Minnesota Ground Water Association
www.mgwa.org
Newsletter

June 2013
Volume 32, Number 2

Featured:

- Groundwater - Surface-Water Interaction near White Bear Lake, MN, page 6
- Multilevel monitoring system provides new insights into a bedrock aquitard, page 12

MGWA President Bob Tipping

Inside:

President's Letter

Our membership is aging. This has been discussed at previous conferences and documented in the MGWA newsletter, where median years of service for both private and public sector responders was over 20 years. (see http://www.mgwa.org/newsletter/mgwa2011-3.pdf). In light of this, the MGWA and MGWA Foundation have recognized the need to attract new, younger members. Those of us in the second half of our professional careers have the opportunity to mentor younger people by answering their questions, and could benefit from new ideas, perspectives and methods.

Our recent spring conference, held April 24th at the University of Minnesota, was at full capacity, in large part because of a big increase in the number of students attending. MGWA Foundation Director Amanda Strommer recognized that there would be many students in new, and perhaps uncomfortable surroundings, and thankfully took on the task of organizing members interested in mentoring one or more of these students throughout the day. Twenty-six members helped thirty-nine students by answering their questions, introducing them to others, and asking them questions about their interests. The verbal and written responses we received were positive from both students and members, and we would like to do it again. Given the broadening recognition of groundwater as a finite resource, there is a pressing need to encourage young people to pursue hydrogeology as a profession, and to make MGWA a part of how they will do business.

And business there will be. From White Bear Lake to greater Minnesota, there has been more public attention paid to groundwater than any time in recent memory. Public interest has resulted in legislative interest, and there is a growing mandate to manage the resource in a

— *continued on page 4*

MGWA Launches White Paper Initiative

Kelton Barr, Past-President

Through the last 30 years of the Minnesota Ground Water Association, we have matured and grown as a professional association. Our newsletter has become an important conveyor of new developments in groundwater research and policy for Minnesota professionals, and our semi-annual conferences have had growing attendance which has now started to exceed the capacity of the venerable venue, the Continuing Education and Conference Center (formerly the Earle Browne Center) at the St. Paul campus of the U of M.

However useful and informative this has been for our members, these activities have not effectively reached beyond our professional community. Furthermore, as issues involving groundwater have arisen, MGWA has not participated in any meaningful way to informing the various sides of these issues about the science involved.

To remedy this, the MGWA Board is launching a White Paper Initiative. The intent is to involve a group of our members to research an issue of current interest and produce a paper of science-based information about the topic and the various aspects involved. This will allow MGWA to become an ongoing source of relevant, unbiased science-based information pertinent to the discussion and resolution of these issues.

This would also allow us to better and more proactively fulfill the objectives of MGWA, namely:

- Promotion and encouragement of the scientific and public policy aspects of groundwater,
- Education of the general public regarding groundwater resources, and
- Dissemination of information on groundwater

(The full listing of the objectives of MGWA can be found at http://www.mgwa.org/about_bylaws.php.)

This is how it will work. The MGWA Board will appoint four members to a White Paper Committee. Its members would serve for staggered term appointments. The Committee

— *continued on page 4*

MGWA Newsletter Team

Editor-in-Chief
Tedd Ronning
Xcel Energy
tedd.a.ronning@xcelenergy.com

Sherri Kroening
current issue editor
Minnesota Pollution Control Agency
sharon.kroening@state.mn.us

Joy Loughry
Minnesota Department of Natural Resources
joy.loughry@state.mn.us

Greg Brick
University of Minnesota
bric0004@umn.edu

Eric Tollefsrud
Geosyntec Consultants
ETollefsrud@geosyntec.com

Andrew Streitz
Minnesota Pollution Control Agency
andrew.streitz@state.mn.us

Advertising Manager
Jim Aiken
Barr Engineering Co.
(952)832-2740
jaiken@barr.com

MGWA Management
WRI Association Mgmt Co.
(651)705-6464
office@mgwa.org

MGWA Web Page
Visit www.mgwa.org for MGWA information between newsletters and to conduct membership and conference transactions.

Newsletter Deadlines

Issue	Due to Editor
September '13	08/02/13
December '13	11/03/13
March '14	02/07/14
June '14	05/02/2014

MEMBER NEWS

Steve Robertson's New Role at MDH

Steve Robertson accepted a position as Supervisor of the Source Water Protection Unit at the Minnesota Department of Health. His acceptance was predicated on the understanding that the role of the previous incumbent, Bruce Olsen, who wears very large shoes, would be replaced by three positions. The Source Water Protection Unit is involved in a variety of activities associated with implementation of the federal Safe Drinking Water Act in Minnesota, most notably wellhead protection planning. Prior to assuming his present role, Steve worked at MDH as a hydrologist supervisor and a staff hydrologist, and for 13 years in environmental consulting.

Joy Loughry Returns to DNR

Joy Loughry has accepted the position of Field Supervisor in the Water Monitoring and Surveys Unit at the Minnesota Department of Natural Resources. The unit exists to support the DNR director and staff by collecting and analyzing data and providing information on stream flows and groundwater and lake levels in Minnesota that are needed to effectively carry out DNR's statutory responsibilities and water management programs. Joy returns to the DNR from MDH where she was a staff hydrologist in the Source Water Protection Unit. Prior to her state service, Joy spent 7 years consulting as a hydrogeologist in Southeastern Wisconsin.

Dennis McComas Joins Braun Intertec

Dennis P. McComas, PG, recently joined Braun Intertec as the Phase I Environmental Site Assessment Manager. He plans and oversees business development activities for the Phase I Environmental Site Assessment (ESA) program, reviews work products, trains and mentors staff, and maintains technical standards. As a liaison to other Braun Intertec departments, he identifies clients' needs during the Phase I ESA process and determines what other services can be used to provide a full-service solution.

Dennis was the Co-founder, Vice President and environmental department leader at Thatcher Engineering. He performed a variety of environmental consulting services, including more than 500 Phase I and Phase II ESAs for lenders, developers, realtors, and industrial and commercial clients. With the history to prove it, Dennis is passionate about promoting smart development while preserving the unique or ecologically-valuable natural features.

Steve Thompson Moves to DNR

Stephen Thompson recently accepted a position as supervisor of Minnesota DNR's Hydrogeology and Groundwater Unit. Primary responsibilities for this Unit include the county atlas hydrogeology mapping program and technical analysis of groundwater use issues such as well interferences, mining impacts to groundwater, and groundwater appropriations. Previously, Steve supervised the MPCA's Ambient Groundwater Monitoring program and the Watershed Pollutant Load Monitoring Network. Prior to that, Steve was a hydrogeologist and supervisor in MPCA remediation programs.

Jeremy Rivord Moves to DNR's Water Monitoring and Surveys

Jeremy Rivord has accepted a position as the 11 County Metro Water Monitoring Specialist in the Water Monitoring and Surveys Unit of the Minnesota Department of Natural Resources. In his new position, Jeremy will assist with the expansion of the DNR's metro groundwater monitoring network and the technical analysis of the network wells. Jeremy previously worked as a Mapping Project Hydrogeologist with the County Geologic Atlas group in the DNR.

Mike MacDonald Accepts New Position at the DNR

Mike MacDonald recently started a new position within the DNR's Groundwater section as the Metropolitan Area Groundwater Specialist. He will provide technical assistance for DNR groundwater appropriation permit staff and general groundwater issues.

Mike had been DNR's Observation Well Network coordinator for the past five years. Prior to that he worked for various environmental consulting firms in Minnesota, Alaska and Wisconsin. He has also worked as a programmer for Wausau Insurance and at age 40 joined the Peace Corps in Mali Africa. Mike has a Bachelors degree in Geology from University of Minnesota Duluth.

Spring Conference is Another Huge Success

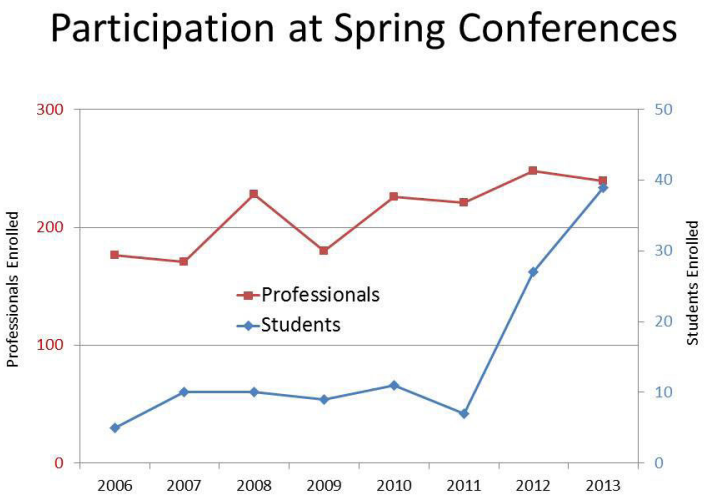
This year's Spring Conference was again a huge success! The theme of this year's conference, which was held on April 24th was on the relationship between groundwater quality and public health. This conference had a record number of student attendees—almost 40, and included a new student mentoring program! Dr. Mark Borchardt from the U.S. Department of Agriculture kicked off the conference with a very interesting talk on the occurrence of viruses in the groundwater, and why we should all care about this little discussed issue. Dr. Patty Toccalino from the U.S. Geological Survey spoke about a subject of great interest to much of our membership—chemical mixtures in groundwater and their toxicity. The work Dr. Toccalino presented was a study done as part of the USGS's National Water-Quality Assessment. Pete Moulton, the water treatment superintendent from the City of St. Peter, spoke about the complexities of treating water obtained from three different aquifers—the Jordan, Tunnel City/Wonewoc, and the Mt. Simon-Hinckley, providing the membership with the view from the perspective of a city struggling to meet demand. Kelton Barr introduced the MGWA's new White Paper Initiative, and Cathy Villas-Horne introduced the first MGWA Foundation Scholarship recipient—Bonnie Ausk.

The afternoon session consisted of a series of talks on unregulated contaminants, arsenic, and the communication of information on contaminants in groundwater. There were three talks by MDH staff. Karla Peterson from the MDH spoke about a monitoring effort that is establishing a baseline chemistry dataset for drinking water systems across the State. This is an update of the MDH "Brown Book" that was first published in 1989, and Karla enlivened what might otherwise have been dry subject matter. Todd Johnson from MDH spoke about the long process used to regulate new contaminants in drinking water. Tannie Eschenauer concluded the presentations from the MDH staff and spoke about the many challenges associated with conveying groundwater quality and public health information to the public. Dr. Mindy Erickson from the USGS reminded us that some important contaminants in our groundwater occur naturally and presented an update on the understanding of naturally-occurring arsenic contamination in the Minnesota's groundwater. Amanda Strommer concluded the conference by presenting her Master's thesis work on evaluating how public water suppliers communicate about contaminants of emerging concern.

More information on the spring conference is available on the MGWA website, including most of presentations. This information is located in the "MGWA Meetings" area of the website at: www.MGWA.org/meetings.php

MGWA Student Outreach

Have you noticed the large crowds at recent MGWA meetings? Have you had trouble finding a seat in your favorite corner, or had to search through the many faces looking for friends? And have you noted that the dominant hair color isn't so overwhelmingly gray? You aren't imagining things, as both the numbers of conference attendees and the number of students have been increasing in the last few years. As MGWA President Bob Tipping mentions in his letter to the membership elsewhere in the newsletter, nearly 40 students attended our Spring Conference in April. And since most of us are scientists and engineers it's obvious you'll want to see the data! The accompanying scatterplot tells the story of rising attendance. We hope to continue the momentum, so please encourage younger professionals in your organization to join MGWA. And if you see a student at the next meeting, take the time to talk about how they might find a place in our growing field.



2013 MGWA Board

Past President
Kelton Barr
Braun Intertec
(952)995-2486
kbarr@braunintertec.com

President
Bob Tipping
Minnesota Geological Survey
(612)627-4780 x 211
tippi001@umn.edu

President-Elect
Eric Mohring
Board of Water and Soil Resources
(651)297-7360
eric.mohring@state.mn.us

Secretary/Membership
Julie Ekman
Minnesota Department of Natural Resources
(651)259-5674
julie.ekman@state.mn.us

Treasurer
Audrey Van Cleve
Minnesota Pollution Control Agency
(651)757-2792
audrey.van.cleve@state.mn.us

The primary objectives of the MGWA are:

- Promote and encourage scientific and public policy aspects of groundwater as an information provider.
- Protect public health and safety through continuing education for groundwater professionals;
- Establish a common forum for scientists, engineers, planners, educators, attorneys, and other persons concerned with groundwater;
- Educate the general public regarding groundwater resources; and
- Disseminate information on groundwater.

MGWA's Corporate Members

Leggette, Brashears & Graham

Barr Engineering

Northeast Technical Services

Liesch Associates

Interpoll Labs

Links at www.mgwa.org

Abbreviations and Acronyms

- ASTM – American Society for Testing and Materials
- DNR – Minnesota Department of Natural Resources
- MDA – Minnesota Department of Agriculture
- MDH – Minnesota Department of Health
- MGS – Minnesota Geological Survey
- MPCA – Minnesota Pollution Control Agency
- USEPA or EPA – United States Environmental Protection Agency
- USGS – United States Geological Survey

President's Letter, cont.

a way that benefits long-term human and natural environments. As an organization, MGWA can help educate the general public on groundwater, and provide guidance on groundwater-related issues. At the spring conference, Kelton Barr introduced a white paper initiative as a way to formalize this contribution (see "MGWA launches white paper initiative" this issue). So if there is a topic that would benefit from your experience, now there's an opportunity to get involved.

Establishing the value of groundwater is implicit in every aspect of professional hydrogeology. We understand the cost of treatment but have many questions about alternative uses. There are still fundamental questions about how groundwater systems function, their role in ecosystems, and how conditions are changing with time. Models used to make decisions based on the value of groundwater will require not only better information on aquifers and aquitards, but also on how changing hydraulics impact groundwater residence times and pathways. Our Fall conference, scheduled to be held on Wednesday, November 13th at the University of Minnesota, will be on the economics of groundwater resource management. The conference is meant to address the value of groundwater at many different scales, and we expect to hear on topics ranging from groundwater science to groundwater policy. More on that in the Fall newsletter – in the meantime, have a good summer. It's here, finally!

White Paper Initiative, cont.

would solicit from the MGWA membership suggestions for White Paper topics from which they would select one or more topics annually. For each topic, they would solicit members interested in participating in a working group for that topic. From those volunteers, the Committee would select members to form the working group, balanced in its makeup and viewpoints.

The work group would then proceed to research the topic, finding pertinent references and studies and interviewing individuals knowledgeable on the various aspects and points of view for the topic. They would then draft a White Paper on the subject that can serve as an authoritative, unbiased, science-based document. Through this they would be overseen and guided by one or more members of the Committee to ensure that the process and final document is timely and balanced. If serious disagreements develop in the process, the Committee will work out a way to resolve that. The draft White Paper will then be subitted to the Board for review, comments for revisions, and final approval. The White Paper would then be posted on the MGWA website and distributed to all stakeholders, including the pertinent media, policy makers, regulators, and public and private interested parties.

Another aspect at this point is that a member of the task force will be identified in the White Paper as a contact for further follow-up. This can allow any interested decision maker or influencer – for example a legislator or a journalist – to fully understand the information in the White Paper.

This process can get around a common frustration: our members constitute the most informed professionals on the various issues involving Minnesota's groundwaters, yet any single member often feels constrained by their employment situation to personally comment on an issue. With this approach a group of professionals can collectively assemble the background, pertinent aspects, and conclusions about a groundwater issue. Their involvement can be seen by their employer as an affirmation of the professional's stature in the groundwater community without perceived conflicts of interest or other employment issues. This can also be another means of participation of our retired members who have acquired decades of wisdom and perspective that can be invaluable to the preparation of these White Papers.

This can elevate the Minnesota Ground Water Association as a go-to source of unbiased information which can often seem scarce or missing in the fray of public discourse and debate. It can make your membership more valuable and elevate our profession in the care and regard for our state's precious groundwater resources. Our state's policies and management of our groundwater can be greatly enhanced and informed by this ongoing endeavor.

If you would be interested in participating, please contact office@mgwa.org and let us know. We look forward to working with you in this new initiative!

Resources Available for Private Well Owners

By Michael Convery, Minnesota Department of Health

The March 2013 issue of the Minnesota Ground Water Association announced the formation of the Minnesota Well Owners Organization (MnWOO). One goal of MnWOO is to provide reliable and useful information to private well owners on well and groundwater issues. Getting information to well owners in a timely and useful manner is an ongoing struggle. Private well owners, too often, never think about their wells as long as the well pumps water and the water tastes fine. It is only when an obvious problem develops do they look for information.

On the national and state levels, there are a number of agencies and organizations that can provide information and advice to private well owners. In addition, many local agencies provide well information and water testing services to their residents. Some of the primary information sources include:

Minnesota Department of Health (MDH) Well Management Section: The goals and purpose of the MDH well program are to (1) provide a safe and sanitary source of drinking water to private well users and (2) protect groundwater quality by establishing minimum construction standards for new wells and borings and in sealing not-in-use wells and borings. In addition to the contractor licensing and regulatory activities, MDH publishes a number of publications, addressing a variety of water quality issues, recovery from natural disasters, well disclosure requirements at property transfer, and well sealing (see: www.health.state.mn.us/divs/eh/wells/). County Well Index – Online, a statewide data system of over 475,000 well and boring records and administered jointly by MDH and the Minnesota Geological Survey, is available through the Well Management website. The *Well Owners Handbook* is a primer on how private wells and water systems work, and includes maintenance / trouble-shooting tips and advice on water testing and treatment (see: www.health.state.mn.us/divs/eh/wells/construction/handbook.pdf).

University of Minnesota (U of M) Extension Service: The U of M Extension Service provides information on water testing, water quality issues, and flood recovery (see: www.extension.umn.edu/topics.html?topic=2&subtopic=99).

Water Systems Council (WSC): WSC addresses the concerns of manufacturers, suppliers, and owners of private water systems. WSC has established the Well Care Well Owners Network, which provides information on the workings and maintenance of private water systems and water treatment. See: www.wellcarehotline.org. On April 1, 2013, WSC issued a reminder to private well owners to perform annual check/maintenance on their water systems.

National Ground Water Association (NGWA): While NGWA is primarily a professional and trade association, it does provide information and services to the public through www.wellowner.org/. The information provided focuses on new well construction, well maintenance, water testing, and groundwater protection.

American Ground Water Trust (AGWT): AGWT has information for private well owners through www.agwt.org/content/well-owner-info. Like the previous sites, AGWT provides information on groundwater basics, well maintenance, and water testing, and water treatment.

Illinois State Water Survey: The Illinois State Water Survey, the Illinois Water Resource Center, the University of Illinois (Urbana-Champaign), and the U.S. Environmental Protection Agency have joined forces to conduct an on-line Private Well Class, specifically targeted to private well owners in the United States. The class consists of 10 weekly email sessions (about 30 minutes each) and three live webinars (approximately 60 minutes each). These classes cover a wide range of topics, including groundwater basics, private well construction, well and water system maintenance, water testing, and water treatment. The real plus with this program is that well owners can view these sessions and webinars at any time and are intended to be as convenient as possible. See: www.privatewellclass.org.

United States Environmental Protection Agency (USEPA): While the USEPA does not regulate private wells and water systems, it does provide a number of publications and online information regarding private wells, with a focus on water quality, public health concerns, and recovery from natural disasters (see: http://water.epa.gov/drink/info/well/). Two publications that warrant highlighting are *Drinking Water from Household Wells* and the *Manual of Individual and Non-public Water Supply Systems.*

In summary, there are a number of information resources available to the public, professionals, and policy makers on private wells and water systems and related groundwater issues. While there is certainly some duplication of information and services, these resources do provide a fairly comprehensive body of information available for well owners to address common issues and problems with their well and water systems.

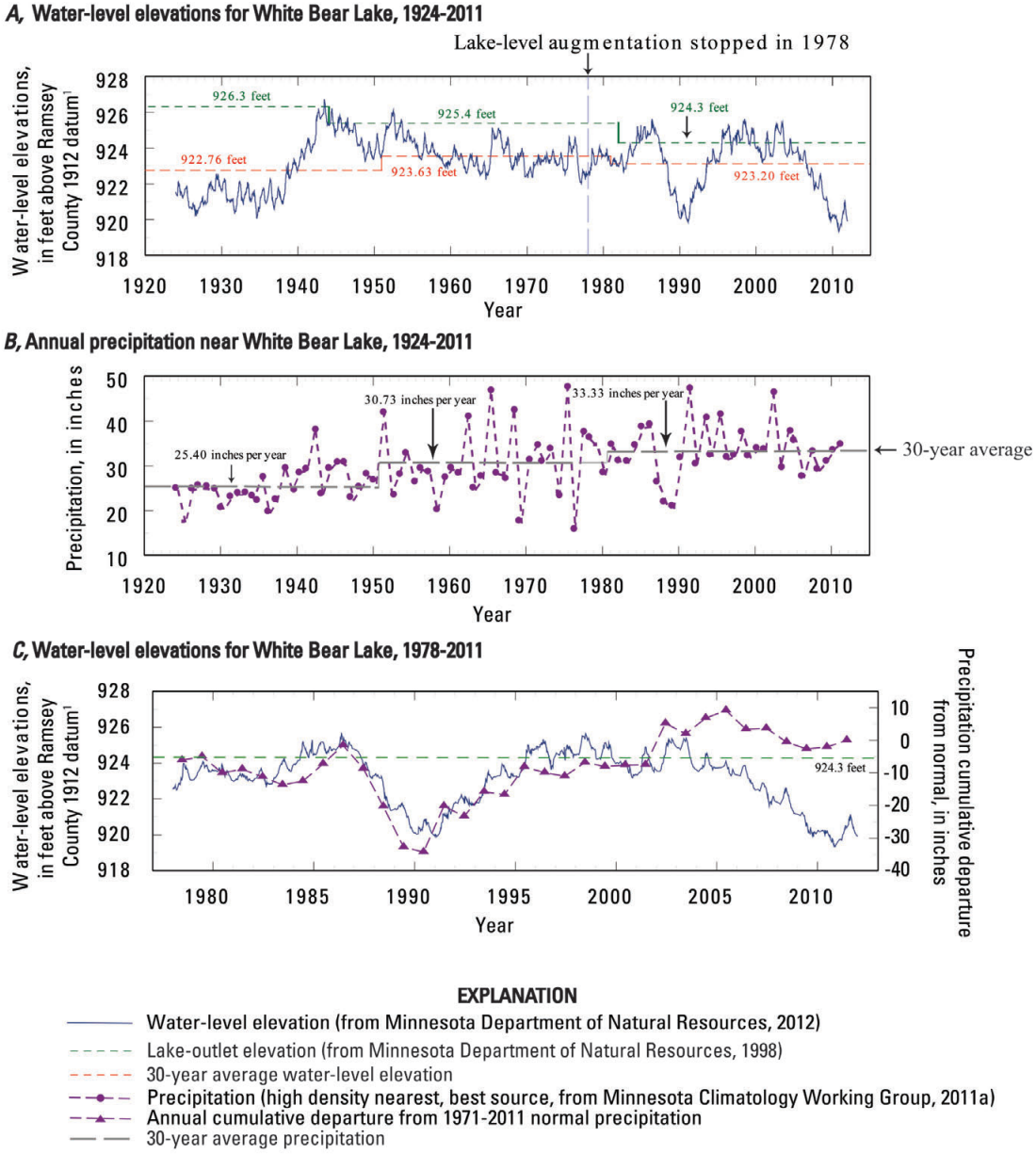
Groundwater and Surface-Water Interactions near White Bear Lake, Minnesota, through 2011

By Perry M. Jones, Jared J. Trost, Donald O. Rosenberry, P. Ryan Jackson, Jenifer A. Bode, and Ryan M. O'Grady

The full report titled "Groundwater and Surface-Water Interactions near White Bear Lake, Minnesota, through 2011" is available at http://pubs.usgs.gov/sir/2013/5044/

The U.S. Geological Survey, in cooperation with the White Bear Lake Conservation District, the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources, and other State, county, municipal, and regional planning agencies, watershed organizations, and private organizations, conducted a study to characterize groundwater and surface-water interactions near White Bear Lake through 2011. During 2010 and 2011, White Bear Lake and other lakes in the northeastern part of the Twin Cities Metropolitan Area were at historically low levels (fig. 1). Previous periods of lower water levels in White Bear Lake correlate with periods of lower precipitation; however, recent urban expansion and increased pumping from the Prairie du Chien-Jordan aquifer have raised the question of whether a decline in precipitation is the primary cause for the recent water-

— continued on page 7



[1] Ramsey County 1912 datum is 0.46 foot lower than NAVD 88.

Figure 1 - Water-level elevations for and annual precipitation and pan-estimated lake-surface evaporation near White Bear Lake, northeast Twin Cities Metropolitan Area, Minnesota. A, Water-level elevations, 1924–2011; B, Annual precipitation, 1924–2011; and C, Water-level elevations, 1978–2011.

level decline in White Bear Lake. Three methods were used in the study to assess groundwater and surface-water interactions on White Bear Lake: (1) a historical assessment (1978–2011) of levels in White Bear Lake, local groundwater levels, and their relation to historical precipitation and groundwater withdrawals in the White Bear Lake area; (2) recent (2010–11) hydrologic and water-quality data collected from White Bear Lake, other lakes, and wells; and (3) water-balance assessments for White Bear Lake in March and August 2011.

Cumulative lake-level change, precipitation, and evaporation from the lake surface over two example 8-year periods,1980–1987 and 2003–10, indicate factor(s) other than abnormally dry weather contributed to the most recent lake-level decline. An analysis of covariance between average annual lake-level change and annual precipitation indicated the relation between the two variables was significantly different from 2003 through 2011 compared with 1978 through 2002, requiring an average of 4 more inches of precipitation per year to maintain the lake level (fig. 2). This shift in the linear relation between annual lake-level change and annual precipitation indicated the net effect of the non-precipitation terms on the water balance has changed relative to precipitation. The average amount of precipitation required each year to maintain the lake level has increased from 33 inches per year during 1978–2002 to 37 inches per year during 2003–11. The combination of lower precipitation and an increase in groundwater withdrawals can explain the change in the lake-level response to precipitation. Annual and summer groundwater withdrawals from the Prairie du Chien-Jordan aquifer have more than doubled from 1980 through 2010 (fig. 3). Results from a regression model constructed with annual lake-level change, annual precipitation minus evaporation, and annual volume of groundwater withdrawn from the Prairie du Chien-Jordan aquifer indicated groundwater withdrawals had a greater effect than precipitation minus evaporation on water levels in the White Bear Lake area for all years since 2003. The recent (2003–11) decline in White Bear Lake reflects the declining water levels in the Prairie du Chien-Jordan aquifer; increases in groundwater withdrawals from this aquifer are a likely cause for declines in groundwater levels and lake levels.

Synoptic, static groundwater-level and lake-level measurements in March/April and August 2011 indicated groundwater was potentially flowing into White Bear Lake from glacial aquifers to the northeast and south, and lake water was potentially discharging from White Bear Lake to the underlying glacial and Prairie du Chien-Jordan aquifers and glacial aquifers to the northwest. Groundwater levels in the Prairie du Chien-Jordan aquifer below White Bear Lake are approximately 0 to 19 feet lower than surface-water levels in the lake, indicating groundwater from the aquifer likely does not flow into White Bear Lake, but lake water may discharge into the aquifer. Groundwater levels from March/April to August 2011declined more than 10 feet in the Prairie du Chien-Jordan aquifer south of White Bear Lake and to the north in Hugo, Minnesota.

Water-quality analyses of pore water from nearshore lake-sediment and well-water samples, seepage-meter measurements, and hydraulic-head differences measured in White Bear Lake also indicated groundwater was potentially flowing into White Bear Lake from shallow glacial aquifers to the east and south. Negative temperature anomalies determined in shallow waters in the water-quality survey conducted in White Bear Lake indicated several shallow-water areas where groundwater may be flowing into the lake from glacial aquifers below the lake. Cool lake-sediment temperatures (less than 18 degrees Celsius) were measured in eight areas along the northeast, east, south, and southwest shores of White Bear Lake, indicating potential areas where groundwater may flow into the lake.

Stable isotope analyses of well-water, precipitation, and lake-water samples indicated wells downgradient from White Bear Lake screened in the glacial buried aquifer or open to the Prairie du Chien-Jordan aquifer receive a mixture of surface water and

— continued on page 8

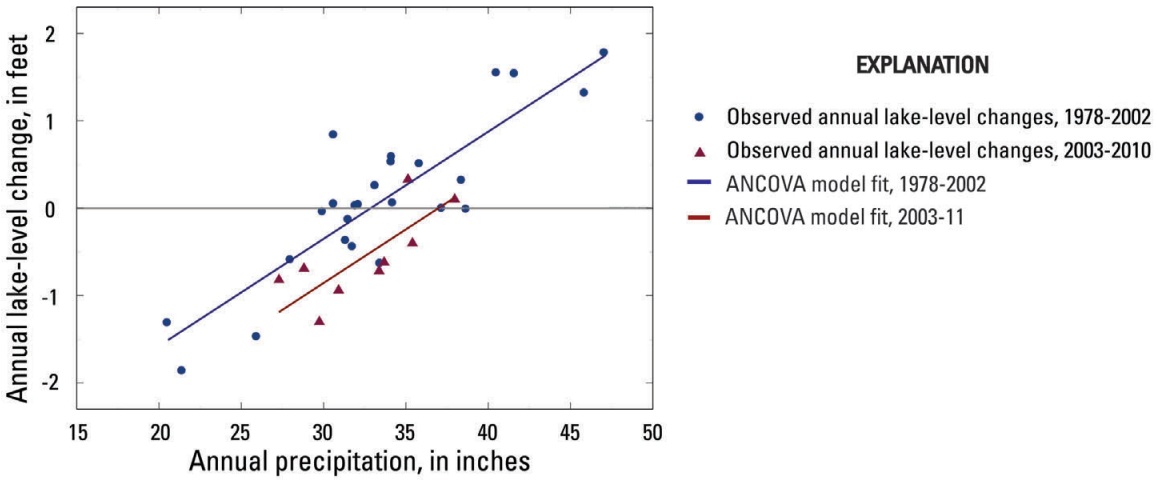


Figure 2 - Relation between observed annual (January through December) lake-level changes and precipitation and model fit of analysis of covariance (ANCOVA) for White Bear Lake, northeast Twin Cities Metropolitan Area, Minnesota, 1978-2011.

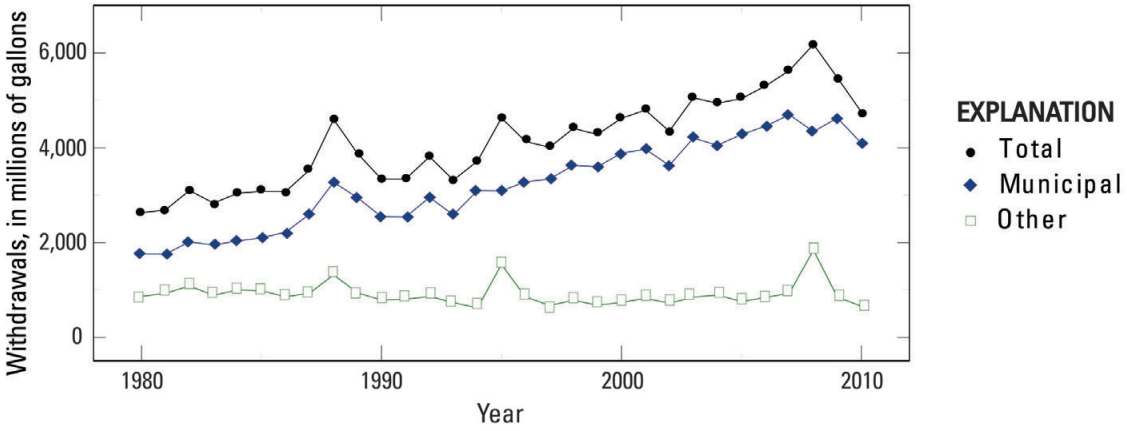
groundwater; the largest surface-water contributions are in wells closer to White Bear Lake (fig. 4). A wide range in oxygen-18/oxygen-16 and deuterium/protium ratios was measured in well-water samples, indicating different sources of water are supplying water to the wells. Well water with oxygen-18/oxygen-16 and deuterium/protium ratios that plot close to the meteoric water line consisted mostly of groundwater because deuterium/protium ratios for most groundwater usually are similar to ratios for rainwater and snow, plotting close to meteoric water lines. Well water with oxygen-18/oxygen-16 and deuterium/protium ratios that plot between the meteoric water line and ratios for the surface-water samples from White Bear Lake consists of a mixture of surface water and groundwater; the percentage of each source varies relative to its ratios. White Bear Lake is the likely source of the surface water to the wells that have a mixture of surface water and groundwater because (1) it is the only large, deep lake near these wells; (2) these wells are near and downgradient from White Bear Lake; and (3) these wells obtain their water from relatively deep depths, and White Bear Lake is the deepest lake in that area.

The linear relation between the oxygen-18/oxygen-16 and deuterium/protium ratios for the well-water samples was used to develop a groundwater/lake-water isotope mixing model to estimate the percentage of surface-water contribution to the well water (fig. 4). Two end points were established for this relation: one point to represent 100 percent groundwater contribution and another point to represent 100 percent surface-water contribution. The percentages of surface-water contribution to the three wells screened in the glacial buried aquifer receiving surface water were 16, 48, and 83 percent (fig. 5). The percentages of surface-water contribution ranged from 5 to 79 percent for the five wells open to the Prairie du Chien-Jordan aquifer receiving surface water; wells closest to White Bear Lake had the largest percentages of surface-water contribution. Water-balance analysis of White Bear Lake in March and August 2011 indicated a potential discharge of 2.8 and 4.5 inches per month, respectively, over the area of the lake from the lake to local aquifers.

The presence of surface water in wells near White Bear Lake can affect the protection and treatment of water for these public water supplies. Public-supply wells with a mixture of groundwater and lake water from White Bear Lake may need to include the lake

— *continued on page 9*

A, Annual groundwater withdrawals by high-capacity wells for municipal and other uses, 1980-2010



B, Annual groundwater withdrawals by high-capacity wells from Quaternary, St. Peter, Prairie Du Chien-Jordan, and multiple aquifers, 1980-2010

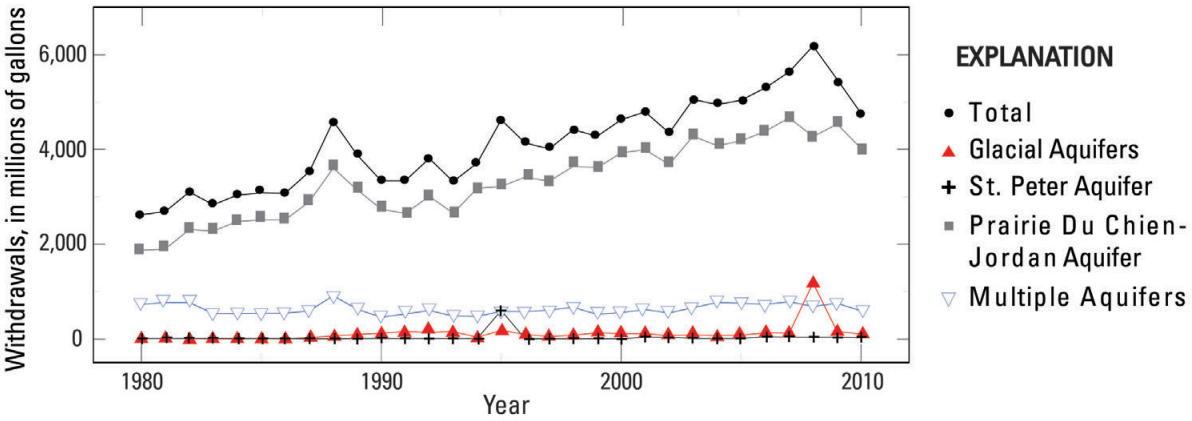


Figure 3 - Groundwater withdrawals by high-capacity wells near White Bear Lake, northeast Twin Cities Metropolitan Area, Minnesota (data from Minnesota Department of Natural Resources, 2011b). A, Annual withdrawals for municipal and other uses, 1980–2010, and B, Annual withdrawals from glacial, St. Peter, Prairie Du Chien-Jordan, and multiple aquifers, 1980–2010.

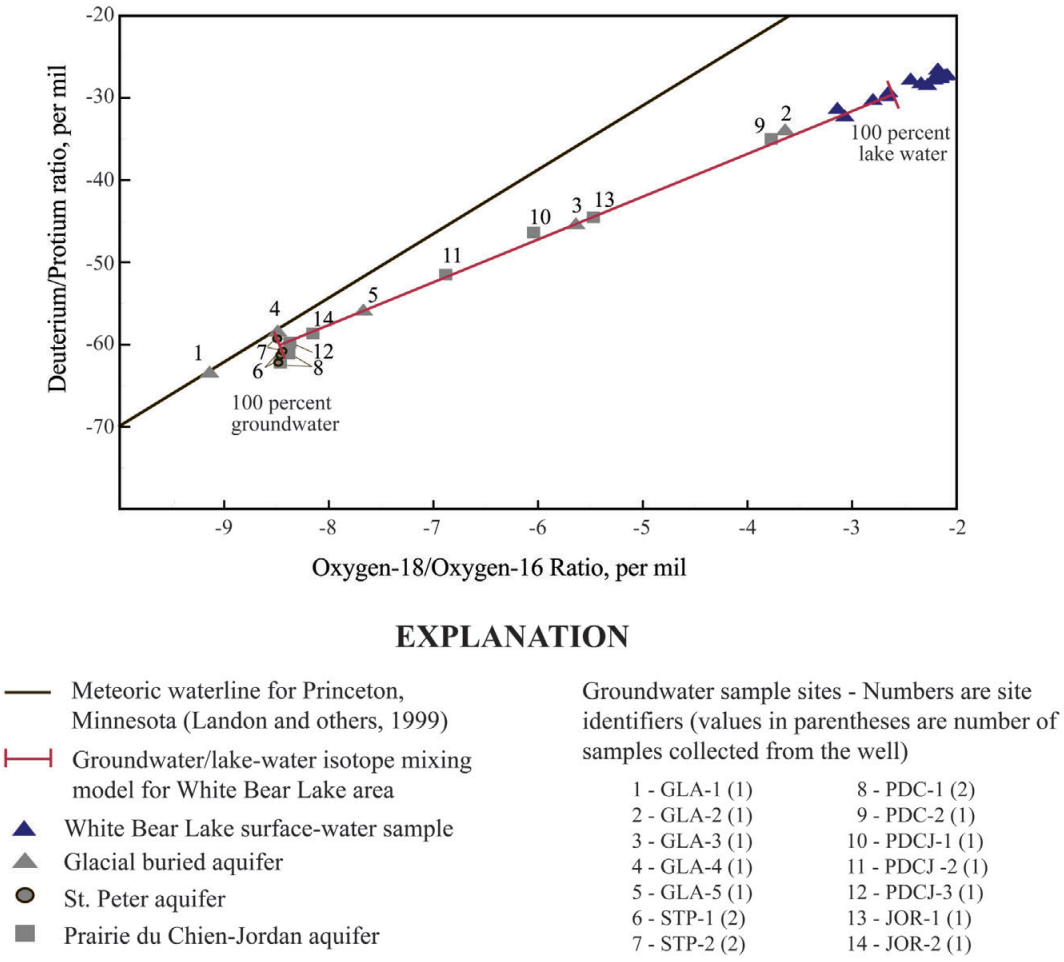
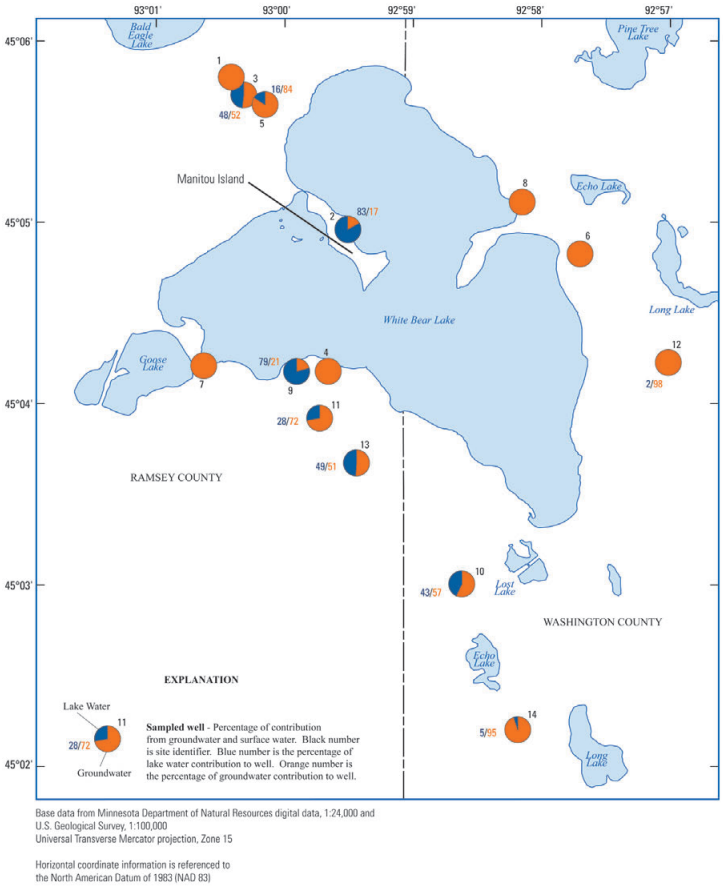


Figure 4 - Oxygen-18/oxygen-16 ratios and deuterium/protium ratios for White Bear Lake waters and well-water samples near White Bear Lake, northeast Twin Cities Metropolitan Area, Minnesota.

watershed in their source-water protection areas. Commonly, the watershed of a lake may be part of source-water protection areas for multiple public-supply wells, potentially serving multiple communities. In addition, water obtained from public-supply wells that extract a mixture of surface water and groundwater may be at risk of contamination from pathogens and viruses not typically found in groundwater (Oregon Health Authority, 2012). This water can be classified as groundwater under the direct influence of surface water. If classified as such in Minnesota, the well water would need to follow water-treatment practices used for surface waters (Minnesota Office of the Revisor of Statutes, 2012).

Historical precipitation and lake-level data indicate the lake levels in White Bear Lake and other northeast TCMA lakes will not recover unless the area receives abundant precipitation or changes water-use and management practices. Potential changes in water-use and management practices involve either increasing the amount of water inputs to the lake or reducing the amount of water discharging from the lake to underlying aquifers. Increasing the amount of water inputs to the lake could include bringing surface water or groundwater from outside the watershed or groundwater watershed. Water imported to the watershed could be pumped directly into the lake or could be used as a source of municipal drinking water, reducing municipal groundwater withdrawals from the Prairie du Chien-Jordan aquifer and, therefore, reducing lake-water discharge to the aquifer. Importing or diverting surface water from outside the lake watershed may require water treatment. The amount of groundwater withdrawals from the Prairie du Chien-Jordan aquifer could be reduced by (1) reducing water withdrawals from wells that have the greatest effect on lakewater discharge to aquifers, (2) implementing or increasing water-conservation practices, (3) using surface-water sources for municipal use instead of groundwater, and (4) treating and discharging wastewater within the watershed. Identifying and limiting groundwater withdrawals from wells that have the greatest effects on lake-water discharge from White Bear Lake may be done through the application of groundwater-flow models and by working directly with municipal water managers to understand their water-use needs and issues. By limiting groundwater withdrawals from wells that have the greatest effect on lake-water discharge to aquifers, groundwater levels in the Prairie du Chien-

— continued on page 10



Jordan aquifer may rise locally, reducing the amount of lake-water discharging to the aquifer. Wastewater from many communities in the northeast TCMA, including the cities of White Bear Lake, Forest Lake, and Hugo, is piped south to the Metropolitan Wastewater Treatment Plant in St. Paul, Minnesota. Treated water from this plant is discharged to the Mississippi River. Treated water from a local wastewater treatment plant within the White Bear Lake watershed could be discharged into infiltration basins upgradient from the lake or directly into the lake, keeping the water within the watershed.

References

Minnesota Office of the Revisor of Statutes, 2012, Minnesota administrative rules—Rule 4720.3920 general requirements for construction of surface water and groundwater under the direct influence of surface water treatment facilities: St. Paul, Minn, accessed December 4, 2012, at https://www.revisor.mn.gov/rules/?id=4720.3920

Oregon Health Authority, 2012, Groundwater under the direct influence of surface water: accessed December 4, 2012, at http://public.health.oregon.gov/HEALTHYENVIRONMENTS/DRINKINGWATER/SOURCEWATER/Pages/gwudi.aspx

Figure 5 - Percentage contribution from groundwater and surface water for well-water samples near White Bear Lake, northeast Twin Cities Metropolitan Area, Minnesota.

Photos from the Archives

This is another offering in our new series on photos relating to the work of our members. This photo was taken in 1988 along the banks of the very dry Pomme de Terre River, where it crosses Highway 12. Only the more mature hydrologists among us remember the drought of the late 1980s and common sights like this. The low head dam has since been removed. (Photo credit: Dave Zapetillo).

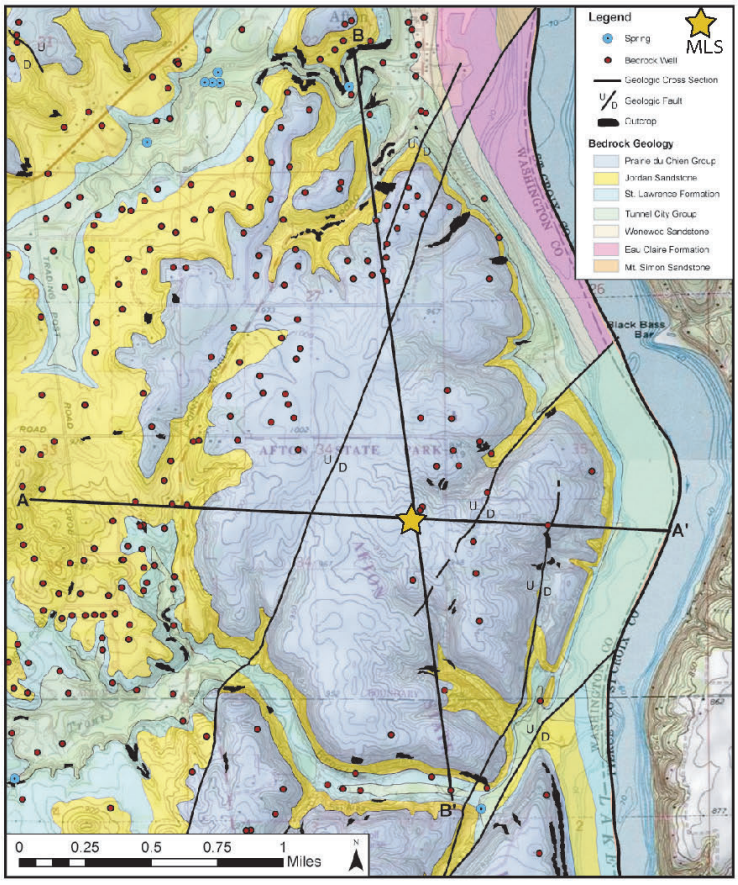
We invite our readers to consider submitting photos for this feature. Please send copies to office@mgwa.org.

A Multilevel Monitoring System Provides New Insights into a Bedrock Aquitard in Southeastern Minnesota

Runkel, Anthony C. [1] ; Tipping, Robert R. [1]; Jones, Perry M. [2]; Meyer, Jessica R. [3]; Parker, Beth L. [3]; Alexander, E.C., Jr. [4]; Steenberg, Julia R. [1], (1) Minnesota Geological Survey, 2642 University Avenue W. St. Paul, MN, 55114, USA (2) US Geological Survey, 2280 Woodale Drive, Mounds View, MN 55112, USA (3) School of Engineering, University of Guelph, Guelph, Ontario, N1G2W1, CAN (4) Earth Sciences, University of Minnesota, 310 Pillsbury Dr. SE, Minneapolis, Minnesota, 55455, USA

Aquitards are an important control on recharge and contaminant transport, yet are relatively poorly understood compared to aquifers, particularly in fractured rock such as that of the Cambrian St. Lawrence bedrock aquitard of southeastern Minnesota. To better understand the properties of bedrock aquitards, we initiated a project that included the construction of a multilevel system (MLS) with numerous ports for monitoring a borehole that spans the St Lawrence Formation in the eastern Twin Cities Metropolitan Area, in Afton State Park (Figure 1). The project was funded by the Legislative-Citizens Committee on Minnesota Resources. The open borehole penetrated about 100 ft of bedrock and ambient flow conditions prior to MLS installation were dominated by strong downflow (~60 gal/min) from the lower Jordan Sandstone to the upper Tunnel City Group, bypassing the intervening St Lawrence Formation. Information from an extensive suite of borehole geophysical logs and packer tests guided construction of the MLS, which includes 14 ports for discrete interval fluid pressure measurements and water sampling, and six ports for higher capacity pumping. Hydraulic head measurements collected since installation of the MLS in November, 2012 reveal that a head difference of ~50 ft between the top and bottom of the open hole is mostly expressed as distinct, large deflections across four thin (<10ft) intervals in the lower Jordan Sandstone and St Lawrence Formations (Figure 2). Meyer *et al.* (2008) documented similarly abrupt shifts in the Paleozoic bedrock of Wisconsin, and suggested they may reflect poor vertical connectivity of fracture sets in adjacent geomechanical and (by definition) hydrogeologic units. Our outcrop observations of fractures in bedrock of southeastern

— continued on page 13



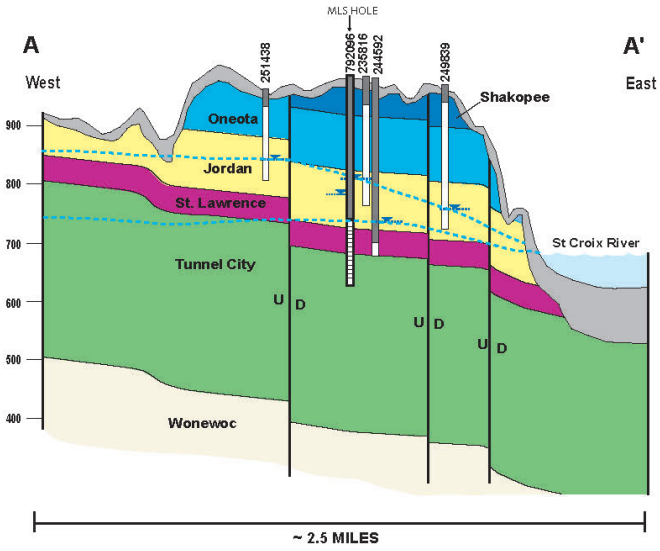


Figure 1. The instrumented well is located in Afton State Park, Washington County (gold star). The site was chosen in part on basis of water well and MN DNR Observation well information that indicated a large head differential across the St Lawrence Formation might be present in this area. Dashed blue lines represent hydraulic head elevation for Jordan Sandstone (upper line) and Tunnel City Group (lower line). The site is characterized geologically by a relatively thin cover of unconsolidated glaciogenic sediment (usually less than 50 feet, except in bedrock valleys) on top of an incised topography of Cambrian and Lower Ordovician bedrock. In this part of Washington County groundwater generally moves from west to east, discharging to the nearby St Croix River. Bedrock faults are common.

A Multilevel Monitoring System Provides New Insights into a Bedrock Aquitard, cont.

Minnesota are consistent with such an interpretation: vertical fractures commonly are stratabound within discrete mechanical units. Analysis of water chemistry from our Minnesota MLS is ongoing, but initial results show variability between units defined by head deflections. This variability might be explained by differences in the relative amount of groundwater contributed to each monitoring zone by the fractures versus the rock matrix and/or differences in the length/residence times of flow paths sampled by each of the monitoring zones.

The results from the Afton State Park MLS will be integrated with other measures of the properties of the St Lawrence Formation, including ongoing dye tracing by the Minnesota Department of Natural Resources and University of Minnesota Department of Earth Sciences. Our goal is to provide an improved understanding of aquitard integrity, which is the capability of an aquitard to protect an underlying aquifer.

Acknowledgements:

We would like to thank the Legislative-Citizen Commission on Minnesota Resources (LCCMR) for funding the project, the Minnesota Department of Natural Resources (DNR) for access to the site, and the Minnesota Department of Health (MDH) for assistance with video logging and well permitting.

Reference

Meyer, J.R., Parker, B. L., Cherry, J.A., 2008, Detailed hydraulic head profiles as essential data for defining hydrogeologic units in layered fractured sedimentary rock, *Environmental Geology* 56:27–44.

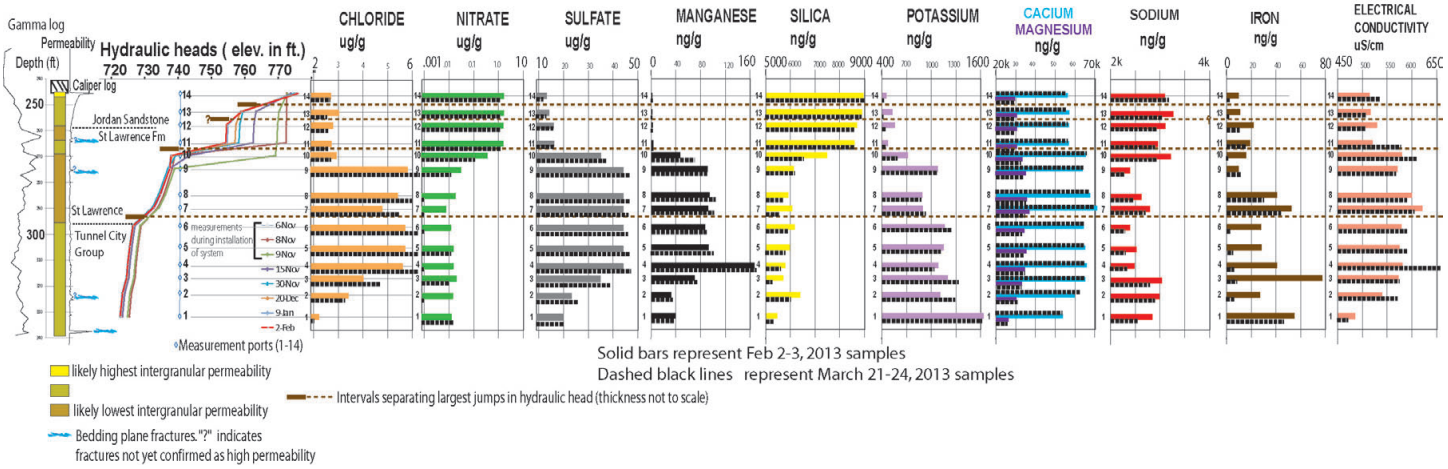


Figure 2. Borehole construction, stratigraphy, MLS port positions, and results of hydraulic head measurements and water chemistry from the Afton MLS monitoring well for November 2012 to March 2013. Evaluation of the water chemistry is ongoing, but initial results show variability between units defined by head deflections. For example, distinct changes in chloride, sulfate, nitrate and manganese concentrations, as well as electrical conductivity, approximate the position of the largest head deflection, in the upper St Lawrence Formation. This variability might be explained by differences in the relative amount of groundwater contributed to each monitoring zone by the fractures versus the rock matrix and/or differences in the length/residence times of flow paths sampled by each of the monitoring zones.

New from the USGS

Decades-old Nitrate Found to Affect Stream Water Quality

USGS hydrologic researchers have found that the movement of nitrate through groundwater to streams can take decades to occur. This long lag time means that changes in the use of nitrogen-based fertilizer (the typical source of nitrate) — whether the change is initiation, adjustment, or cessation — may take decades to be fully observed in streams, according to a recent study published in the journal *Environmental Science and Technology* (http://pubs.acs.org/doi/abs/10.1021/es305026x).

Water quality experts have been noting in recent years that nitrate trends in streams and rivers do not match their expectations based on reduced regional use of nitrogen-based fertilizer. The long travel times of groundwater discharge, like those documented in this study (http://onlinelibrary.wiley.com/doi/10.1111/j.1752-1688.2010.00482.x/full), have previously been suggested as the likely factor responsible for these observations.

"This study provides direct evidence that nitrate can take decades to travel from recharge at the land surface to discharge in streams," said Jerad Bales, acting USGS Associate Director for Water. "This is an important finding because long travel times will delay direct observation of the full effect of nutrient management strategies on stream quality."

Rivers and streams are fed by both groundwater held in underground aquifers and surface water from precipitation runoff. In low streamflow conditions, groundwater sources take a larger role.

In this study, USGS scientists closely examined surface and ground waters at seven study sites from across the nation to determine the portion of stream nitrate derived from groundwater. They found that most of the nitrate observed in streams located in groundwater-dominated watersheds was derived from groundwater sources. To determine the time it takes groundwater to reach a stream in a groundwater-dominated watershed, an age dating tracer study was conducted in the Tomorrow River in central Wisconsin. The findings indicated that decades-old nitrate-laden water was currently discharging to this stream. Consequently, base flow nitrate concentrations in this stream may be sustained for decades to come, regardless of current and future practices.

The slow release of groundwater nitrate to streams may also affect the water quality of large rivers. For example, increases in nitrate concentrations during low and moderate flows in large rivers in the Mississippi River Basin have been observed to be greater than or comparable to increases in nitrate concentrations during high flows. (See http://water.usgs.gov/nawqa/pubs/nitrate_trends, Nitrate in the Mississippi River and its tributaries, 1980 to 2008.) These findings also suggest that increasing nitrate concentrations in groundwater are having a substantial effect on nitrate concentrations in rivers and nitrate transport to the Gulf of Mexico. Because nitrate moves slowly through groundwater to rivers, the full effect of management strategies designed to reduce nitrate movement to these rivers may not be seen for many years.

Citation: *"Vulnerability of Streams to Legacy Nitrate Sources"* Anthony J. Tesoriero, John H. Duff, David A. Saad, Norman E. Spahr, and David M. Wolock, Environmental Science & Technology; April 16, 2013

Groundwater and Surface-water Interactions Near White Bear Lake, Minnesota, Through 2011

2013, Jones, Perry M.; Trost, Jared J.; Rosenberry, Donald O.; Jackson, P. Ryan; Bode, Jenifer A.; O'Grady, Ryan M. USGS Scientific Investigations Report: 2013-5044

See the article on page 6 of this issue.

New MODFLOW Variation

The Office of Groundwater is pleased to announce the release of a new MODFLOW variation, called MODFLOW-USG (http://water.usgs.gov/ogw/mfusg/). MODFLOW-USG was developed through a partnership with private industry and academia. MODFLOW-USG stands for MODFLOW for UnStructured Grids and is based on a generic finite-volume formulation that allows many different types of grids to be used for simulating groundwater flow. Grids can be nested to add focused resolution in areas of interest, for example. Grids can also be constructed using triangles, hexagons, and other cell shapes. This gridding flexibility can be useful for simulating pinched aquifers and aquifers that have been offset by faults. MODFLOW-USG also includes a Newton-Raphson formulation, similar to the formulation implemented in MODFLOW-NWT, which can help improve solution convergence for unconfined aquifer simulations with cells that dry and rewet. The overall feel and design of MODFLOW-USG is similar to other MODFLOW versions, including support for most of the packages that have been developed for MODFLOW-2005.

The flexibility provided by MODFLOW-USG offers new challenges for designing grids and post processing model results. Support tools currently are being developed by the Office of Groundwater and by commercial software developers. Those interested in applying MODFLOW-USG for a project should contact USGS authors Chris Langevin, Rich Niswonger, or Joe Hughes for information on support tools and other related development efforts.

Citation: Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013, *MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*, USGS T&M book 6, chap. A45, 66 p.

New from the Freshwater Society

A new report from the Freshwater Society is now available online. "Minnesota's Groundwater: Is our use sustainable?", was released in April 2013, and uses the anxiety over falling water levels at White Bear Lake as an introduction to the growing concern over Minnesota's groundwater resources. Read it at: http://freshwater.org/wp-content/uploads/2013/04/freshwater-report4-8-13.pdf

Midwest Ground Water Conference
September 23-25, 2013
Bismarck, North Dakota

Call for Abstracts

You are invited to submit an abstract for the Midwest Gound-water Conference to be held in Bismarck, ND September 23-25, 2013.

We solicit abstracts at MWGWC.org pertaining to all aspects of groundwater related issues:

- applied research
- regulatory and policy
- case studies

The deadline for submitting abstracts is August 1, 2013. Abstracts should be 250 words or less. Presentations will be oral and will be limited to 20 minutes each. For questions about the program and session topics, please contact Jon Patch, North Dakota State Water Commission at jpatch@nd.gov.

University research is welcomed. Professors and Graduate students are encouraged to present their research and thesis progress and findings in any and all matters related to hydrogeology. Industry research and case studies are welcomed. Government regulatory and research agencies are welcomed. Case studies, special projects, research areas and policy topics are invited. Once the papers and presentations have been submitted, the sessions with be categorized accordingly.

Please give some thought on how your work can be shared with others and presented to the greater hydrogeologic community.

MGWA BOARD MINUTES

Minnesota Ground Water Association Board Meeting Minutes

Meeting Date: February 1, 2013

Location: Fresh Grounds Café 1362 West 7th Street, St. Paul, MN

Attendance: Bob Tipping, President; Kelton Barr, Past President; Eric Mohring President-Elect; Audrey Van Cleve, Treasurer; Julie Ekman, Secretary; Jennie Leete, WRI; Sean Hunt, WRI

Past Minutes: January minutes approved as amended.

Treasury: Copies of the report were provided by Van Cleve. Total income through January 30th is $14,833 with a net income of $14,803; total current assets: $72,432.

Newsletter: Tipping reported that today is the deadline to get articles in for the next edition. Jeff Broberg approached him about starting up a well owners association in SE Minnesota. Tipping encouraged Jeff to write an article for the newsletter on this topic.

Web Page: Hunt reported that job openings are now posted on MGWA's website. He has received scholarship applications and has forwarded these to Cathy Villas Horns.

WRI Report: Leete handed out a summary report on activities since the last Board meeting in January. She also provided each of those in attendance with a folder of information then gave an oral summary of MGWA bylaws and explained the differences between three 501(c) organizations—MGWA is a 501(c)(4) and the MGWA Foundation is a 501(c)(3).
Leete will post the MGWA Operations Manual on MGWA's Google Docs website.

Foundation: Barr reported that the Foundation group will meet on February 20th. The Foundation's exhibit at the spring conference will afford a fundraising opportunity. Volunteers are needed to plan and work the exhibit.

Old Business: MGWA Spring Conference—
Tipping reported on speakers that have been confirmed for this spring's conference: Karla Peterson, Todd Johnson, and Tannie Eschenauer from MDH; Pete Moulton, St. Peter Water Superintendent; Patty Tocallino from California; someone for the USGS; and Mark Borchardt, WI Department of Agriculture. The group discussed additional speaker possibilities.
Posters will be solicited from the whole MGWA membership.
The Conference Program will be ready within a few weeks; Barr will include this in the Call for Papers and Posters.
White Paper—Volunteers on this committee will meet next week
2015 Joint MGWA/Sinkhole conference—Planners held a conference call and will talk again next week to work out contractual business for sharing the conference.

New Business: New Officers: Eric Mohring has agreed to run for MGWA's president-elect; Audrey
The group discussed conducting another salary survey and what the frequency of this survey should be.
Van Cleve moved that MGWA Board conduct a salary survey this year. Motion carried.

Meeting Date: March 1, 2013

Location: Fresh Grounds Café, 1362 West 7th Street, St. Paul, MN

Attendance: Bob Tipping, President; Kelton Barr, Past President; Eric Mohring President-Elect; Audrey Van Cleve, Treasurer; Julie Ekman, Secretary; Tedd Ronning, Newsletter Editor; Sean Hunt, WRI; Gil Gabanski, MGWAF president.

Past Minutes: February minutes approved as amended

Treasury: Copies of the report were provided by Van Cleve. Total income through February 27th is $16,336 with a net income of $13,045; total current assets: $64,376. Board members agreed that Van Cleve would investigate investment options to earn better interest. Van Cleve will report on this at the April Board meeting.

Newsletter: Ronning reported that the newsletter will be ready to hand over to Hunt for publishing at the end of today.

Web Page: Hunt reported on the conference web page and online ordering development; information on conference speakers can be added as they are received.

WRI Report: Hunt distributed Leete's report to Board members. There will be space at the spring conference for at least 24 vendors.
Current membership is at 400. This is low; however, membership typically increases dramatically after the conference notification is delivered.

Foundation: Gabanski reported that the Foundation Board will need to seek his replacement before June and that the MGWA Board can participate in the search/ recommendation process.
Barr reported that he has had conversations with E. Calvin Alexander and Hans Olaf Pfannkuch regarding the potential for a combined fund to provide scholarships for hydrogeology camp.
The Foundation has received eight applications for the general student scholarship money. The winner will be announced at the spring conference.
Gabanski reported that the Foundation will need to develop strategies for investing funds.

MGWA 2013 Membership Dues

Professional Rate:	$35
Full-time Student Rate:	$15
Newsletter (printed and mailed)	$20
Directory	$7

Membership dues rates were revised at the October 1, 2010 meeting of the MGWA Board. They remain unchanged.

MGWA Minutes, cont.

The MGWA Board of Directors meets once a month.

All members are welcome to attend and observe.

Old Business: Those present discussed the aging membership and the need to recruit younger members for MGWA.

MGWA Spring Conference—it was agreed that MGWA members attending the spring conference would be asked to volunteer to mentor a young participant at the event. Gabanski offered to ask Amanda Strommer, MGWAF Director, if she would be willing to write up text for this; Hunt would include this in a general email to MGWA members. Gabanski will also get this information to Ronning for the newsletter.

Tipping will send the spring conference agenda to Board members for review. The MGWAF scholarship winner will be announded right before lunch.

Barr has been receiving responses to the call for posters. He also reported on the costs for tables and booths. He and Gabanski are contacting potential vendors and expect to complete this by end of next week. Leete is working on the contract language for table and booth costs.

The groundwater quality focus of this conference may be of interest to private well owners. Tipping will contact colleagues at MDH about contacting well owners with information on the conference.

Barr is sending information on the conference to professors to share with their students.

White Paper—Tipping is planning to announce the white paper initiative and topic ideas two times at the conference to solicit interested people to participate and contribute to the effort on topics of interest. A first topic could be aquifer naming. The white paper committee will make arrangements with volunteers to address various topics.

New Business: Hunt is developing a process for posting speaker presentations on MGWA.org after the conference. Speakers will be informed at the conference and can opt out. He will include this information and instructions with the email he'll send to speakers requesting their biographies.

Jennie Leete has developed a template that can be used for writing up a sponsorship agreement for use when MGWA partners with another group for a conference such as the 2015 NCKRI/MGWA joint conference.

The Board discussed the fall field trip cosponsored with AIPG and AWG.

Meeting Date: April 5, 2013

Location: Fresh Grounds Café 1362 West 7th Street, St. Paul, MN

Attendance: Bob Tipping, President; Kelton Barr, Past President; Eric Mohring President-Elect; Julie Ekman, Secretary; Sean Hunt, WRI.

Past Minutes: Approved as amended.

Treasury: Copies of the report were provided by Leete. Leete reported that Van Cleve had checked into options for better interest-earnings at Affinity Plus; no good options are available. The MGWA is in good financial shape nonetheless.

Newsletter: No report.

Web Page: Hunt reported that the December newsletter has been distributed electronically and Hunt conducted routine web page maintenance focusing on the newsletter, directory, employment opportunities and conference registration.

WRI Report: A written report was distributed: The membership database is being updated as renewals are received. The UofM conference facility was visited to check on space for exhibitors. The conference brochure is finalized and emailed to all on the MGWA email list. Membership is currently at 515. Several corporate membership renewals have been received. Our Treasurer was not present to pay the WRI bill so Barr moved that the Board authorize payment to WRI. Motion carried.

Foundation: No report. There was discussion about the status of the $1000 the Board has given the Foundation for hydrogeology camp..

Old Business: Conference – the agenda was finalized; volunteers will meet the evening before to collate materials for conference attendees; members will be contacted about volunteering to mentor college students attending the conference; several students have registered already and more are expected.

The White Paper – committee met to finalize the process for engaging volunteers to collaborate on ideas and writing papers. This will be announced at the conference. The next newsletter will include a call for topics and for participants.

Increasing the MGWA membership – the board discussed ideas on how to retain new members from conference attendance; an idea was to send a letter of welcome.

New Business: Conference speakers will be informed at the conference that their presentations will be posted on the MGWA website unless they choose to opt out.

MGWA/NCKRI 2015 conference co-sponsorship—Barr reported that he and Leete participated in a conference call to work out details; a draft agreement has been prepared and is ready to send to the National Cave and Karst Research Institute (NCKRI) Board. MGWA Board members will receive a copy in email to review. The conference will be the first week in October of 2015.

MGWA Fall Conference is November 13, 2013; the Fall Field Trip is October 18 & 19, 2013.

First Ever MGWA Student Scholarship Awarded

The Scholarship Committee of the Minnesota Ground Water Association Foundation awarded the first ever student scholarship in the amount of $1,000 to Ms. Bonnie Ausk at the MGWA Spring Conference held on April 24, 2013. Bonnie is currently a Ph.D. candidate in Civil Engineering at the University of MN Twin Cities (U of MN) with Dr. Otto Strack as her advisor. She earned a Bachelor's Degree in Civil Engineering in 2008 from the U of MN. Her current research involves the application of the Generating Analytic Element Approach and the Analytical Element Method to groundwater heat transfer. Ms. Ausk provided a poster describing her research at the spring MGWA conference.

In addition to the financial award, Ms. Ausk will also receive a one year free membership in MGWA! She plans to use the scholarship award to attend several conferences related to her research.

The MGWAF Scholarship committee received eight (8) applications for the scholarship from students in Minnesota, Wisconsin and North Dakota. There were a number of excellent candidates and it was not easy to pick just one. Applicants were asked to provide an essay, two letters of reference, and unofficial undergraduate and graduate transcripts with their applications.

The MGWAF Scholarship committee consisted of MGWA members Joy Loughry, Jim Lundy, Amanda Strommer and Cathy Villas-Horns.

Cathy Villas-Horns (left) presents Bonnie Ausk (right) the 2013 MGWA Foundation Student Scholarship

MGWA Foundation Board of Directors

The MGWA Foundation is a 501(c)3 charitable organization. Donations to the Foundation are deductible on your state and federal income tax returns.