

WISCONSIN GEOLOGICAL & NATURAL HISTORY SURVEY

The Wisconsin Geological & Natural History Survey (WGNHS), part of the University of Wisconsin-Madison's Division of Extension, performs basic and applied groundwater research and provides technical assistance, maps, and other information and education to aid in the management of Wisconsin's groundwater resources. The WGNHS groundwater program is complemented by the Survey's geology programs, which provide maps and research-based information essential to the understanding of groundwater recharge, occurrence, quality, movement and protection. The Survey distributes maps, reports and data related to Wisconsin's geology and groundwater. The Director of the WGNHS is a permanent member of the Wisconsin Groundwater Coordinating Council (GCC) and several WGNHS staff members serve on GCC subcommittees.



WGNHS geoscientist investigating a rock outcrop in Crawford County. (Photo by Sarah Bremmer)

FY 2024 Highlights

(See [the WGNHS 2023 Year In Review](#); also see this [interactive project map](#) describing the projects in more detail.)

- Began a new groundwater study of Burnett County
- Completed an Inventory and Analysis of Flowing Artesian Wells in Bayfield County
- Completed analysis of water chemistry results from over 150 samples collected from lakes, streams, springs, and campground wells throughout the Chequamegon-Nicolet National Forest in northern Wisconsin
- Evaluated the efficacy of NR151 and ATCP50 regulations
- Investigated PFAS in groundwater in western and eastern Wisconsin
- Investigated Neonicotinoids in groundwater and surface water in central Wisconsin
- Conducted bedrock geologic mapping in Columbia, Crawford, Grant, Jefferson, Lafayette, and Sauk Counties
- Conducted Quaternary geologic mapping in Wisconsin's Driftless Area and in Bayfield, Burnett, Green, Jackson, Juneau, Lafayette, Price, and Sauk Counties
- Prepared a new statewide Quaternary map of Wisconsin for publication
- Upgraded Wisconsin's statewide groundwater monitoring network
- Upgraded and enhanced geoscience information delivery
- Began development of a series of online groundwater educational modules for new local officials, county staff, producer-led watershed groups, and the public

Details of Ongoing Activities

Groundwater-Level Monitoring Network

The WGNHS continues to cooperate with the Department of Natural Resources and U.S. Geological Survey (USGS) in the operation and maintenance of Wisconsin's statewide groundwater-level monitoring network. The WGNHS supports evaluation and maintenance of the monitoring network, aids in data collection, interpretation, and provides information to public and private clients. The most recent grant from the USGS's National Groundwater Monitoring Network program resulted in \$178,000 in new funding to repair and evaluate old wells, replace failing wells, and drill new wells in areas of the state lacking monitoring coverage. In 2023, and in close coordination with our network partners at the USGS Upper Midwest Water Science Center and the DNR, WGNHS staff installed 6 new monitoring wells and instrumented 15 wells to monitor the water levels more continuously and to see smaller changes that occur daily or even hourly in response to precipitation, evapotranspiration, and pumping withdrawals. The WGNHS also continues to maintain a webpage dedicated to the monitoring network documents the current activities and value of the network (<https://home.wgnhs.wisc.edu/water/groundwater-level-monitoring-network>).

County and Local Groundwater Studies

Geologic and groundwater studies at county and local scales continue to be an important part of WGNHS programs. With funding from the National Cooperative Geologic Mapping Program's STATEMAP component or local sources, WGNHS scientists initiated or carried out county or locally focused geologic and/or groundwater studies during 2023 in twelve Wisconsin counties. New geologic mapping is the fundamental starting point for understanding groundwater resources in Wisconsin. Many of these studies will generate or have generated water-table maps or depth-to-bedrock maps (<https://home.wgnhs.wisc.edu/maps-publications>).

- **Burnett County Groundwater.** Working with the Burnett County Board, WGNHS scientists, including our new County Hydrogeologist, began surficial geologic mapping and compiling groundwater-related maps of water-table elevation, groundwater recharge, depth-to-water, depth-to-bedrock, and groundwater susceptibility. Work completed in 2023 includes geolocation of water supply wells in the county, preliminary water table mapping, collection of 20 sediment cores, and surficial geologic mapping for the southern part of the county.
- **Bayfield County Inventory and Analysis of Flowing Artesian Wells.** The WGNHS completed a project in Bayfield County to map and inventory flowing artesian wells. Flowing artesian wells are a remarkable resource of high-quality water that both community members and tourists value. The final report, which was submitted and presented to the county board, compiles well characteristics and flow rates, provides baseline water quality data, and describes water sources to the flowing wells. This [report](#) was published as a WGNHS open-file report in early 2024.
- **Grant County Water Table Mapping.** Building on bedrock mapping efforts in Grant County and the recently completed Southwest Wisconsin Geology and

Groundwater (SWIGG) study, WGNHS scientists made significant progress on a new water-table map for Grant County.

Regional Groundwater Studies

Regional groundwater studies usually span multiple counties. During 2023 the WGNHS was involved in several regional projects, including the following:

- **Hydrogeology of the Chequamegon-Nicolet National Forest (CNNF).** WGNHS continued several groundwater studies in the CNNF. These include characterizing groundwater-surface water interactions of recently flooded seepage lakes near Drummond, WI in Bayfield County. Seepage lakes in the region experienced extreme flooding in 2018. Lake levels are dropping steadily but remain high. Another project along the North Fork Yellow River in Taylor County seeks to improve understanding of the local hydrogeology and document baseline water chemistry. Ongoing permit negotiations for mineral exploration at the Bend site prompted this effort. Over the course of the year, the project team made regular visits to this area to sample water, monitor water levels, and collect a variety of hydrologic and geophysical measurements. WGNHS also completed analysis of water chemistry results from over 150 samples collected from lakes, streams, springs, and campground wells throughout the CNNF. This work contributes an updated reference point for establishing long-term records and for identifying trends of water quality conditions within the CNNF.
- **Groundwater quality in the Central Sands region of Wisconsin.** WGNHS scientists began working to forecast the impact of climate and nitrate loading changes on nitrate contamination of groundwater in the Central Sands region of Wisconsin. Years of sampling and research have assessed the extent of nitrate contamination, yet very little is known about the fate and residence time of nitrate in this environment. To fill this knowledge gap, Dave Hart and Emily Baker will incorporate particle tracking into the Central Sands Lake Study Model to predict groundwater transit times and discharge locations. The results will provide a tool to be used to inform actions for the reduction in nitrate leaching and timing needed to improve groundwater quality in the Central Sands.
- **Hydrogeology of southwest Wisconsin.** WGNHS staff and collaborators published the final [report](#) for the Southwest Wisconsin Geology and Groundwater (SWIGG) study in 2023. Building on this effort, WGNHS continued to collaborate with the USGS on a project funded through Joint Solicitation for Groundwater



Collecting water samples from a seepage lake in the CNNF. (Photo by Caroline Rose)

Monitoring Proposals and entitled *Risk from pathogens and exposure to antibiotic resistance genes in private wells in southwest Wisconsin*.

Groundwater Research Activities

The WGNHS carries out specific groundwater research projects focused on understanding topics important to groundwater use and management in Wisconsin and elsewhere. Active research projects during 2023 included the following:

- **NR151 monitoring project.** WGNHS staff continued monitoring to assess the impact of DNR rule NR151 at one spring site in Calumet County and one farm (well) site in Door County by collecting monthly samples for nitrate-N and bacteria and quarterly samples for pathogens. The NR151 legislative code regulates the spreading of agricultural manure in locations such as eastern Wisconsin, where groundwater resources in thinly buried Silurian dolomite are particularly sensitive to surface contamination.
- **Mapping depth-to-bedrock.** WGNHS scientists used airborne electromagnetic (AEM) geophysical data collected over large parts of eastern Wisconsin, well construction reports, county studies, and soil surveys to create an up-to-date map of the depth-to-bedrock over the Silurian dolomite in eastern Wisconsin. This map will be used to support ATCP50 and NR151 land spreading rules. WGNHS delivered the mapping results to DATCP in 2023 and publication of the methodology is planned for 2024.
- **Studying PFAS in groundwater.** WGNHS hydrogeologists are collaborating with UW–Madison, the Town of Campbell, La Crosse County, and the USGS to assess risk of PFAS contamination to the Mount Simon aquifer on French Island near La Crosse, Wisconsin. They provided a hydrostratigraphic framework for a PFAS transport model and are contributing expertise in borehole geophysics, drilling methods, and interpretation of geologic logs. Additionally, WGNHS is collaborating with UW–Milwaukee to understand PFAS flux into Lake Michigan by examining present and historic contamination of Wisconsin’s connected aquifers.
- **Neonicotinoid contaminants in Wisconsin groundwater: relationships to landscape cropping systems.** WGNHS hydrogeologists continue to collaborate with researchers at the UW-Madison Department of Entomology to better constrain the temporal and spatial dynamics of neonicotinoids in stream water across the Central Sands region and analyze potential linkages between land-use activity and neonicotinoid concentrations in streams. Neonicotinoid monitoring results in



WGNHS hydrogeologists sampling groundwater for the NR151 monitoring project. (Photo by G. Graham)

streams will be evaluated using a calibrated groundwater flow model for the Central Sands to delineate groundwater contributing areas to these streams. Agricultural land use patterns within the groundwater contributing areas will then be analyzed to develop statistical relationships between land-use type and neonicotinoid concentration in streams. These results will provide stakeholders an additional tool to assess risk to aquatic invertebrates, better protect sensitive taxa, and inform regulatory and land-use management decisions.

Groundwater Data Management and Support

In 2023 the WGNHS continued to collect geologic and groundwater data and provide these data to a variety of users. Significant databases and data efforts include the following:

- **Enhanced publications catalog.** The WGNHS maintains hundreds of reports, maps, and other records in digital form for free downloads to the public. During 2023 the Survey continued to upgrade the functionality of this service, allowing easier data searching, previewing, and downloading of information related to Wisconsin's groundwater and geology. Catalog: <https://wgnhs.wisc.edu/catalog>.
- **Collection of downhole geophysical logs.** The WGNHS continually collects and compiles downhole geophysical logs from research wells and "wells of opportunity," such as municipal wells. The logs, including natural gamma radiation, temperature, caliper and borehole diameter, fluid conductivity, and optical imaging, are important tools for understanding water-quality problems in individual wells, and for correlating geologic units in the subsurface. In addition to municipal wells, geophysical logging has been used to troubleshoot problems in private wells and wells owned by state agencies including Department of Corrections, Department of Natural Resources, and Department of Transportation. The WGNHS maintains a publicly-accessible data viewer for geophysical logs and Quaternary core. Data viewer: <https://data.wgnhs.wisc.edu/data-viewer>.
- **Hydrogeologic Data Viewer maintenance.** The WGNHS continues to support the Hydrogeologic Data Viewer, a map-based application to access a statewide catalog of hydrogeologic data. The application provides DNR staff with online access to data and publications and includes several methods to search by area for data of interest, such as geologic and geophysical logs or well construction reports. Many of the geophysical logs are collected for the DNR in wells where water quality or lack of data is an issue.
- **wiscLITH database.** When requested, the Survey provides updates of the digital database, wiscLITH, which contains lithologic and stratigraphic descriptions of geologic samples collected in Wisconsin. This is a publicly available database, and current work efforts focus on including more data for areas of the state with active geologic and hydrogeologic projects. Database: <https://wgnhs.wisc.edu/pubs/wofr200903>.
- **Well construction reports.** The WGNHS serves as the repository for well construction reports (WCRs) from wells installed between 1936 and 1989 and can provide digital or paper copies to those who request them. In addition, WGNHS

serves as a point-of-contact for questions about WCRs and updates records when errors are found during project work.

- **High-capacity well approval tracking.** WGNHS continues to track high-capacity well approvals in an internal database. This enables a more proactive approach for WGNHS researchers, in collaboration with the DNR, to work with well drillers, pump installers, and consultants to collect samples and borehole geophysical logs from priority areas of the state.
- **WGNHS Research Collections and Education Center.** The WGNHS archives geologic records, rock samples, core samples and other materials in Mount Horeb, Wisconsin. Our core repository contains over 2.5 million feet worth of drillhole cuttings, more than 650,000 feet of drill core and more than 15,000 individual hand samples of rock from across the state. Examination tables and basic laboratory facilities allow convenient analysis and study of these materials by qualified individuals. Core repository: <https://home.wgnhs.wisc.edu/research-data/core-repository>.

Groundwater Education

WGNHS groundwater education programs for the general public are usually coordinated with the DNR or the Central Wisconsin Groundwater Center at UW–Stevens Point or with the UW–Madison science outreach community as well as with the UW-Madison Division of Extension. WGNHS produces and serves as a distributor of many groundwater educational publications through our website. We also distribute information about Wisconsin groundwater on our website at <https://home.wgnhs.wisc.edu/water>. Recently, we have expanded our outreach efforts to reach different audiences through our website and a variety of social media tools, including:

- Website, <https://home.wgnhs.wisc.edu>
- Facebook, <https://www.facebook.com/WGNHS>
- Twitter, <https://twitter.com/wgnhs>
- YouTube, <https://www.youtube.com/c/WGNHS>
- Instagram, https://www.instagram.com/wgnhs_uw
- Pinterest, <http://www.pinterest.com/WGNHS>

WGNHS presents groundwater educational activities at various museums and schools and at UW-Madison outreach events (such as at the UW Science Expeditions, the UW Science Festival, and Saturday Science at the Wisconsin Institutes for Discovery).

In 2023, WGNHS staff members participated in groundwater educational meetings in counties where mapping and/or hydrogeologic studies are in progress. Staff members will continue to work with the DNR and the Central Wisconsin Groundwater Center on teacher-education programs connected to the distribution of groundwater sand-tank models. Additionally, our new County Hydrogeologist began collaborating with UW-Madison Division of Extension (Extension) colleagues on an Extension Innovation Grant-funded project to develop a series of online groundwater educational modules for new local officials, county staff (i.e., Extension, county land conservation departments, county health departments), producer-led watershed groups, and the public. Planned modules

include *Water WELLness: Managing your private well water system*, *Basics of groundwater/geology*, and *Managing groundwater for local officials*, with the goal of launching all modules by August 2025.

The WGNHS maintains a long commitment to the continuing education of water well drillers, pump installers, and plumbing contractors through participation in the programs of the DNR and the Wisconsin Water Well Association. Geologic and hydrogeologic field trips and presentations for DNR water staff and new DNR employees have been held in the past and will continue as requested.

The WGNHS Research Collections and Education Center is providing a locale for various groups to conduct related educational programs. Researchers and consultants also use our core holdings in that collection to better understand the subsurface and its aquifers. Staff of WGNHS organize and annually present papers at the Wisconsin Section of the American Water Resources Association reaching consultants, academics, and state and federal agency scientists with results of our research.

For more information:

Visit <https://home.wgnhs.wisc.edu>

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