrate inputs originate from manure spreading, agricultural fertilizers, and legume cropping systems.[F4] On-site wastewater systems (septic systems) can also be a significant nitrate source in densely populated areas, areas where fractured bedrock is near the surface, or areas with coarse-textured soils.[F5]

Concentrations of nitrate-nitrogen in private water supplies frequently exceed the drinking water limit (federal and state Maximum Contaminant Level, or MCL) of 10 mg/L. In 2005, the WDNR combined data from three statewide groundwater databases and found that 11.6% of 48,818 private wells exceeded the nitrate limit.[F3]

**Percentage of Wisconsin drinking water samples with nitrate levels over the health standard**




Land use affects nitrate concentrations in groundwater. As shown in the figure on the right, an analysis of over 35,000 Wisconsin drinking water samples found that drinking water from private wells was three times more likely to be unsafe to drink due to high nitrate in agricultural areas than in forested areas. High nitrate levels were also more common in sandy areas where the soil is more permeable.[F6] Groundwater with high nitrate from agricultural lands is more likely to contain pesticides than groundwater with low nitrate levels.[F7]

**Health effects of nitrate**
READ MORE

Human health is the primary reason high levels of nitrate in drinking water are of concern.[F3] Nitrate can cause a condition called methemoglobinemia, or "blue-baby syndrome," in infants

under six months of age. Nitrate in water used to make baby formula converts to nitrite in the child's stomach and changes the hemoglobin in blood to methemoglobin. The infant's body is then deprived of oxygen. In extreme cases, methemoglobinemia can be fatal; the long-term effects of lower-level oxygen deprivation are unknown.

The conversion of nitrate to nitrite in the human body also creates N-nitroso compounds, which are some of the strongest carcinogens known. As a result, additional human health concerns linked to nitrate-contaminated drinking water include increased risk of non-Hodgkin's lymphoma[F8], gastric cancer[F9, E10], and bladder and ovarian cancer in older women.[F11] There is also growing evidence of a correlation between nitrate and diabetes in children.[F12, E13] The current drinking water limit of 10 mg/L for nitrate-nitrogen addresses only methemoglobinemia; the concentration at which cancer risks occur is unknown.

**Ecosystem effects of nitrate**
READ MORE

Nitrate also affects surface water ecosystems by increasing the growth of nuisance algae that then die and deplete the water of oxygen. Between the late 1960s and the early 1980s, nitrate levels in waters flowing into the Gulf of Mexico more than doubled, causing a "dead zone" that in 1999 was approximately the size of the state of New Jersey.[F14] In Wisconsin, the effects of increasing nitrate levels in surface waters are mostly unstudied.

**Solutions**
READ MORE

Because of the health concerns, public water supplies that exceed the 10 mg/L limit are required to reduce the nitrate-nitrogen level. The most common solutions include drilling a new, usually deeper, well; blending contaminated water with non-contaminated water to lower the nitrate concentration; or removing nitrate through water treatment processes. However, such solutions are often costly. By 2006, 25 Wisconsin public drinking water systems had exceeded the nitrate limit and collectively spent over $24 million on remedies. This number is up sharply from just 14 in 1999.[F3] For information about which public drinking water systems exceeded the nitrate limit see Money Spent on Cleanup.

The Wisconsin Well Compensation fund can assist a private well owner if the nitrate level in his or her well exceeds 40 mg/L (four times the human health limit), but only if the well is used for livestock watering. Options for private well owners include replacing or modifying the well, connecting to a public water supply, installing a water treatment system, or using bottled water for cooking and drinking.[F3]

Private well water testing and education programs offered by the University of Wisconsin – Extension have been successful in increasing both public awareness of individual nitrate problems and local government officials' interest in taking proactive planning steps to protect groundwater. In Iowa County, for example, town officials began using groundwater information collected through such programs as criteria for siting new facilities and developments.[F15]

Many educational programs have also been put in place to help farmers limit the loss of nitrogen to groundwater. These programs emphasize soil testing and proper crediting of nitrogen sources already in place to avoid overfertilization, and good management practices for fertilizer storage and handling to minimize spills and other losses. However, numerous researchers have shown that in central Wisconsin, such best management practices are not always adequate to prevent contamination of groundwater with nitrate above the drinking water limit.[F16, E17]

Recent research on Wisconsin farms has shown that cattle raising using management intensive

grazing (also known as rotational grazing or grass-fed agriculture) has potential for protecting groundwater from nitrate contamination.[F18] In general, well-managed organic farming practices also lower nitrate inputs to groundwater,[F19, E20] but at times, leaching from organic systems may also exceed the drinking water limit for nitrate.[F21]

Some local governments have been successful with providing incentives to farmers to grow groundwater-friendly crops or otherwise limit nitrogen applications around city wells. For example, the city of Waupaca identified fields in the recharge area for its wells and provided various incentives for farmers to enter into cropping agreements to limit nitrate inputs.[F22] A community may choose to hire a specialist to evaluate nitrate-susceptible areas and develop possible management strategies.

In addition, three rules currently being proposed or implemented could decrease nitrate contamination of groundwater:[F3]

- NR243 (finalized and to be promulgated in spring 2007) lowers nitrogen levels reaching groundwater from manure and process wastewater by requiring improved manure storage facilities and prohibiting excessive or improper application of manure and process wastewater on cropped fields. This rule will apply to large Concentrated Animal Feeding Operations of 1000 animal units and larger. Currently, there are about 150 of these permitted operations in Wisconsin.
- ATCP51 (enacted in April 2006) is a livestock siting standard that protects areas susceptible to groundwater pollution. Required standards prevent runoff from entering sinkholes, ensure that existing storage structures do not leak, and require a manure application plan that minimizes risks to groundwater, including existing wells. This adopted rule is expected to apply to about 70 new and expanding farms of more than 500 animal units each year.
- ATCP50 (still pending as of April 2007) applies to all farms and includes the requirement for nutrient management plans by 2008. It incorporates new 2005 USDA NRCS nutrient standards (590 standards) for both nitrogen and phosphorus application.

**Planning**

READ MORE

Some nitrate loss from agricultural activities seems inevitable even with good management practices, especially in areas with coarse-textured soils or shallow soils over fractured bedrock. From a planning perspective, therefore, the solutions may lie in keeping new agricultural operations out of the zone of influence for existing wells, and in avoiding the location of new private or public wells in areas where nitrate contamination in groundwater has already occurred.

The 2002 UW-Extension publication titled "Planning for Natural Resources - A Guide to Including Natural Resources in Local Comprehensive Planning" gives more details about the following implementation tools that can be used to address natural resources issues in the planning process:

1. **Education Tool:** Education and citizen participation in making land use decisions, implementing land use goals, and taking private actions aimed at limiting nitrate contamination of groundwater.
2. **Environmental Assessment Tool:** Environmental assessment requirements within zoning or subdivision ordinances to provide detailed information about the potential effects of proposed development on nitrate levels in groundwater, or to ensure that suitable sources of water for private wells are available on a proposed development site.
3. **Facility Planning Tool:** More detailed facility plans for potential contamination sources, such as spill containment plans for potential nitrate sources.

4. **Regulatory Tools,** including:
    a. Zoning
        - Performance zoning, which outlines general water quality goals that developers or other landowners can meet by a variety of methods.
        - Overlay zoning, which allows special regulations of sensitive environmental areas such as wellhead protection districts or groundwater recharge areas.
        - Planned Unit Developments may allow developers to vary some of the standards in local zoning ordinances to allow innovative approaches that may better protect groundwater.
    b. Subdivision regulations could include requirements for adequate and safe water supply and wastewater disposal and treatment facilities, as well as addressing land suitability and environmental and design issues. (For further information on subdivisions' impacts on groundwater, see footnote #3).
    c. Increased nitrate treatment by onsite wastewater systems could be encouraged with financial incentives or density bonus incentives, although the current Wisconsin Administrative Code (Comm 85.035) does not allow such systems to be required.[F23]
    d. Density transfers can allow the transfer of development rights from one parcel that a community wants to protect to another parcel where the community wants development to occur.
5. **Acquisition Tools,** including:
    a. Outright purchase of land needed for groundwater protection by communities or non-profit conservation organizations.
    b. Conservation easements could limit land uses to those not likely to contaminate groundwater with excess nitrate.
    c. Purchase of development rights can protect land from development with certain types of groundwater-contaminating activities while allowing the landowner to retain ownership of the land and the ability to sell or transfer it at any time.
    d. Eminent domain allows government to take private property for public purposes with compensation to the owner, even without the owner's consent. This tool could be used to acquire critical groundwater protection areas.
6. **Fiscal Tools,** including:
    a. Capital improvement programs that help a community plan and budget for capital improvements such as water supplies and wastewater treatment facilities.
    b. Impact fees can require new developments to pay for improvements needed to serve that development.
    c. WDNR may provide grant or loan programs to help communities assess and meet their needs in areas involving sensitive natural resources such as groundwater.

A community could also consider hiring a specialist to evaluate areas where groundwater is particularly vulnerable and to identify agricultural and other strategies to minimize nitrate leaching.

## PESTICIDES

- A 2002 study estimated that 36% of private drinking water wells in the region of Wisconsin that includes Wood County contained a detectable level of an herbicide or herbicide metabolite. Pesticides occur in groundwater more commonly in agricultural regions, but can occur anywhere pesticides are stored or applied.[F24]
- 2,256 acres of land in Wood County are in atrazine prohibition areas.[F25]

### Definition and Use

A pesticide is any substance used to kill, control or repel pests or to prevent the damage that pests may cause.[F26] Included in the broad term "pesticide" are herbicides to control weeds,

insecticides to control insects, and fungicides to control fungi and molds. Pesticides are used by businesses and homeowners as well as by farmers, but figures for the amounts and specific types of pesticides used are not generally available on a county-by-county basis.

A 2005 report indicates that approximately 13 million pounds of pesticides are applied to major agricultural crops in Wisconsin each year, including over 8.5 million pounds of herbicides, 315,000 pounds of insecticides, one million pounds of fungicides, and 3 million pounds of other chemicals (this last category applied mainly to potatoes).[F27] The report also shows that herbicides are used on 100% of carrots for processing, 99% of potatoes, 98% of cucumbers for processing, 98% of soybeans, 97% of field corn, 89% of snap beans for processing, 87% of sweet corn, and 84% of green peas for processing. Insecticides are used on 97% of potatoes, 96% of carrots, and 88% of apples. Fungicides are used on 99% of potatoes, 88% of carrots, and 89% of apples.

**Top five crops by acreage grown in Wood County in 2005-06 and average pesticide application per crop in Wisconsin.**

| Commodity | Acres | Pounds of pesticides applied per acre (statewide average) |
|---|---|---|
| Corn for grain | 37,800 | 2 |
| Soybeans | 14,000 | 1 |
| Corn for silage | 11,000 | 2 |
| Oats | 5,300 | 0.1 |
| Barley all | 1,400 | 0.1 |

Source: USDA Quickstats[F45] and USDA Statistics by State[F46]

The number of pounds of pesticide applied per acre in Wisconsin varies greatly by crop, from 28 pounds/acre for apples to less than one pound/acre for oats and barley (see table below).[F27]

**Total pounds of pesticides applied to major crops in Wisconsin, 2004-2005.**

| Crop | Acres | Total pounds of pesticides applied | Pounds of pesticides applied per acre |
|---|---|---|---|
| Apples | 5,800 | 163,300 | 28 |
| Potatoes | 68,000 | 950,000 | 14 |
| Tart cherries | 1,800 | 14,700 | 8 |
| Carrots for processing | 4,200 | 29,400 | 7 |
| Snap beans | 76,000 | 251,600 | 3 |
| Sweet corn | 88,400 | 198,000 | 2 |
| Field corn | 3,800,000 | 6,503,000 | 2 |
| Green peas for processing | 30,200 | 33,500 | 1 |
| Soybeans | 1,610,000 | 1,770,000 | 1 |
| Cucumbers for processing | 4,600 | 3,800 | 1 |
| Cabbage, fresh | 4,400 | 2,700 | 1 |
| Barley | 55,000 | 5,000 | <1 |
| Oats | 400,000 | 25,000 | <1 |

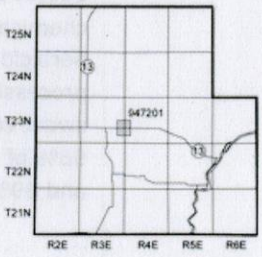
**Atrazine Prohibition Areas**

As of 2006, the WDATCP has prohibited the use of the popular corn herbicide atrazine on 102 designated atrazine prohibition areas in Wisconsin, covering about 1.2 million acres.[F25] The map below shows the 2,256 acres of land located in atrazine prohibition areas in Wood County.

**Environmental fate of pesticides**

Once a pesticide is applied, it ideally will harm only the target pest and then break down through natural processes into harmless substances.

However, the actual fate of pesticides in the environment may include evaporation into the air; runoff into surface water; plant uptake; breakdown by sunlight, soil microorganisms or chemical reactions; attachment to soil particles; leaching into groundwater; or remaining on the plant surface and removal at harvest.




*Atrazine prohibition areas in Wood County*

CLICK FOR FULL SIZE

The WDATCP conducted a private well water study from 2000-2001, looking for some of the most commonly used herbicides in Wisconsin.[F29] From that study, the statewide estimate of the proportion of private drinking water wells that contained a detectable level of a herbicide or herbicide metabolite (breakdown product) was 37.7%. The map at the right shows the estimated percentage of wells containing herbicide or herbicide metabolites by region. The study did not look at less commonly used herbicides or any insecticides or fungicides. WDATCP is doing a similar study in 2007 that includes analysis for a greater number of pesticides.

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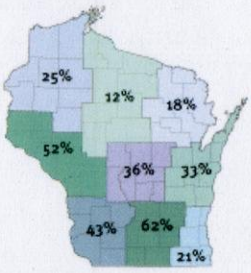


*Percentage of private wells with herbicides or herbicide metabolites*

CLICK FOR FULL SIZE

How much of a pesticide application will leach to groundwater depends upon four factors:[F30]

- **pesticide properties** such as high water solubility, low adsorption (the ability of a pesticide to attach to soil particles), and high persistence (how long it takes for the chemical to degrade)
- **soil characteristics** such as high permeability and porosity, low soil compaction, low amounts of organic material, and high amounts of sand and gravel content
- **site conditions** such as shallow depth to groundwater, high amount of precipitation, and excessive irrigation
- **management practices** such as poor timing of pesticide application, not incorporating the pesticide into the soil, poor handling of the chemical, and solely relying on chemicals for pest control

Determining which pesticides are in groundwater at a given location and time is difficult and can be expensive. A pesticide test generally looks for a single chemical, or more commonly, a broad group of chemicals, but not all pesticides are detected by any one test. Pesticides break down over time into metabolites which may not have the same testing method as the parent compound. Further, some pesticides do not have approved testing methods, so they cannot be measured in water.

**Health effects of pesticides**

READ MORE

The health effects of pesticide exposure vary by pesticide. For example, atrazine, a common corn herbicide, has been linked to weight loss, cardiovascular damage, retinal and some muscle degeneration, and cancer when consumed at levels over the drinking water limit for long periods of time.[F31] Long-term exposure to alachlor, another herbicide, is associated with damage to the liver, kidney, spleen, and the lining of the nose and eyelids, and cancer.[F32] Only about 30 pesticides currently have health-based drinking water limits in Wisconsin, so occasionally, pesticides are detected in drinking water, but their harmful levels or health effects are unknown. Also unknown are the health effects of a combination of pesticides in drinking water, even at levels below the drinking water limit for any one of the pesticides.

To learn more about pesticides, please see

- Extension Toxicology Network: includes pesticide trade names, regulatory status, and toxicological and ecological effects
- National Pesticide Information Center: includes how pesticides work, toxicity, metabolites, and environmental effects.

**Planning**
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Goals for groundwater protection from pesticides may include:

- Determine what pesticides are being used and where. Test wells in these areas for these pesticides and their metabolites.
- For pesticides with established drinking water limits, keep concentrations below the drinking water limit.
- Encourage and support the use of organic farming methods in the county.
- Limit use of lawn pesticides (perhaps by limiting lawn size).

**Implementation tools**

Because of differences in pesticides, soils, and management practices, knowing which crops are grown in an area alone does not accurately indicate the risk to human health. However, knowing where pesticide use is likely to be heaviest may be useful in comprehensive planning if one of the goals is to minimize human exposure to potential contaminants in the environment.

Implementation tools that can be used to address groundwater issues in the planning process may include:

1. **Education Tool:** Education and citizen participation in making land use decisions, implementing land use goals, and taking private actions aimed at limiting pesticide contamination of groundwater.
    a. Private well water testing and education programs offered by the University of Wisconsin – Extension can increase public awareness of pesticide contamination in groundwater and local government officials' interest in taking proactive planning steps to protect groundwater. In Iowa County, for example, town officials began using groundwater information collected through such programs as criteria for siting new facilities and developments.[F15]
    b. The University of Wisconsin – Madison and UW - Extension have many educational programs in place to help farmers limit the use of pesticides and pesticide losses to the environment,[F33] such as the Integrated Crop and Pest Management (ICPM) program, which can be accessed and implemented locally through the county Extension office.
2. **Environmental Assessment Tool**: Environmental assessment requirements within zoning or subdivision ordinances to ensure that suitable sources of water for private wells

are available on a proposed development site.

3. **Facility Planning Tool**: More detailed facility plans for potential contamination sources, such as spill containment plans for potential pesticide sources.
4. **Regulatory Tools:** including
    a. Zoning
        i. Performance zoning, which outlines general water quality goals that developers or other landowners can meet by a variety of methods.
        ii. Overlay zoning, which allows special regulations of sensitive environmental areas such as wellhead protection districts or groundwater recharge areas.
    b. Density transfers can allow the transfer of development rights from one parcel that a community wants to protect to another parcel where the community wants development to occur.
5. **Acquisition Tools,** including:
    a. Outright purchase of land needed for groundwater protection by communities or non-profit conservation organizations.
    b. Conservation easements could limit land uses to those not likely to contaminate groundwater with pesticides.
    c. Purchase of development rights can protect land from development with certain types of groundwater-contaminating activities while allowing the landowner to retain ownership of the land and the ability to sell or transfer it at any time.
    d. Eminent domain allows government to take private property for public purposes with compensation to the owner, even without the owner's consent. This tool could be used to acquire critical groundwater protection areas.
6. **Fiscal Tools**: including WDNR grant or loan programs to help communities assess and meet their needs in areas involving sensitive natural resources such as groundwater.[F34]
7. **Incentive Tools**: Incentives from local governments to grow groundwater-friendly crops including
    a. A community could identify agricultural lands in the recharge area for its wells and provide various incentives for farmers to enter into cropping agreements to limit pesticide inputs.
    b. Woodbury County, Iowa offers property tax rebates to farmers who switch to organic methods.[F35]
    c. A community may hire a specialist to evaluate areas of high pesticide use and develop possible pesticide management strategies or promote low-pesticide agricultural systems or organic farming systems which forbid the use of synthetic pesticides.
    d. A community may encourage food processors that purchase organic or groundwater friendly foods to locate or form in the area.

## ARSENIC

- 100% of 4 private well samples collected in Wood County met the health standard for arsenic.[F43]

Of the 4 water samples analyzed for arsenic in Wood County, 1 sample (25%) has detectable arsenic and 1 sample (25%) is greater than the recently reduced drinking water limit of 10 µg/L (micrograms per liter, or parts per billion).[F44]

Most private wells in the county have unknown arsenic levels.

### Introduction

Arsenic is an element that occurs naturally in some of Wisconsin's aquifers and may contaminate well water drawn from those aquifers. It is a particular problem in parts of the Fox River valley of northeastern Wisconsin. However, arsenic has been detected in wells in every

county in Wisconsin, and arsenic concentrations greater than the drinking water limit of 10 µg/L have been documented in 51 of Wisconsin's 72 counties.[F3]

**Health effects of arsenic**
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Drinking water with elevated levels of arsenic may lead to a variety of health effects, including:[F36] skin cancer, internal cancers (bladder, prostate, lung, and other sites), thick, rough skin on hands and feet, unusual skin pigmentation (dappling of dark brown or white splotches), numbness in the hands and feet, circulatory disorders, tremors, stomach pain, nausea, diarrhea, diabetes, depression.

**Release of arsenic into groundwater**
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In northeastern Wisconsin, most of the arsenic is found in a highly mineralized zone at the top of the St. Peter Sandstone aquifer. The oxidation mechanism that releases arsenic occurs naturally in some cases, but can also be triggered by either:[F3]

- Local and regional drawdown (drop in water level) caused by increasing water use, which exposes the arsenic-bearing zone to the atmosphere or
- Well construction techniques that introduce oxygen into the aquifer.

However, revised WDNR drilling rules and special well casing requirements have greatly reduced well construction problems.[F44] Maps are available from the WDNR that show special well construction and well casing requirements by section for towns in Winnebago and Outagamie Counties.

In southeastern Wisconsin and the glacial moraines of northern Wisconsin, the mechanism by which arsenic is released from geologic materials is different. The arsenic is associated with iron oxides and is released by natural reduction reactions that cannot readily be prevented or controlled.[F3, E38, E39] In such areas, alternatives are limited to treating water or using another (often shallower) aquifer, if one is present and not contaminated with nitrate or other human-induced contaminants.

**Planning**
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Arsenic contamination could be addressed in comprehensive planning in the following ways:

- Maps and other resources can be consulted to determine the likelihood of arsenic contamination of drinking water supplies in areas designated for residential development, and possible need for alternate water supplies in those areas.
    - Generalized maps can be found on the WDNR web site for both public and private water supplies sampled until 2000.
    - Madeline Gotkowitz (mbgotkow@wisc.edu, 608/262-1580) at the Wisconsin Geological and Natural History Survey has done extensive research and public outreach on arsenic problems in Wisconsin's groundwater.
- Testing and education programs can be conducted for owners of existing private wells in arsenic-prone areas to check current arsenic levels in private wells, to advise about treatment options, and to inform about ways to limit further arsenic release in the aquifer, where applicable.
- Restricting residential growth, encouraging or mandating water conservation, or finding alternate water sources may be beneficial in areas where oxidation is the primary method of arsenic release.

For further information on arsenic, please visit the WDNR Arsenic in Drinking Water and Groundwater web site.

## OTHER GROUNDWATER CONTAMINANTS

Information on volatile organic compounds, pharmaceuticals and personal care products, and chloride.
READ MORE

**Volatile Organic Compounds**
Volatile organic compounds (VOCs) are a group of common industrial and household chemicals that evaporate, or volatilize, when exposed to the air. Sources of VOCs include a variety of everyday products such as gasoline, fuel oil, solvents, degreasers, and dry cleaning solutions. When chemicals containing VOCs are spilled or disposed of on or below the land surface some of the chemicals can be carried down into the groundwater where they may pose a threat to nearby wells. Some VOCs are quite toxic while others pose little risk. Health risks vary depending on the type of VOC, but effects of long-term exposure can include cancer, liver damage, spasms, and impaired speech, hearing, and vision.[F40]

**Pharmaceuticals and Personal Care Products**
The list of pharmaceuticals is long and includes such medications as tranquilizers, pain killers, antibiotics, birth control, hormone replacement, lipid regulators, beta blockers, anti-inflammatories, chemotherapy, antidiabetics, seizure control, veterinary drugs, antidepressants, and other psychiatric drugs. There is a related category of chemicals referred to as "personal care products" that includes cosmetics, perfumes, soaps, sunscreens, insect repellants, and so forth. The volume of pharmaceuticals and personal care products entering the environment each year is about equal to the amount of pesticides used.

In 2000 the U.S Geological Survey conducted a nationwide assessment of drugs in streams and groundwater. They picked locations likely to be contaminated, but found pharmaceuticals in about 60% of groundwater samples. Sources of discharge of pharmaceuticals to the environment include wastewater treatment plants, onsite wastewater treatment systems, landfills, sludge and manure spreading, and livestock feedlots. Why be concerned about traces of chemicals that were designed to be consumed? We're only beginning to understand the health effects. Because of the low concentrations, any effects are likely to appear only after years of exposure. A real concern is that some of the drugs are endocrine disruptors. Endocrine glands, such as the thyroid, pituitary or thymus send hormones, such as adrenaline, estrogen or testosterone to specific cells stimulating certain responses. There are hundreds of different hormones, and they are messengers that regulate a multitude of normal biological functions, such as growth, reproduction, brain development, and behavior. The delivery of hormones to various organs is vital, and when the delivery, timing, or amount of hormone is upset, the results can be devastating and permanent. Chemicals that are similar to hormones ("hormone mimics") can fit onto the receptor sites on the target cells and either block the real hormones or trigger abnormal responses in the cells. Scientific studies have indicated links between endocrine disruptors and reproductive disorders, immune system dysfunction, certain types of cancer, congenital birth defects, neurological effects, attention deficit, low IQ, low sperm counts, and early onset of puberty in girls.[F41]

**Chloride**
Chloride at levels greater than 10 mg/L usually indicate contamination by onsite wastewater treatment systems (including water softener regeneration), road salt, fertilizer, animal waste, or other wastes. Chloride is not toxic in concentrations typically found in groundwater, but some people can detect a salty taste at 250 mg/L. Levels of chloride that are above what is typical under natural conditions indicate that groundwater is being affected by human activities, and extra care should be taken to ensure that land use activities do not further degrade water

quality.[F42]

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## POTENTIAL SOURCES OF CONTAMINANTS

Since groundwater gets into the ground at the land surface, it makes sense that what happens on the land surface can have impact on groundwater. A great many land use activities have the potential to impact the natural quality of groundwater, as shown in the table below. A landfill may leach contaminants into the ground that end up contaminating groundwater. Gasoline may leak from an underground storage tank into groundwater. Fertilizers and pesticides can seep into the ground from application on farm fields, golf courses or lawns. Intentional dumping or accidental spills of paint, used motor oil, or other chemicals on the ground can result in contaminated groundwater. The list could go on and on.[G1] The rest of this section provides county-specific information about potential sources of groundwater contaminants.

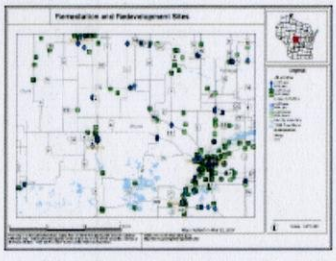
### ACTIVITIES THAT MAY CONTAMINATE GROUNDWATER [G1]

<table>
<tr><th>Place of Origin</th><th colspan="4">Potential Pollution Sources</th></tr>
<tr><td></td><td>Municipal</td><td>Industrial</td><td>Agricultural</td><td>Other</td></tr>
<tr><td></td><td colspan="4">Waste-related</td></tr>
<tr><td rowspan="2">At or near the land surface</td><td colspan="2">Sludge and wastewater disposal</td><td rowspan="2">Feedlots<br><br>Manure storage and spreading<br><br>Whey spreading</td><td rowspan="2">Septage disposal<br><br>Junkyards</td></tr>
<tr><td></td><td>Wastewater irrigation & landspreading</td></tr>
<tr><td rowspan="2">Below the land surface</td><td colspan="2">Landfills<br>Wastewater impoundments</td><td rowspan="2">Manure pits</td><td rowspan="2">Septic systems<br><br>Holding tanks</td></tr>
<tr><td>Seepage cells<br><br>Sanitary sewers</td><td></td></tr>
<tr><td></td><td colspan="4">Non-waste</td></tr>
<tr><td rowspan="2">At or near the land surface</td><td rowspan="2">Salt piles<br><br>Snow piles<br><br>Contaminated stormwater infiltration</td><td colspan="2">Above and on the ground storage of chemicals</td><td rowspan="2">Highway deicing salt<br><br>Lawn fertilizers<br><br>Pesticides</td></tr>
<tr><td>Stockpiles<br><br>Spills<br><br>Tailing piles</td><td>Irrigation<br><br>Fertilizers<br><br>Pesticides<br><br>Silage</td></tr>
<tr><td>Below the land surface</td><td>Underground tanks<br><br>Pipelines</td><td></td><td>Improperly constructed and abandoned wells<br><br>Over-pumping (induced pollution)</td></tr>
</table>

## CONTAMINATED GROUNDWATER AND/OR SOIL

- There are 120 open-status sites in Wood County that have contaminated groundwater and/or soil. These sites are composed of 51 Leaking Underground Storage Tank (LUST) sites, 44 Environmental Repair (ERP) sites and 25 spill sites.[G2]

Properties that were or are contaminated with hazardous substances can be found using the WDNR's Bureau for Remediation and Redevelopment Tracking System (BRRTS). The figure on the right shows the BRRTS map of contaminated sites in Wood County. Royal blue diamonds on the map indicate open leaking underground storage tank (LUST) sites which have contaminated soil and/or groundwater with petroleum, which includes toxic and cancer-causing substances. However, given time, petroleum contamination naturally breaks down in the



***BRRTS sites***

environment. Turquoise diamonds on the map indicate open environmental repair (ERP) sites which are sites other than LUSTs that have contaminated soil and/or groundwater. Examples include industrial spills or dumping, buried containers of hazardous substances, and closed landfills that have caused contamination. More information for the sites on the figure is available online.

*in Wood County*
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**About the BRRTS**
READ MORE

The WDNR Bureau of Remediation and Redevelopment Tracking System (BRRTS) contains information about locations at which there have been releases of hazardous or potentially hazardous substances to the lands, waters, or air of the State of Wisconsin. Degradation of groundwater quality is one of the primary concerns at BRRTS sites, but soil, vapor, air, and surface water contamination are also areas of concern.

**What is a Hazardous Substance?**
READ MORE

A Hazardous Substance is defined in s. 292.01, Wis. Stats., as "any substance or combination of substances, including any waste of a solid, semisolid, liquid or gaseous form which may cause or significantly contribute to an increase in the mortality or an increase in serious irreversible or incapacitating reversible illness, or which may pose a substantial present or potential hazard to human health or the environment because of its quality, concentration or physical, chemical or infectious characteristics. This term includes, but is not limited to, substances that are toxic, corrosive, flammable, irritants, strong sensitizers or explosives as determined by the WDNR."

Types of hazardous substance occurrences or discharges that are documented in the BRRTS database include:

- **Abandoned Container (AC)** – an abandoned container with potentially hazardous contents has been inspected and recovered, but discharge to the environment has not occurred.
- **Leaking Underground Storage Tank (LUST)** – a leaking underground storage tank has contaminated soil and/or groundwater with petroleum. Petroleum products contain cancer-causing and toxic substances, but may biodegrade, or break down naturally in the environment, over time.
- **Environmental Repair (ERP)** – sites other than LUSTs that have contaminated soil and/or groundwater. Industrial spills or dumping, buried containers of hazardous substances, closed landfills, and leaking above-ground petroleum storage tanks are potential ERPs.
- **Voluntary Party Liability Exemption** - an elective process in which a property owner conducts an environmental investigation and cleanup of an entire property and then receives limits on future liability for that contamination.
- **Spills** – discharges of hazardous substances, usually cleaned up quickly.

For further information, see the BRRTS web site glossary.

**How to use BRRTS information in comprehensive planning**
READ MORE

BRRTS information provides a snapshot of contaminated sites that need to be considered when developing land use plans. Steps toward incorporating BRRTS information into a comprehensive plan include

1. **Inventory contaminated sites and identify their status.** The summary document prepared for each county on this web site lists BRRTS sites that are still open. Other sites of interest may include closed sites and conditionally closed sites on the BRRTS list, or sites in the community that have not yet been investigated by WDNR but are suspected to have had hazardous releases in the past.
2. **Identify land use restrictions and deed restrictions assigned to contaminated properties.** Land use restrictions are placed on BRRTS sites to protect public health and the environment. A BRRTS site that is "closed" and requires no further cleanup action may still have residual soil or groundwater contamination. If it does, it is moved to the GIS Registry of Closed Remediation Sites. Sites on the Registry have restrictions that may include
   - site maintenance plans
   - requirement for WDNR approval before new well construction
   - special required well construction features
   - special precautions when excavating soils

   Details about such restrictions are available in the GIS Registry of Closed Remediation Sites fact sheet.
3. **Identify properties on which redevelopment would be desirable for the community.** Communities may be eligible for assistance in redeveloping contaminated or formerly contaminated industrial or commercial sites that are abandoned, idle or underused through WDNR initiatives aimed at brownfield redevelopment. Helpful tools for redevelopment include
   - environmental liability exemptions
   - financial incentives
   - WDNR assurance letters

Details on programs to help with brownfield redevelopment are found in the WDNR publication Woodfields and Comprehensive Planning

A list of WDNR staff contacts to assist with various aspects of remediation and redevelopment of contaminated sites, including assistance grants for local governments, is available online.

For more information, please see Environmental Contamination – The Basics, WDNR publication PUB-RR-674 July, 2004.

## CONCENTRATED ANIMAL FEEDING OPERATION (CAFO):

- There is 1 concentrated animal feeding operation in Wood County.[G3]

  Vobora Farms
  6000 Elm Rd
  Auburndale WI 54412

By definition, CAFOs have greater than 1000 animal units. CAFOs are required under their Wisconsin Pollutant Discharge Elimination System (WPDES) permits to practice proper manure management and ensure that adverse impacts to water quality do not occur. Permit applicants must submit detailed information about the operation, a manure management plan, plans and specifications for all manure storage facilities, and a completed environmental analysis questionnaire. Once a WPDES CAFO permit is issued, operators must comply with the terms of the permit by following approved construction specifications and manure spreading plans, conducting a monitoring and inspection program, and providing annual reports.

Other potential groundwater contaminants from agriculture include fertilizers and pesticides. Large amounts of nitrogen fertilizers are used when fields are planted continuously with corn, and they can leach into groundwater as nitrate.

For more information, please visit the WDNR CAFO web site.

## LICENSED LANDFILLS

- There are 3 licensed landfills in Wood County.[G4]

DOMTAR AW CORP ASH BARK SITE
PARTS GOVT LOTS 4 & 5
PORT EDWARDS, WI 54469

DOMTAR AW CORP WASTEWATER TREATMENT SITE
PARTS GOVT LOTS 4, 5, 8 & 9
SARATOGA, WI 54469

STORA ENSO NORTH AMERICA - WATER QUALITY CTR
2811 FIFTH AVE N
WISCONSIN RAPIDS, WI 54495

The county may have additional facilities listed in the Registry of Waste Disposal Sites, available from the WDNR, that includes active, inactive, and abandoned sites where solid or hazardous wastes were known, or were likely, to have been disposed. The inclusion of a site on the Registry does not mean that environmental contamination has occurred, is occurring, or will occur in the future. The Registry is intended to serve as a general informational source for the public, and State and local officials, as to the location of waste disposal sites in Wisconsin.

**About Wisconsin's Solid Waste Management Program**
READ MORE

Wisconsin's solid waste management program has been in place for over 30 years. In the first two decades of the program, efforts were primarily directed toward: licensing existing solid waste facilities; closing poorly located or operated facilities; and ensuring that new solid waste facilities were properly located, designed, constructed, operated, closed, and maintained. During this period, the vast majority of municipal and industrial solid waste generated was landfilled.

In the 1990s, things began to change. Wisconsin's Recycling Law was passed in 1990, with most of the requirements taking effect in 1995. In 1997, ch. NR 538, Wis. Adm. Code was promulgated, facilitating the beneficial use of industrial byproducts. These two milestones resulted in significant and still-increasing quantities of waste being diverted from landfills.

As of the summer of 2001, Wisconsin has the following numbers of licensed/regulated facilities in operation: 44 municipal solid waste landfills; 41 industrial waste landfills; 36 construction and demolition waste landfills; 1,446 solid waste transporters; 78 transfer stations; 64 processing facilities; 6 municipal waste combustors; 148 composting facilities (mostly yard waste); and 125 woodburning sites.[G5]

The solid waste program strives to ensure proper management of solid waste and works with its customers to increase waste reduction, reuse, and recycling. For more information on solid waste management in Wisconsin, see the Future of Waste Management Study completed in 2001.

A complete list of licensed landfills in Wisconsin for 2007 can be found online.

More information on solid waste is available from the WDNR.

## SUPERFUND SITES

- There are no Superfund sites in Wood County.[G6]

**What is Superfund?**
READ MORE

In 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the Superfund law. The Superfund law created a tax on the chemical and petroleum industries. The tax went into a trust fund to help pay for cleaning up abandoned or uncontrolled waste sites.

The U.S. Environmental Protection Agency (EPA) administers the Superfund trust fund and works closely with state and local governments and tribal groups to remediate sites that may endanger public health or the environment. The contamination at many of these sites was created years ago when environmental regulations were virtually nonexistent and companies dumped or emitted hazardous materials freely into the environment. Years later the threat to humans and the ecosystems remains so great that the sites need to be cleaned up.

Unfortunately, since much of this contamination was caused so many years ago, it can be hard to find the parties responsible, or the parties responsible may be unwilling or unable to pay for the cleanup. In these cases, the Superfund trust fund can be used to pay for most of the cleanup process. States must pay for a portion of such cleanups.

CERCLA also provides EPA with enforcement tools to compel those responsible for causing the contamination to pay for the cleanup, including the issuance of administrative orders. If the trust fund is used, then EPA and the state may go to court to recover their expenditures from those who are responsible.[G7]

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## NEXT STEPS

Now that you've inventoried groundwater data and analyzed it, what's next? How do you use this information to lead to on-the-ground actions?

Now comes the key part of the planning process, where it's important to involve as many community members as possible to develop and implement a plan of action to protect groundwater. The following sections of this web site are intended to help your community move forward together to protect groundwater.

- Develop groundwater goals, objectives, and policies
- Prioritize policies
- Decide how to monitor progress

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For more information about this site, its contributors, and the data contained herein, click here.

For assistance concerning comprehensive planning, please contact Lynn Markham, UW-Stevens Point.

For assistance concerning groundwater, please contact Charles Dunning, USGS.

Page contact: Webmaster, USGS

Page last updated: January 14, 2008

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### MUNICIPAL WATER SYSTEMS B1

| Municipal water system | Wellhead protection plan | Wellhead protection ordinance |
|---|---|---|
| Biron Water Utility | Yes | No |
| Marshfield Electric and Water | Yes | No |
| Milladore Waterworks | Yes | No |
| Nekoosa Waterworks | No | No |
| Pittsville Waterworks | Yes | Yes |
| Port Edwards Waterworks | No | No |
| Vesper Waterworks | No | No |
| Wisconsin Rapids Water Works and Lighting Commission | Yes | No |

Of those municipal water systems that have wellhead protection (WHP) plans, some have a WHP plan for all of their wells, while others only have a plan for one or some of their wells. Similarly, of those municipal water systems that have WHP ordinances, some ordinances apply to all of their wells and others just one or some of their wells.

Protecting Wisconsin's Groundwater Through Comprehensive Planning

## Wood County

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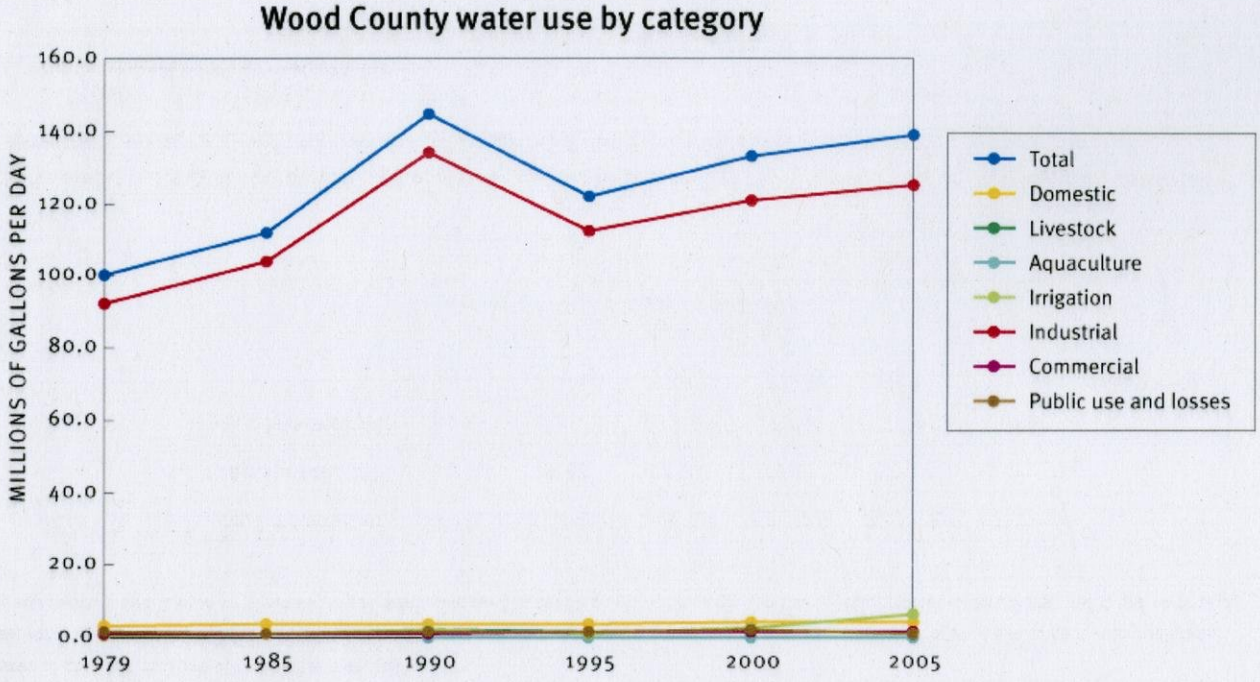
### WATER USE*




Water-use data from U.S. Geological Survey *Water Use in Wisconsin* reports for calendar years 1979, 1985, 1990, 1995, 2000 and 2005.

figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

**Wood County water use by year (millions of gallons per day)**

| | 1979 | 1985 | 1990 | 1995 | 2000 | 2005 |
|---|---|---|---|---|---|---|
| Surface-water use | 89.86 | 102.12 | 132.56 | 110.73 | 112.40 | 124.20 |
| Groundwater use | 10.11 | 9.82 | 11.94 | 11.13 | 20.45 | 14.78 |
| **Total water use** | **99.97** | **111.94** | **144.50** | **121.86** | **132.85** | **138.80** |

* Thermoelectric and mining data are not considered in water-use tables or figures on this web site. Thermoelectric-power water use is the amount of water used in the process of generating thermoelectric power. The predominant use of water is as non-contact cooling water to condense the steam created to turn the turbines and generate electricity[D1].

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## GROUNDWATER CONTAMINATION SUSCEPTIBILITY MAP

**Use of this Map:**

The composite Groundwater Contamination Susceptibility Map can be used by state agencies and others when deciding where they should more closely study impacts on groundwater. Local officials can also use this in determining whether they should study their region in more detail for potential groundwater problems. The groundwater contamination susceptibility map can be combined with other planning tools such as land use maps, groundwater quality data and contamination source information to help make sound groundwater management and land use decisions.

The Groundwater Contamination Susceptibility Map of Wisconsin doesn't show areas that **will** be contaminated, or areas that **cannot** be contaminated. Whether an area will have groundwater contamination depends on the likelihood of contaminant release, the type of contaminants released and the sensitivity of the area to the contamination. In turn, the likelihood of contaminant release depends on the type and intensity of the land use and contaminant sources in an area.This map highlights areas sensitive to contamination and shows them in a generalized way.

There are many limitations in the use of this composite map. It is compiled from very generalized statewide information at a small scale, and therefore, cannot be used for any site specific purposes. For example, siting waste disposal facilities or locating an industry requires site-specific, geologic and hydrogeologic information, and can't be made based on this composite map. The Groundwater Contamination Susceptibility Map doesn't consider the individual characteristics of specific contaminants or the subsurface release of contaminants. That is, it only considers the ability of water to move from the land surface to the water table.

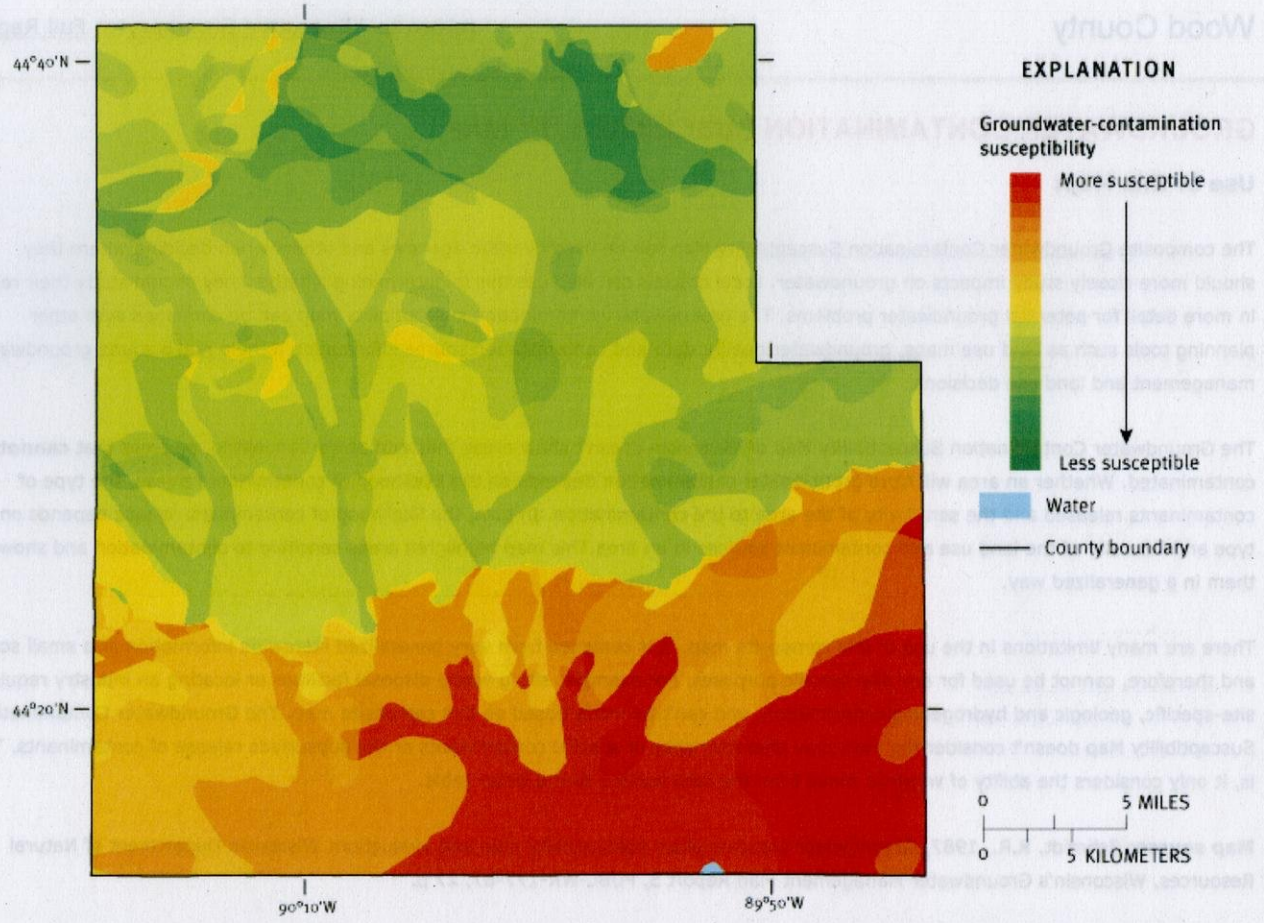
**Map source**: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

More information about individual data layers can be found in this guidance.

**County data**: Wisconsin Department of Natural Resources, 2004, 1:24,000 digital data, Wisconsin Transverse Mercator Projection, North American Datum of 1983 (1991 adjustment).

**Lake and stream data**: U.S. Geological Survey, 2003, 1:2,000,000 digital data, North American Datum of 1983.

## Wood County – Groundwater-Contamination Susceptibility Analysis




**This groundwater-contamination susceptibility map is a composite of five resource characteristic maps, each of which was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

In Wisconsin, 70% of residents and 97% of communities rely on groundwater as their drinking water source. Wisconsin has abundant quantities of high-quality groundwater, but once groundwater is contaminated, it's expensive and often not technically possible to clean. Because of these factors, we need to be careful to protect our groundwater from contamination. Our activities on the land can contaminate groundwater - most contaminants originate on the land surface and filter down to the groundwater. In some cases however, groundwater can become contaminated from natural causes such as radioactivity due to the presence of radium in certain types of rocks.

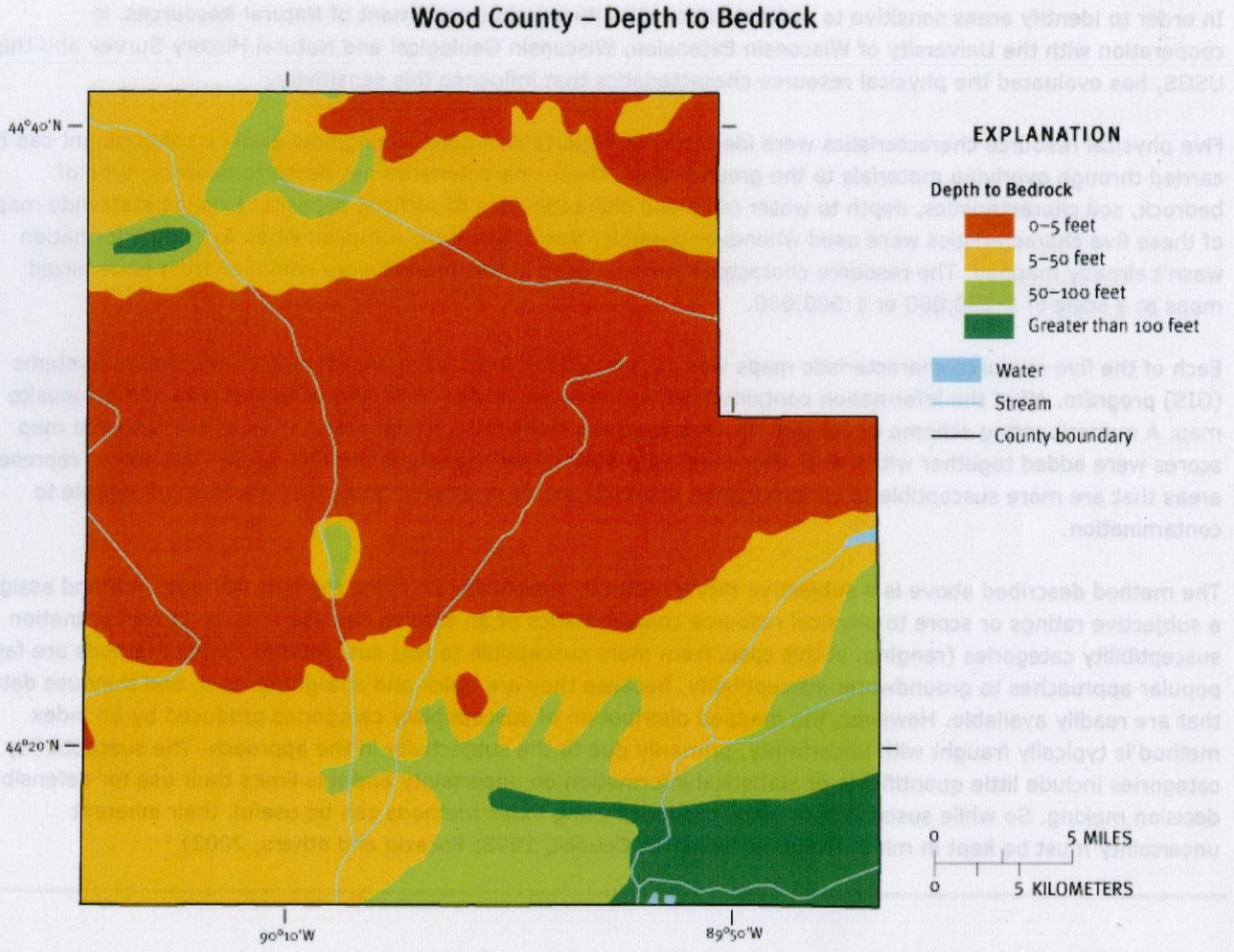
"Susceptibility of Groundwater to Pollutants" is defined here as the ease with which a contaminant can be transported from the land surface to the top of the groundwater called the "water table". Many materials that overlie the groundwater offer good protection from contaminants that might be transported by infiltrating waters. The amount of protection offered by the overlying material varies, however, depending on the materials. Thus, in some areas, the overlying soil and bedrock materials allow contaminants to reach the groundwater more easily than in other areas of the state.

In order to identify areas sensitive to contamination, the Wisconsin Department of Natural Resources, in cooperation with the University of Wisconsin Extension, Wisconsin Geological and Natural History Survey and the USGS, has evaluated the physical resource characteristics that influence this sensitivity.

Five physical resource characteristics were identified as important in determining how easily a contaminant can be carried through overlying materials to the groundwater. These characteristics are depth to bedrock, type of bedrock, soil characteristics, depth to water table and characteristics of surficial deposits. Existing statewide maps of these five characteristics were used whenever possible. New maps were compiled when existing information wasn't already mapped. The resource characteristic maps used in this project were compiled from generalized maps at a scale of 1:250,000 or 1:500,000.

Each of the five resource characteristic maps was put into digital form using a Geographic Information Systems (GIS) program. All of the information contained in the five maps was overlaid and combined into one composite map. A numeric rating scheme developed for each map was used to score the maps and the five resource map scores were added together within GIS. The composite map shows the scores for each area – low scores represent areas that are more susceptible to contamination and high scores represent areas that are less susceptible to contamination.

The method described above is a subjective rating method; specifically an index method. An index method assigns a subjective ratings or score to physical resource characteristics of an area to develop a range of contamination susceptibility categories (ranging, in this case, from more susceptible to less susceptible). Index methods are fairly popular approaches to groundwater susceptibility, because they are quick and straightforward, and they use data that are readily available. However, the mapped distribution of susceptibility categories produced by an index method is typically fraught with uncertainty, primarily due to the subjectivity in the approach. The susceptibility categories include little quantifiable or statistical information on uncertainty and this limits their use for defensible decision making. So while susceptibility maps produced using index methods can be useful, their inherent uncertainty must be kept in mind. (National Research Council, 1993; Focazio and others, 2002).



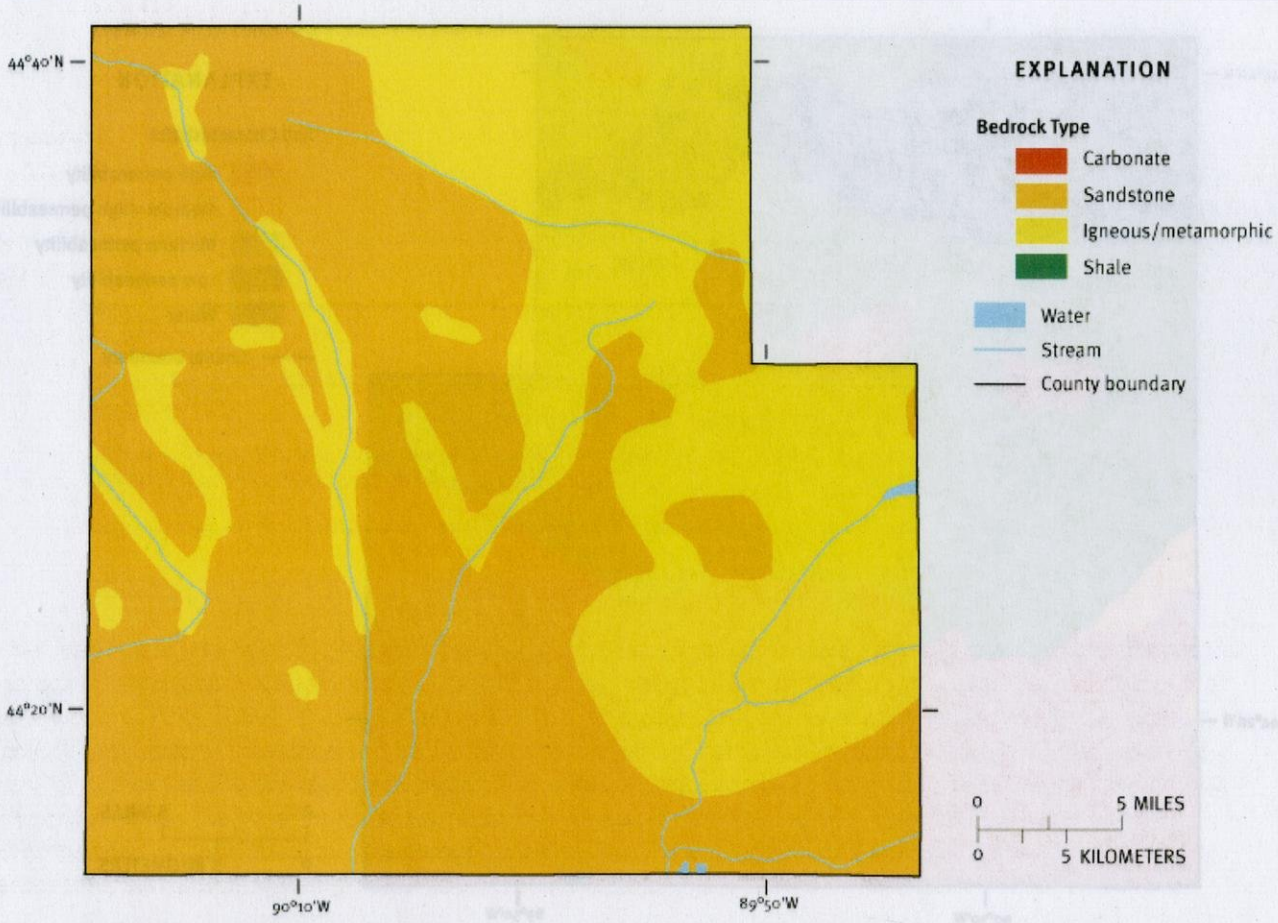

**This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

The depth to bedrock indicates the amount of soil and surficial deposits that exist in an area and, therefore how important the type of bedrock is in evaluating pollution potential. Information on the depth to bedrock map is used to determine the relative weight given to the other resource characteristic maps. For example, where the bedrock surface is deep and the water table occurs above the bedrock, the type of bedrock is not considered in determining groundwater contamination susceptibility. Where the depth to bedrock is shallow (less than 50 feet below the land surface), the water table is likely to occur in the bedrock. In that case, the type of bedrock is considered because it could influence a contaminant's ability to reach the groundwater. This map identifies areas where the depth to bedrock is 0-5 feet (in at least 35% of the area), 5-50 feet, 50-100 feet and greater than 100 feet.

## Wood County – Bedrock Type



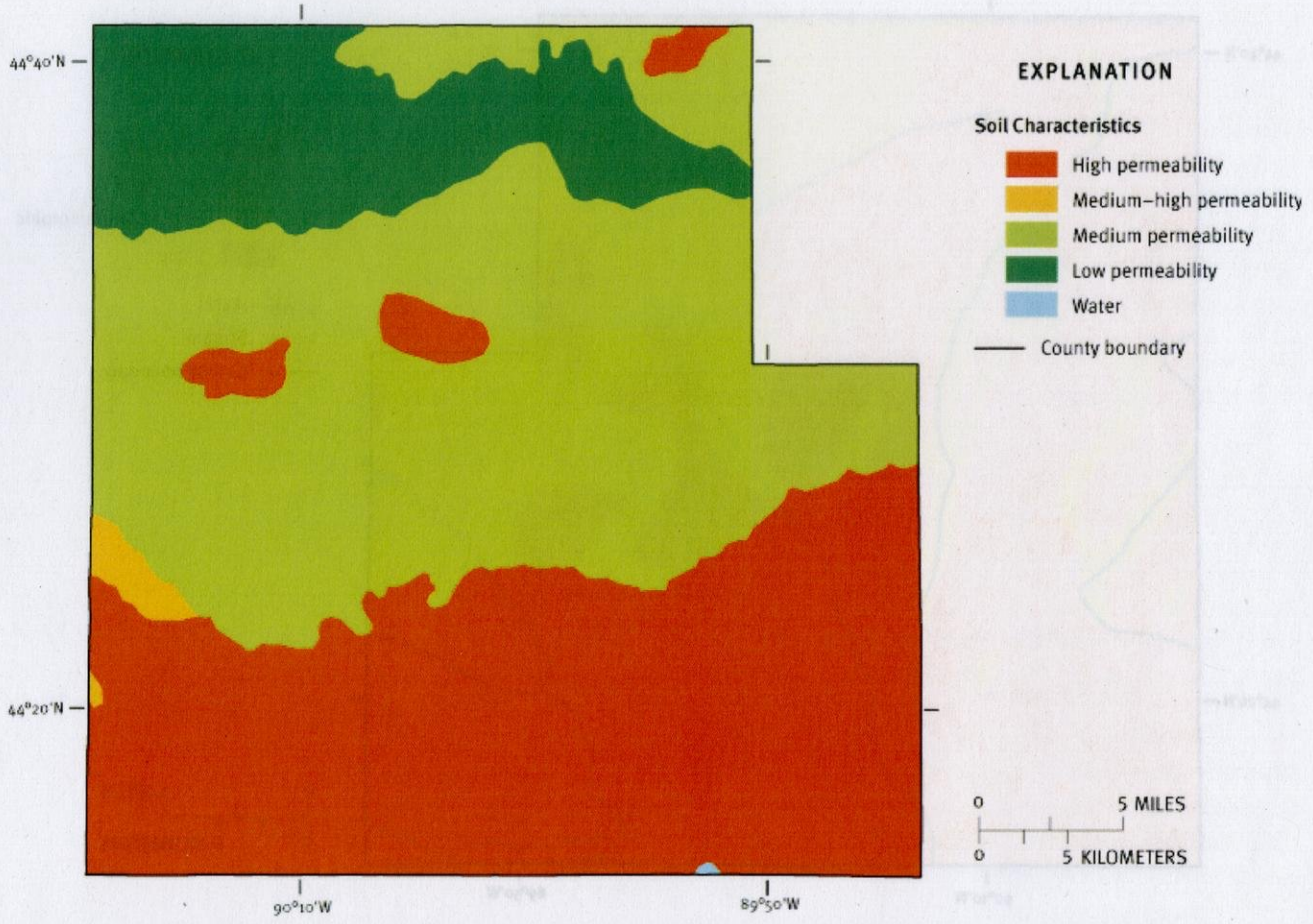

**This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

When bedrock is less than 50 feet from the land surface and the water table occurs in the bedrock, the type of bedrock is important in determining how easily a contaminant can reach the groundwater. Bedrock types that allow water to pass quickly through them will offer less protection from contaminants. In Wisconsin, these types of bedrock are typically limestone and dolomite which are highly fractured. Igneous and metamorphic rocks (e.g. granite) and sandstone are less fractured and offer some protection from infiltrating water which may contain contaminants. On the other hand, shale bedrock is almost impermeable, and doesn't allow water and accompanying contaminants to pass through it as easily. The bedrock categories used for this project are carbonates, sandstone, igneous/metamorphic/volcanic, and shale.

## Wood County – Soil Characteristics



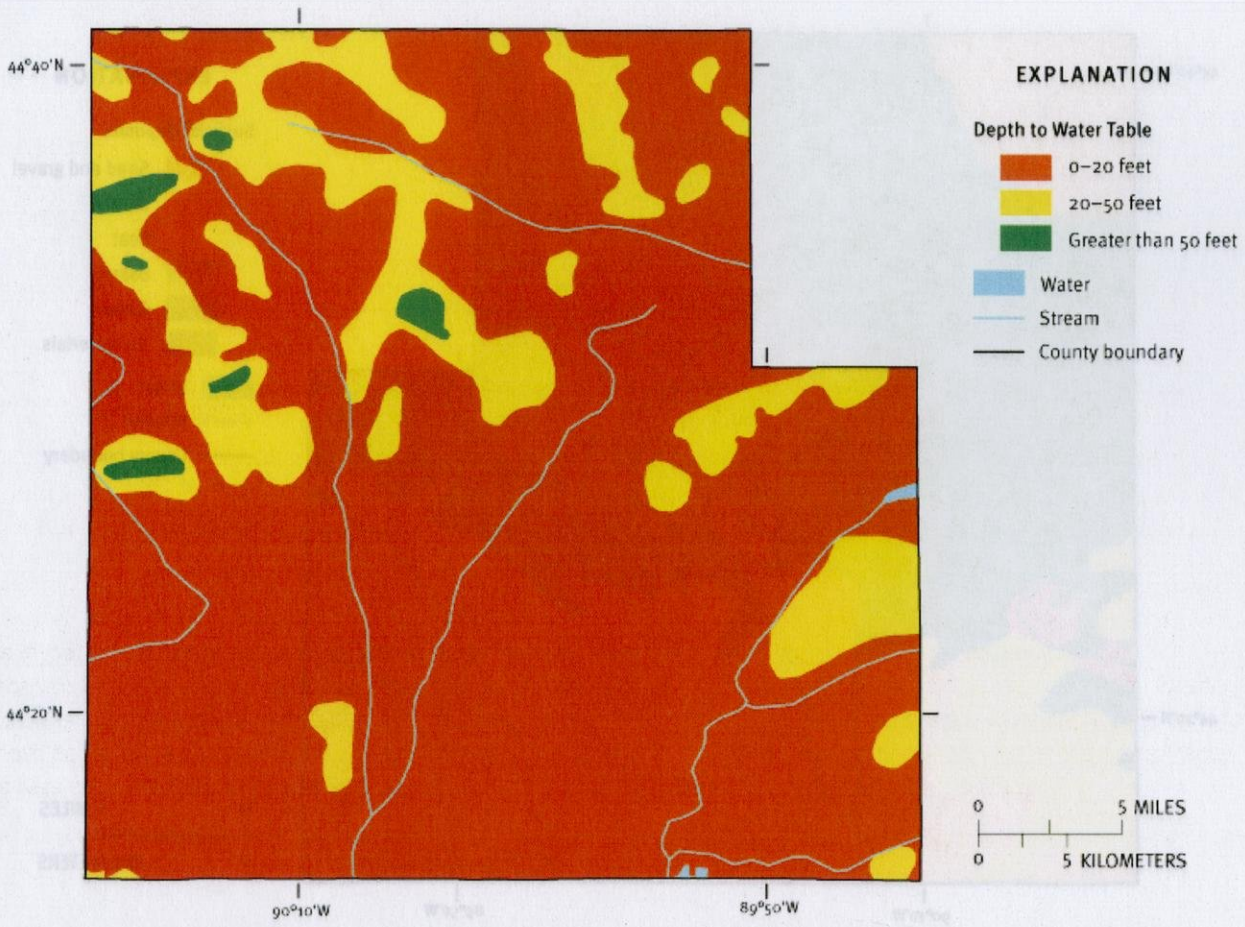

**This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

The top layer of materials covering most of the land in Wisconsin is the soil. The soil is defined as the unconsolidated material occurring from the land surface to five feet below the land surface. This is the first material through which water (and accompanying contaminants from the land surface) flow on their way to recharging the groundwater. The soil categories called "associations" have been rated by their ability to restrict the downward movement of water and accompanying pollutants. Important characteristics to consider are soil texture (the amount of sand, silt and clay), organic matter content, permeability and water holding capacity. The soil associations were grouped according to the following characteristics: high susceptibility (highly permeable soils with coarse texture, e.g., sand and gravel); medium/high susceptibility (permeable soils with coarse texture, e.g., sandy soils); medium susceptibility (moderately permeable soils with medium texture, e.g., loamy soils); and low susceptibility (least permeable soils with fine texture, e.g., silty and clayey soils).

## Wood County – Depth to Water Table



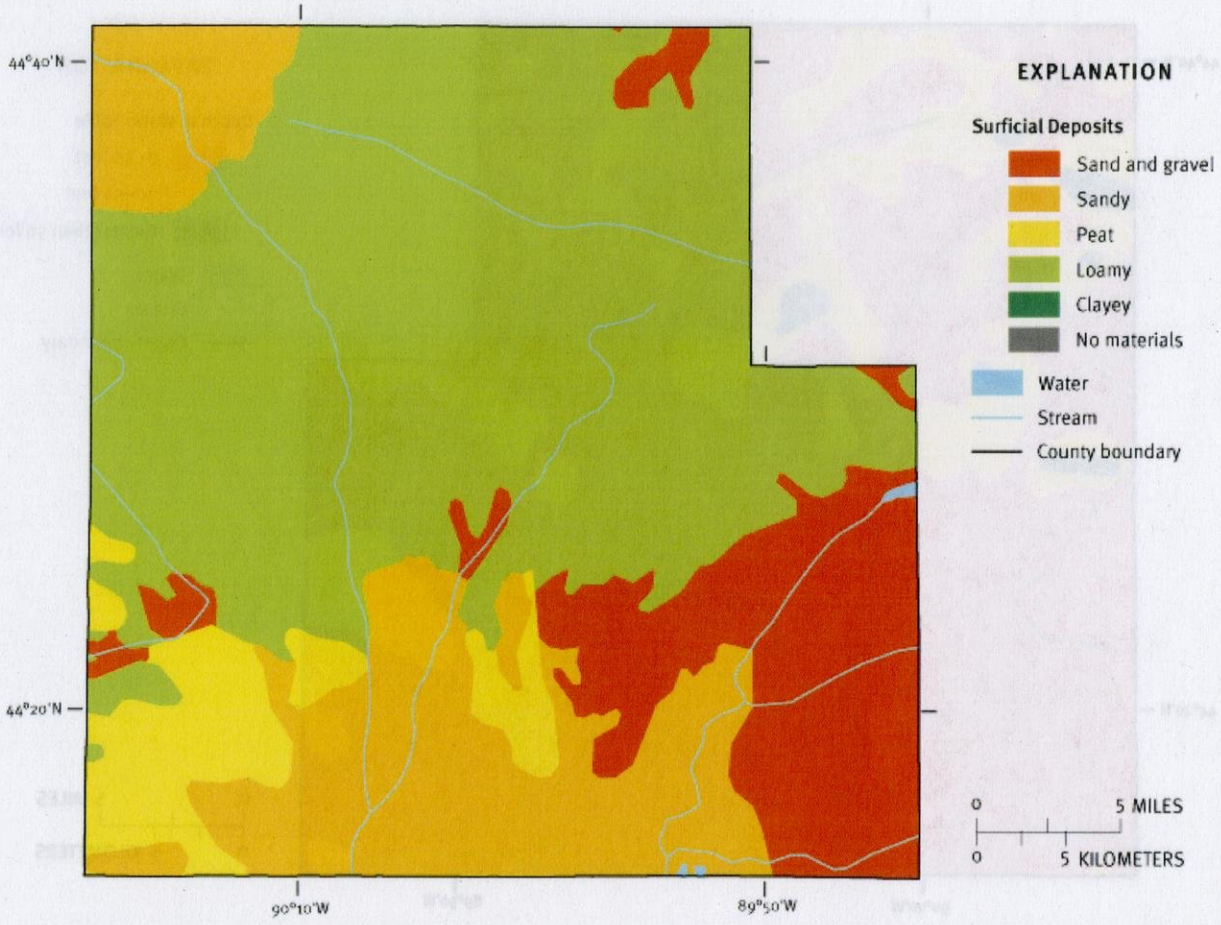

**This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

It is important to know where the water table is when trying to determine groundwater contamination susceptibility. The closer the water table is to the land surface, the less contact contaminants have with filtering materials overlying the water table. The depth to water table is difficult to map on a statewide basis because it's almost as variable as the terrain. The information used in this mapping project identified where the water table was less than 20 feet, between 20 and 50 feet, and greater than 50 feet from the land surface.

## Wood County – Surficial Deposits




**This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.**

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

Surficial deposits are unconsolidated materials lying on top of bedrock. Except for the unglaciated southwest portion of the state, most of the surficial deposits in Wisconsin were left by glaciers. These materials differ, depending on how they were deposited. Some glacial materials were deposited by melting waters, and are well sorted or have layers of both fine materials and gravelly materials. Infiltrating waters must pass through these materials en route to the groundwater. Except in areas of shallow bedrock, the surficial deposits are considered the most important factor in determining how susceptible an area is to groundwater contamination. The surficial deposits have been categorized into six groups: sand and gravel; sandy; loamy; peat; and no materials (not shown at this scale). Areas having sand and gravel deposits are considered susceptible to groundwater contamination; and areas with clayey deposits are considered less susceptible.

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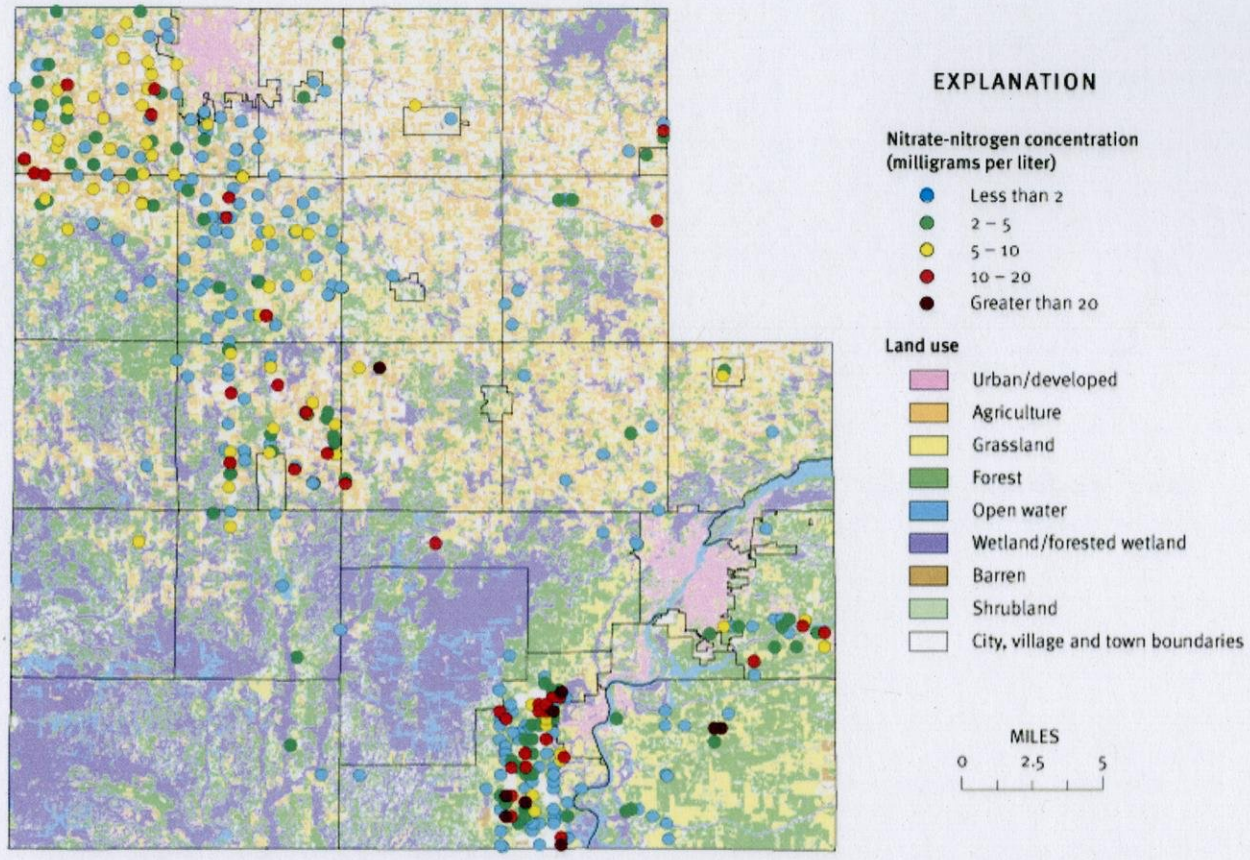
## Wood County – Nitrate-Nitrogen Concentrations

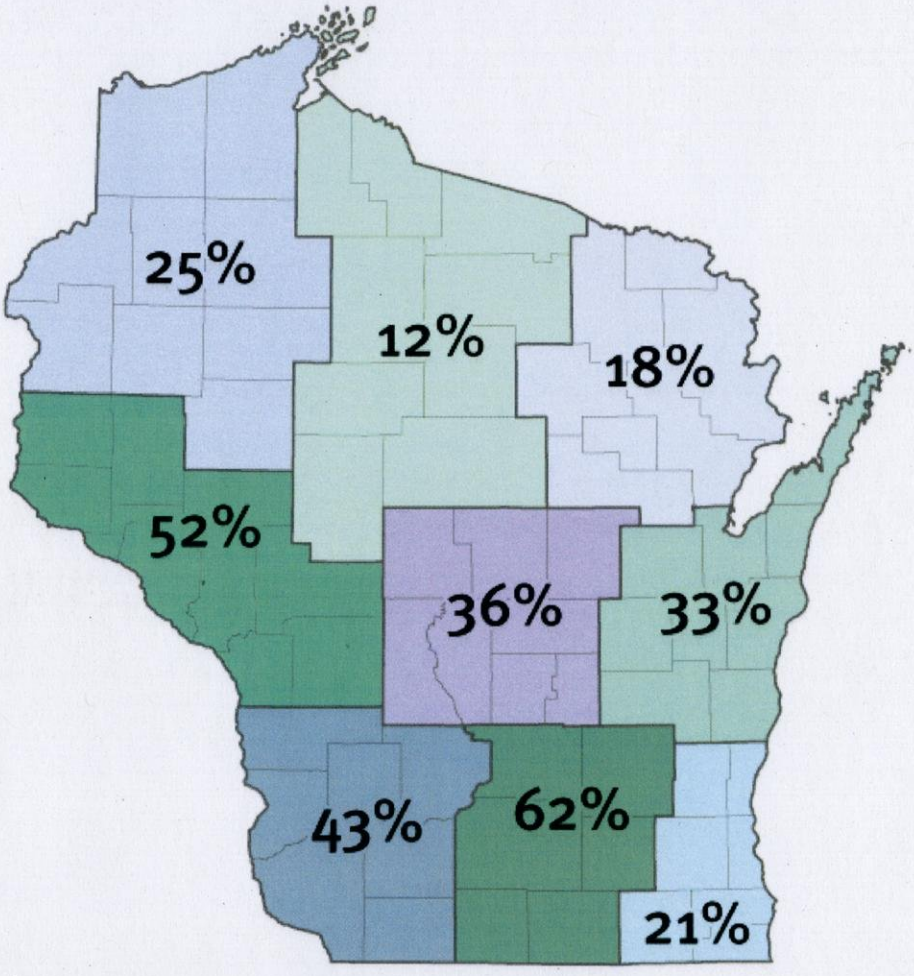



**Private well nitrate-nitrogen data presented on this map should not be considered comprehensive. Data are from sampling conducted during 1985-2004 as reported by the Wisconsin Department of Natural Resources, the Wisconsin Department of Agriculture, Trade and Consumer Protection, and the Central Wisconsin Groundwater Center. Data collected at other times or by other sources are not included.**

Land cover data: Wisconsin Department of Natural Resources, 1998, WISCLAND land cover (WLCGW930) 1991-1993, available at *http://www.dnr.state.wi.us/maps/gis/datalandcover.html*

Figure created by Raquel Miskowski, University of Wisconsin-Stevens Point, Center for Land Use Education, for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007. *http://wi.water.usgs.gov/gwcomp/*

## Percentage of Private Wells with Detectable Herbicides or Herbicide Metabolites (2001)




Herbicide data: Wisconsin Department of Agriculture, Trade and Consumer Protection, 2002, Agricultural chemicals in Wisconsin groundwater: final report, *http://www.datcp.state.wi.us/arm/agriculture/land-water/environ_quality/pdf/arm-pub-98.pdf*

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*

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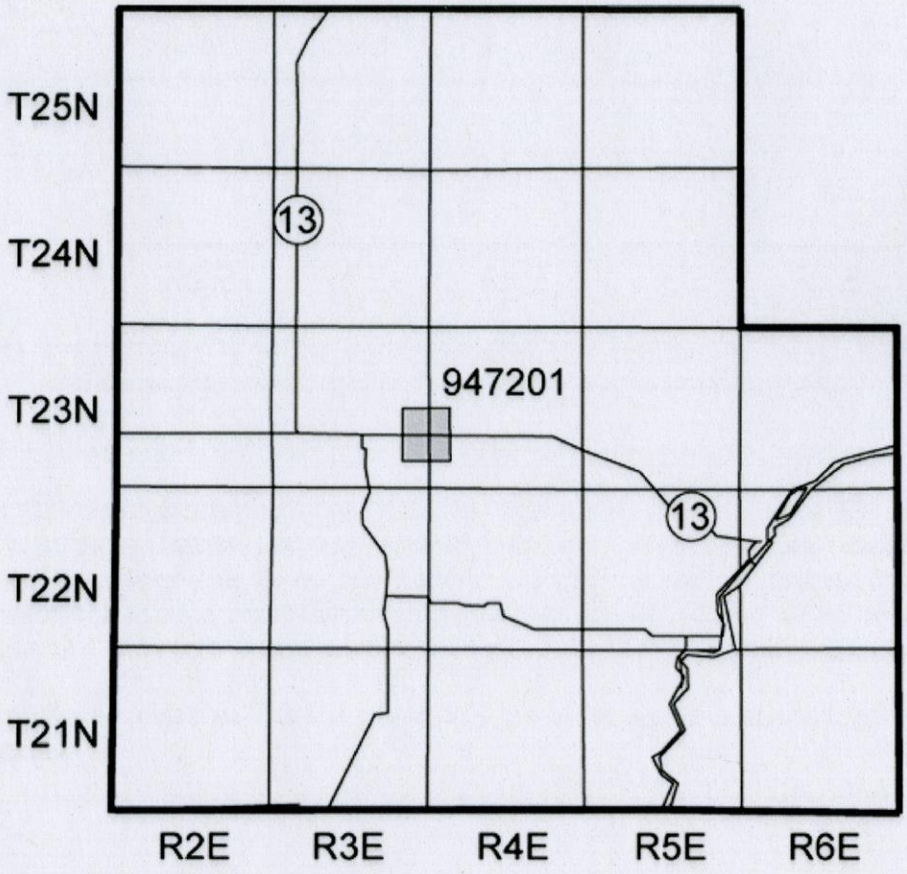
### ATRAZINE PROHIBITION AREAS




Atrazine figure created by Wisconsin Department of Agriculture, Trade and Consumer Protection, available at http://www.datcp.state.wi.us/arm/agriculture/pest-fert/pesticides/atrazine/cnty_list.jsp

2,256 acres of land within the county are in atrazine prohibition areas.

Atrazine is a popular corn herbicide that is used to control weeds in corn fields and has been used in Wisconsin for over 25 years. Atrazine may have entered Wisconsin's groundwater as a result of its use on farm fields. In some cases it may be the result of a spill or improper disposal of unwanted or unused product. As of 2006, there are 102 atrazine prohibition areas in Wisconsin, covering about 1.2 million acres. An atrazine prohibition area is an area of land where all uses of atrazine are prohibited.

For more information please visit the web site provided by the Wisconsin Dept. of Agriculture, Trade and Consumer Protection.

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## BRRTS MAP OF CONTAMINATED SITES

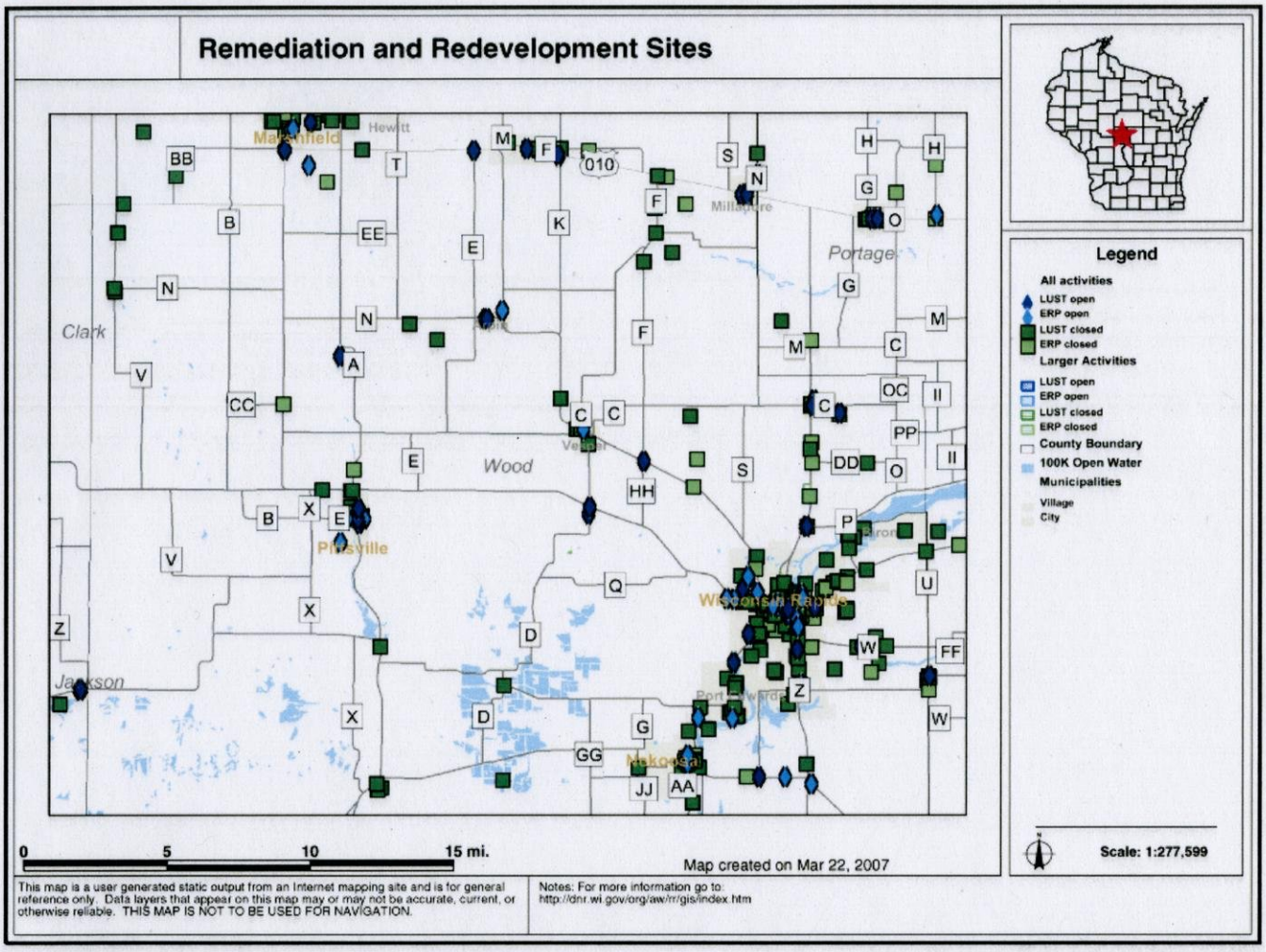


Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, *http://wi.water.usgs.gov/gwcomp/*


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