Minnesota Ground Water Association
www.mgwa.org
Newsletter

June 2008
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Featured:

MGWA President Stu Grubb

Inside:

Rushford Responds to Flash Flood

By Stew Thornley, Minnesota Department of Health

"I thought I knew everything about water and wastewater," said Jeff Copley, water and wastewater supervisor for the city of Rushford, "until the flood came."

On the evening of Saturday, August 18, 2007, torrential rains began in southeastern Minnesota. In the early hours of Sunday, Rushford, a community of 1,700 people, filled up with water. Emergency vehicles drove through the city with the sirens sounding, using loudspeakers to inform residents to evacuate.

A dike protects Rushford from the Root River, described as "the traditional enemy of the city" by Rushford city administrator Winthro "Windy" Block. But it was Rush Creek, usually a quiet trout stream running into the Root

Rushford during the 2007 Flood

River, that erupted. As more than 17½ inches of rain fell in the area, over five feet of water built up within Rushford, creating what Block

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President's Letter

By Stu Grubb

Minnesotans will vote in November on an amendment to the state constitution that could significantly impact ground water resources and our industry. The Clean Water, Land, and Legacy Amendment would increase the sales tax by three-eighths of one percent between July 1, 2009 and 2034 (25 years). The tax increase would raise about $280 million to $300 million per year (2008 dollars). The money would be allocated as follows: 33% for water quality, 33% for wildlife habitat, 19.75% for arts and cultural resources, and 14.25% for parks and trails.

The process for amending the Minnesota State Constitution involves first passing bills through the state legislature (H.F. No. 2285 and S.F. No. 2146). The amendment then is put to a vote during the general election. Rather than put the entire amendment on the ballot, the bills specify language that is put before the voters. The November ballot will read as follows:

"Shall the Minnesota Constitution be amended to dedicate funding to protect our drinking water sources; to protect, enhance and restore our wetlands, prairies, forests, and fish, game and wildlife habitat; to preserve our arts and cultural heritage; to support our parks and trails; and to protect, enhance, and restore our lakes, rivers, streams and ground water; by increasing the sales and use tax rate beginning July 1, 2009, by three-eighths of one percent on taxable sales until the year 2034?"

What does this mean for ground water? The proposed amendment states that "at least 15 percent of the receipts shall be deposited in the sustainable drinking water fund and may be spent only to protect the state's drinking water sources…" It further states "At least 97 percent of the money appropriated from the (sustainable drinking water) fund must be spent to protect the state's drinking water sources including, but not limited to, well monitoring and cleanup, wellhead and source protection, the state match for available

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Newsletter Deadlines

Issue	Due to Editor
September '08	08/08/2008
December '08	11/07/2008

MGWA NEWS

Member News

Susan Thornton has been appointed as the Director of the Legislative-Citizen Commission on Minnesota Resources. She had been Assistant Director for the Commission since 2002 and Acting Director since March 2008. As Director she will oversee annual allocations equaling approximately $23 million, and growing, from the Trust Fund to projects maintaining or enhancing the environment and natural resources of Minnesota.

Pat Bloomgren is retiring from the Minnesota Department of Health (MDH) in June. She is retiring as Director of the Infectious Disease, Epidemiology, Prevention and Control Division, a position she has held since March 2006. Prior to this position she was the Director of the Environmental Health Division at the MDH since 1992. During her career she also worked at the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources, and the Minnesota Board of Water and Soil Resources. She is looking forward to spending more time with her grandchildren (Cruz, age 3 and Linnea, age 1) and in the garden at her home in the picturesque town of Stillwater.

Hans Neve is a new supervisor in the Resource Conservation and Recovery Act and Superfund programs at the Minneosta Pollution Control Agency. Hans received a Masters Degree in Hydrogeology from Western Michigan University in 1995 and a Bachelor of Arts in Geology from Gustavus Adolphus College in 1994. Hans has been at the MPCA since 1996 working in the remediation programs. From 2002 until 2008, he was part of the Emergency Response Team responding to spills of oil and hazardous material spills, as well as other environmental emergencies.

Stu Grubb, MGWA President, has taken a new position as a Senior Hydrogeologist with AMEC Geomatrix Consultants, Inc. Stu's work will include pollution remediation, brownfield redevelopment, environmental permitting, and mining. Stu was previously

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President's Letter, cont.

federal dollars, and ground water protection according to law." Over $40 million per year could be available for ground water projects. Additional money could be available as well if ground water is included in other clean water initiatives, such as Total Maximum Daily Load (TMDL) implementation.

It is not clear what effect the influx of money from a new source would have on existing sources of state funding. Would the state continue to fund the DNR, PCA, MDA, LCCMR, BWSR, grant programs, etc. the same way they do now? There would certainly be competition and much political wrangling for the new sales tax money.

Supporters of the amendment say that this is the best way to increase funding for environmental programs that have been neglected for too long. Natural resource management requires long-term planning and sustained funding to be effective. Funding from other sources has been insufficient and unreliable.

Opponents of the amendment point not only to the increase in taxes, but also to the way the taxes are levied. The ballot referendum and the constitutional amendment cannot be vetoed by the governor. If the amendment passes, the funding will not be subject to the usual legislative process. It restricts any flexibility state legislators might need to address more pressing funding issues.

There is no apparent reason why funding for arts and cultural resources should be linked to funding for the environment. Most observers agree that the arts funding was included in the amendment to secure needed political support within the state legislature.

MGWA generally does not advocate any political positions, and we won't be an advocate for or against the Clean Water, Land, and Legacy Amendment. Our objective is to be an educational organization for ground water professionals and others concerned with ground water issues. However, we think that the newsletter could be an excellent forum for discourse about the amendment, with a particular focus on ground water issues. Our readers could benefit from hearing from other ground water professionals before making their own decision about how to vote. We encourage MGWA members to submit letters to the editor of the newsletter expressing informed opinions about the amendment. The next newsletter will be published in September 2008, just before the November 4 ballot.

Rushford Flood, cont.

called "a bathtub effect, water threatening from the outside and also the inside."

The wastewater plant, as well as Rushford's two primary sources of drinking water, wells 3 and 4, were flooded and shut down. Power and communication were out as more than 50 percent of the city was inundated.

Although many cities in the area had been hard hit by the flood, Rushford was the only one to have a public water supply knocked out of service.

Recovery

Help from the outside came quickly. Jeff Dale of Minnesota Rural Water Association soon arrived, along with Minnesota Department of Health (MDH) engineer Mark Sweers, who came from Mankato. Hawkins Chemical Company and Minnesota Pipe & Equipment were among the companies donating labor and supplies. Utility workers from neighboring communities showed up with equipment and trucks. Four-wheelers were also used to get around town as all vehicles in Rushford had been submerged.

"Utilities was the place to start," Block said of the recovery efforts. "The top of the dike system had water on both sides. Pumps were down and more rain was threatening to fall. Since we have a large agricultural community in the area, we benefited from the pumps and tractors [which were brought in], which helped the town to dry out."

Sweers said the immediate goal for the water system was "to go from no pressure, dealing with line breaks, to get the system pressurized, at least for fire protection." Well number 2, a backup well more than 50 years old, hadn't been flooded and was put into service. "They shut off both reservoirs, the tower and ground-storage tank," explained Dale. "There was little pressure, 8 psi [pounds per square inch], when they turned well 2 on. They shut off curb stops to people's homes and started getting pressure back." The system was fully pressurized after two days.

The city issued a notice to residents to not use the water for any reason for fear of losing well number 2. In addition, the wastewater plant wasn't operating, leading to pressure from some city officials to turn well 2 off. Dale, saying they didn't want to go back to negative pressure, resisted the suggestion and was backed by Sweers. The city soon allowed people to use the water but advised them to boil it before cooking or drinking until the water system was stable and samples showed no coliform bacteria in the distribution system.

However, positive bacterial samples were continuing at wells 3 and 4. The city hoped to get them back on-line quickly to take the load off well 2, which had a broken check valve but couldn't be repaired until another well was operational. The wells were disinfected and flushed more than 15 times. However, the wells continued to have problems with bacteria. Eventually, well 3 was sealed and taken out of service. It wasn't until the following March, nearly nine months after the flood, that well 4 was put back into service.

Danny Nubbe and others from Mineral Service Plus of Green Isle, Minnesota, worked with Copley and the others on the wells. "After we worked on the problem of disinfecting wells and we were failing at it," said Nubbe of wells 3 and 4, "we started to wonder if there was something else than the flood water going down the well, a conduit or a channel for contamination. We weren't getting anywhere.

"So we started going around looking for wells to see if we could find any open wells. Most of the houses in town that we found wells in were there before the water system [which started in the 1930s]. We found as many as four wells in one house, where people said they didn't have any, but people welcomed us to come in and look."

The crews discovered a variety of wells in the homes, mostly sand-point wells. Copley said they anticipated finding anywhere from 40 to 80 sand-point wells as they went from home to home. As of mid-March in 2008, they had found more than 300 and were still finding more. Some residents have never connected to the public water supply and still had operating wells in their homes. However, other wells had been abandoned. Some were capped but not sealed, and some weren't sealed at all. Dale said the abandoned wells were "acting like a floor drain into the shallow aquifer used by some residents with operational private wells. We had to tell residents with operational wells not to use them, that the water could be contaminated."

Nubbe and his crew began sealing the abandoned private wells (with costs covered by the county) and also set out in search for other wells in the city. "We investigated old records, talked to people—one guy in a rest home had a lot of good information. We started going through every record of the history of the town," Nubbe said. "We went to

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2008 MGWA Board

The primary objectives of the MGWA are:

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

MGWA's Corporate Members

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Links at www.mgwa.org

Save the Date!

MGWA's Fall Conference Advances in Field Data Collection

November 13, 2008

Rushford Flood, cont.

museums to find out about industries in the town. We found there were wells drilled back in the 1800s that were 300 feet deep, so now we know there are large rock wells in the area.

"After finding information that the wells were there, we had to find out where the wells are. Some of the buildings are long gone. So with the help of the health department, we started getting old Sanborn insurance maps, started looking for landmarks, and started finding large wells."

City well 1, long abandoned, eluded the crews for several weeks. Finally they determined it was beneath the Rushford State Bank. With permission from the bank, they chopped through the floor in the lobby. They didn't find the well but did dig up an old water main. Following that, they finally located the well under the bank's board room. The well, extending through the Ironton-Galesville, Eau Claire, and Mount Simon aquifers, was 580 feet deep and cased to 108 feet. It was full of rubble and other debris, including wood with creosote on it.

They dropped a camera down the well and could see the upflow coming from the Mount Simon and running into the Ironton-Galesville aquifer. "That helped open our eyes as to what was going in," Nubbe said.

Another abandoned well, used by the railroad depot and going back to the 1800s, was found. "It was a dug well 14 feet across, pumping 450 gallons a minute," said Nubbe. "The concern was that if a well will give 450 gallons a minute, it will take 450 gallons a minute, and the well was full of rubble. So we kept going through the town, locating wells, cleaning them out, sealing the wells, trying to eliminate all possibilities of contamination."

Wells 3 and 4 continued to resist efforts to clean them up, and well 2 continued to supply the city's water through the winter. Finally, in February, the decision was made to seal well 3. At this point, well 4 finally came up clean and was put back into service in March.

Minnesota WARN

The response to the flood was aided by the emerging Minnesota Water and Wastewater Agency Response Network (MnWARN). Although not yet formally activated, the mutual-aid network helped in organizing a timely response from other communities.

MnWARN is a mutual-aid agreement between utilities to help one another with personnel and other resources in the event of an emergency. In the past, police and fire departments and public-health agencies have had mutual-aid networks. A missing element has been utilities, which are now organizing. New Ulm water supervisor Al Lamm is a veteran of flood response. When he was with the Thief River Falls water department in 1997, Lamm coordinated response activities to the flooding in East Grand Forks. Lamm said it took him five days to organize that response. "With MnWARN," Lamm said, "the response can be organized in a matter of hours."

Since the flood, Rushford became one of the original partners in MnWARN, along with the cities of St. Peter, Hawley, and Elbow Lake. MnWARN has a web site at www.mnwarn.org.

What's Next?

"Barring any unforeseen hang-ups, the city is on its way to remedying its water woes with a $1,500,000 water treatment plant," the Tri-County Record of Rushford reported August 10, 2007. The unforeseen hang-up of a flood came up a week-and-a-half later. As a result, the city has to move the site of the new plant and re-issue bids. Radium has been a problem for Rushford, particularly with well number 4. In addition, there have been aesthetic problems with the water because of iron and manganese. The new plant, along with the drilling of a new well, should solve the problems.

Member News, cont.

with Emmons & Olivier Resources.

Gilbert Gabanski has accepted a position as Environmentalist with the Contaminated Lands Unit at Hennepin County Environmental Services. Gil will be contracting and coordinating consultants working on Hennepin County brownfields, selected impacted parcels owned by the county, area-wide groundwater studies, and assessments along county right-of-way projects. He will maintain his private consulting for projects outside of the county.

Craig Wills has joined DNR Waters in the Central Region office as East Metro Area Hydrologist. He previously worked as an environmental consultant for NRG and a Water Resource Specialist and Environmental Department Director for the Prairie Island Indian community. He recently returned to Minnesota after working in Alaska.

INDUSTRY NEWS

New Fee Schedule - Minnesota Department of Health, Well Management Section

Effective July 1, 2008, new state fees for well construction notifications, well sealing notifications, permits, variance requests, and well disclosures will be implemented by the Minnesota Department of Health, Well Management Section. Fees for licenses/registrations and hoist/drilling machine registrations are not changing. The fee schedule will be as follows:

Well Construction Notifications

Water Supply Well	$ 215
Dewatering Well	$ 215
Dewatering Project (5 or more wells)	$ 1075

Permits

Elevator Boring	$ 215
Ground Water Thermal Exchange Device	$ 215
Vertical Heat Exchanger (Heat Loop)	$ 215
Monitoring Well	$ 215
Well Maintenance	$ 175
Dewatering Project (5 or more wells) Maintenance Permit	$ 875

Well Sealing Notification $ 50

Variance Application $ 215

Monitoring Well Site Permits

Motor Fuel Retail Outlet	$ 215
Petroleum Bulk Storage Site	$ 215
Agricultural Chemical Facility	$ 215

License Fees (not changed)

Qualification Application	$ 75
Renewal Late Fee	$ 75
Elevator Shaft Contractor	$ 75
Monitoring Well Contractor	$ 75
Limited Well/Boring Contractor	$ 75
Explorer	$ 75
Well Contractor	$ 250
Hoist/Drilling Machine Registration	$ 75

Well Disclosure Certificate $ 45

Any payments received prior to July 1, 2008, will be accepted at the current rates. Insufficient fee payments for notifications, permits, variances, or licenses on or after July 1, 2008, will be returned to the contractor or the individual making payment. Permits and variance requests will not be reviewed, and notifications and license applications will not be processed, until sufficient funds are submitted to the MDH. The county recorder will not accept submittal of well disclosure certificates without the appropriate fee.

Federal, state, and local government entities are exempt from payment of fees, but are not exempt from other requirements, including well disclosure, licensing, notification, and permitting requirements.

Well fees in jurisdictions of delegated well programs are established by the delegated program. Individuals should check with the delegated program for fee amounts and any other administrative requirements.

PROFESSIONAL NEWS

Professional License Renewals

The Minnesota Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience and Interior Design (AELSLAGID) reminds licensed professionals that all licenses and interior design certificates expire on July 1, 2008, unless renewed, regardless of when they were first issued.

You will need 24 Professional Development Hours to renew your license (including up to 12 hours of carryover from your 2006 renewal form). If you were licensed on or after July 1, 2006, you are automatically exempt from reporting continuing education for this renewal period. You will need 24 PDH obtained on or after July 1, 2008, to renew your license in 2010.

Go to this link to renew online for July 1, 2008 - June 30, 2010: https://renewals.aelslagid.state.mn.us/License.aspx

Go to this link to download a 2008-2010 renewal form to complete and send in by mail with a check or money order: http://www.aelslagid.state.mn.us/renewals.html

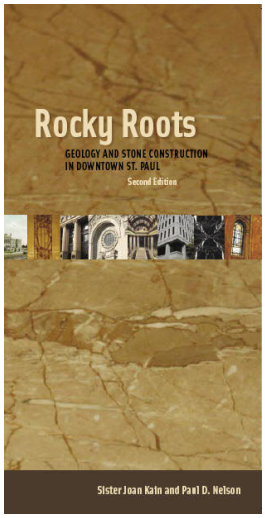
You no longer need to complete a separate continuing education reporting form listing all of your courses and activities. Put the total number of Professional Development Hours in the space provided on the renewal form and maintain your records until July 1, 2010, in case you are selected for a random continuing education audit.

Renewal forms will NOT be mailed as they have been in the past. It is the responsibility of each licensee or certificate holder to maintain records of their continuing education activity for four years after reporting it to the Board. When you renew online, carryover will automatically be applied. Do NOT call the Board office to request the staff to lookup your carryover.

If your license or certificate expired prior to July 1, 2008, contact Andrea Barker at the Board office for reinstatement instructions (651-757-1511 or andrea.barker@state.mn.us).

Guide to Building Stone in St. Paul

A second edition of Rocky Roots - Geology and Stone Construction in Downtown St. Paul, has been published by the Ramsey County Historical Society. This second edition, by Paul D. Nelson, like the first, is a guide to the use of stone, particularly stone quarried in Minnesota, in downtown St. Paul architecture. Over the past thirty years some buildings that are discussed in the first edition have been torn down and a number of new buildings that use ornamental stone have been erected. The text, photos, and maps can be a useful resource for several different walking tours through town. For more information see www.rchs.com/books.htm.



News from the Spring 2008 MGWA Conference on Biofuelds and Water Resources

Over 200 people attended this year's spring conference on May 8, 2008, exploring the relationship between biofuels and ground water. One of many biofuels, ethanol has had much attention in Minnesota in recent years with the rapid expansion of production capacity. MGWA President **Stu Grubb** of AMEC Geomatrix introduced the day's program and noted that while biofuels development may represent environmental and economic opportunities, it also represents potential resource impacts.

MGWA President Stu Grubb

Mark Seeley of the University of Minnesota led off the program with a review of Minnesota weather trend indicators of climate change, including warmer winters, greater frequency of higher dewpoints, and more intense rainfall events. He next discussed some impacts of those changes, such as greater survival of pests over winter, more freeze-thaw cycles, and modified energy consumption patterns. He concluded that Minnesota citizens and policy makers need to respond in a variety of ways that may run the gamut from greater need for erosion control to increased monitoring to track climate change.

Katsumi Matsumoto, University of Minnesota

Katsumi Matsumoto of the University of Minnesota provided a broad introduction to global warming. He reviewed the data of multiple systems (detection) that indicate global warming is occurring, noting that instrumental records are consistent. As an oceanographer, he indicated a key piece of evidence is the increasing ocean heat content, leading to sea level rise from thermal expansion of water. He next examined the issue of the cause of global warming, pointing out analytical tools and data to separate anthropogenic response from natural response. The current scientific consensus of physical-system based modeling is that natural forcing is insufficient to account for observed global warming.

Harvey Thorleifson of the Minnesota Geological Survey (MGS) discussed the need to respond with multiple approaches to address climate change, focusing on carbon sequestration as one alternative. He noted that while the technology for storage deep underground are relatively well developed, capturing CO_2 is much more expensive than injecting it for storage. A recent study conducted by the MGS concluded that the prospects for sequestration in Minnesota is generally not good because of the low hydraulic conductivity values of the buried sandstones in the Mid Continent Rift underlying the eastern part of the state.

MGS Director Harvey Thorleifson

Mark Lindquist of the Minnesota Department of Natural Resources reviewed Minnesota water use for biofuels, in particular ethanol, in recent years, considered some of the issues related to water use, and looked ahead to the near future. He noted that the initial plants were relatively small, but that plants constructed now are larger, and therefore require more water. He discussed some of the issues surrounding the current debate, such as water value, other uses, and use efficiency. He concluded by discussing future needs including continued study of the resource, encouraging plants to consider water supply early in planning, and improving water efficiency.

Michael Yost of the Minnesota Department of Agriculture reviewed state and federal legislation affecting the biofuels industry. The federal 2007 energy bill set the target for biofuels at 15 billion gallons, an increase from the current 9 billion gallons, and authorized, but has not yet funded, subsidies, grants, and other incentives for biofuels. At the state level are energy policies and a number of initiatives and recommendations. Recommendations include an increased biofuel blending percentage, promoting a low-carbon fuel standard, considering alternative biomass production, and others.

Jim Sehl of the Minnesota Department of Natural Resources reviewed the water appropriation permitting process for large appropriators. The permit process evaluates supply sustainability, possible interferences with other users, and ground water – surface water interactions. The data needed to make these evaluations is largely provided by a resource test that is run long enough (30

Jim Sehl, DNR Waters

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2008 Spring Conference, cont.

days) and at a high enough pumping rate to adequately stress the resource. Issued permits specify maximum pumping rate and total annual volume and also require annual reporting of water use. The issued permit may also specify resource protection thresholds to assure both aquifer protection and water resource protection.

Derek Comption, University of Minnesota Extension

Derek Compton, University of Minnesota Extension Service, provided a look at farm scale biofuel production from canola seed. The pressed oil is used in biodiesel engines and heating fuel. Canola and sunflower seeds have approximately 40% oil, double that of soybeans; 1000 lb. of canola seed can produce 300 lb. of oil and 700 lb. of meal. Meal can be used to feed livestock, as well as dried and pelletized for home heating.

Ralph Groschen, Minnesota Department of Agriculture

Ralph Groschen of the Minnesota Department of Agriculture provided a history of the developing biofuel industry in Minnesota noting that in 1986 two thirds of Minnesota corn was exported. The interest in ethanol was driven by large crops, low prices, little livestock, and seasonal transportation. Encouraged by these factors and subsidies, the first small ethanol plant in Minnesota began production in 1993. Today, there are 18 ethanol plants and 23 % of the Minnesota corn crop is used in industrial processing. Energy policies, promotions, and other incentives are continuing to encourage biofuel expansion.

Nancy Kelly of the Minnesota Technical Assistance Program at the University of Minnesota provided a technical look at water and energy efficiency in ethanol production. MNTAP is pursuing benchmarking and best practices studies with Minnesota ethanol plants. Using process diagrams of water use and energy consumption Nancy pointed out the components of the process that were large users of water or energy and that are the primary targets for greater efficiency practices. She noted that water recycling in ethanol production can lead to increases in total dissolved solids in the discharge water, which can limit water efficiency.

Clarence Lehman of the University of Minnesota reviewed current research on production of native biofuels, such as prairies. He reminded us that native biofuels are not new; wood fires and hay have a very long history. However using wood for fuel releases carbon that takes 800 years to recapture into forests. He pointed out the great potential for prairie systems, especially mixed ecosystems to capture and store carbon and which also capture nitrogen. One future approach that is being investigated is biofuel buffer strips that could be both a biofuel source and a contaminant filter.

Mark Mason of Natural Resource Group, LLC discussed water use by ethanol facilities. Currently about 3-4 gallons of water per gallon of ethanol is required for the production process. The amount needed depends on the plant's design, the water supply, and the water quality. Water use may be limited by the water treatment required, either before or after production use, and whether it is process or non-process water.

Mary Savina and **Michael Griffin**, Carleton College, discussed public education issues surrounding ethanol production using a web site created by students. The students assembled existing information and worked with both community partners and professionals to develop content for the web site. One section of the site focused on water issues, including use, impacts, and other concerns. The web site, http://acad.carleton.edu/projects/ethanol/ provides an opportunity to translate the academic to the practical. The project also established a separate site www.medialab.blogs.com/our_ethanol_debate/ as a forum for discussion.

Jeff Broberg, McGhie and Betts Environmental Services, Inc., and President of the Minnesota Trout Association advocated the preservation and restoration of trout streams and other water resources in southeastern Minnesota in the face of increased ground water use for ethanol production.

MGWA members may access the speakers' presentations online at www.mgwa.org/membersonly/2008.html

Submitted by Jan Falteisek, MGWA Newsletter Team

MDH UPDATES

Health Based Value Established for PFBA

Staff of the Health Risk Assessment Unit of the Minnesota Department of Health (MDH) recommended a health-based value (HBV) for Perfluorobutyric acid (PFBA) in February, 2008. A value of 8 micrograms per liter (ug/L) was recommended for acute (1 day) exposures and 7 ug/L for each of the following: short-term (up to 30 days) exposures, subchronic (up to about 8 years), and chronic (lifetime) exposure durations.

A HBV is the concentration of a compound in water that, based on the current level of scientific understanding, poses little or no risk to human health, even if consumed daily over a lifetime. Detailed information about the development of the HBV is presented in a memorandum that is posted on the MDH web site at: www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/pfbamemo0208.pdf

MDH develops HBVs in response to requests from other Minnesota agencies that have found a contaminant in Minnesota ground water. The HBVs are developed using the same methods and assumptions utilized to develop Health Risk Limits (HRLs). HBVs are therefore similar to HRLs with one significant exception: HRLs have been promulgated as rules; HBVs have not. The HBV for PFBA is an important tool for MDH and other state and local authorities to use in managing areas with groundwater contamination by PFBA and other perfluorinated chemicals.

PFCs in Washington County: A Groundwater "Perfect Storm"

By Ginny Yingling, Environmental Health Division, Minnesota Department of Health

In 2003, the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health (MDH) began investigating what, at the time, appeared to be an isolated problem of on-site waste disposal at the 3M Cottage Grove manufacturing facility. In four short years since then, the Washington County perfluorochemical (PFC) contamination problem has become one of the largest groundwater contamination sites in the United States, covering nearly 100 square miles and affecting the drinking water of eleven communities and over 100,000 people.

PFCs are a class of chemicals that are used in a wide range of industrial applications and consumer products. Because they form stain-, oil-, grease- and water-resistant films and non-stick coatings, they have been used widely in the textile, paper, cookware, photographic, semi-conductor, telecommunications, aeronautics, and other industries and are used widely in fire-fighting foams. They were manufactured at the 3M Cottage Grove plant beginning in the 1940s.

The scale of the problem is the result of a "perfect storm" of waste disposal and water management decisions, chemistry, geology, and hydrology. In the 1950s through the early 1970s, PFC wastes were disposed of at three unlined sites in Oakdale, Lake Elmo and on the Woodbury-Cottage Grove border, and at

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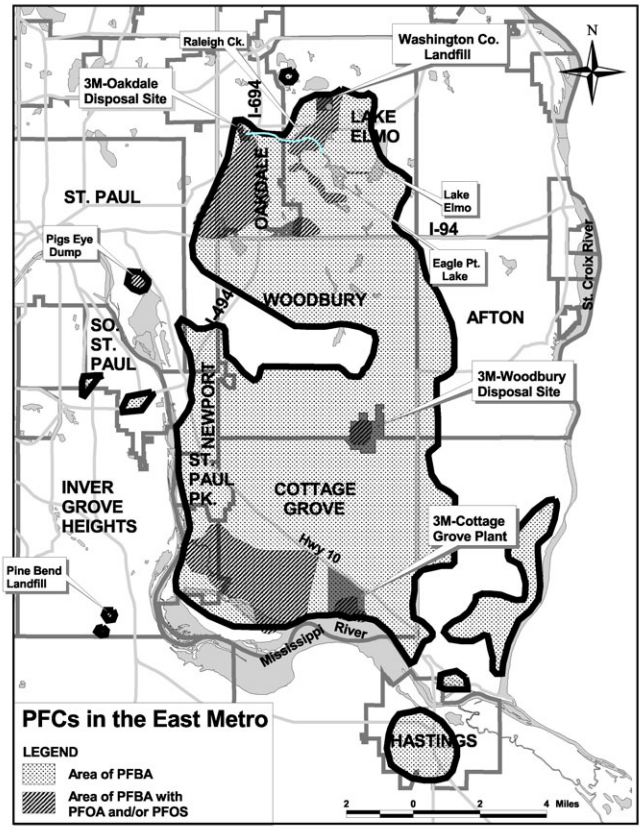

Figure 1: PFCs in the East Metro.

Washington County PFC's, cont.

several lesser sites in Ramsey and Dakota counties (see Figure 1). The main disposal areas are characterized by a shallow water table within a thin veneer of sands and gravels above sedimentary bedrock that is highly susceptible to groundwater contamination. PFCs, because of their unique chemical structure, are highly soluble, mobile and persistent. The location of the disposal sites in this portion of Washington County created an ideal setting for the PFCs to rapidly enter the groundwater and impact four major drinking water aquifers.

Structural geology of the area compounded the problem. Bedrock along the St. Croix and Mississippi rivers is fractured in a series of northeast-southwest trending faults that have as much as 150 feet of vertical displacement, placing normally protected units like the Franconia Sandstone into direct contact with overlying formations. The bedrock is also transected by numerous buried valleys that play a significant role in local groundwater flow. Solution cavities, or karst features, in the Prairie du Chien Group, and even in the St. Peter and Jordan Sandstones (particularly near the bedrock valleys), provide yet another set of potential flow paths that complicate groundwater and contaminant movement.

The hydrologic setting, both natural and manmade, adds yet another layer of complexity. South Washington County is bounded to the east by the St. Croix River and to the south and southwest by the Mississippi River. The groundwater divide that separates these two major watersheds is located immediately east of the Washington County Landfill and runs under the eastern edge of the 3M-Woodbury Disposal Site. Near the convergence of the two rivers, near Hastings, and south of the Woodbury Disposal site, groundwater "fans out" and flows southeast, south, and southwest.

Shallow groundwater at the Oakdale site discharges to a surface water, known as Raleigh Creek, and flows eastward to Lake Elmo, where it either discharges to Eagle Point Lake inside the Lake Elmo Park Reserve or infiltrates again into the groundwater (all noted on Figure 1). PFCs do not biodegrade or photo-degrade or volatilize and so they travel this same pathway relatively unaltered aside from dilution. Also, from 1988-1995, solvent-contaminated groundwater extracted from the Washington County Landfill was discharged to a storm sewer that feeds into Raleigh Creek, carrying a large load of PFCs that nobody knew was there at the time. Eagle Point Lake, the discharge point of Raleigh Creek, used to overflow to Lake Elmo at times of flooding. The movement of PFCs through the surface water system and back again into the groundwater has allowed them to migrate far to the southeast of the Oakdale and Lake Elmo sites and across the groundwater divide, even though the regional groundwater flow is to the south-southwest.

This complex picture of the geology and hydrogeology of south Washington County has been pieced together through a massive public and private well sampling effort by MDH and MPCA, site investigations by 3M and MPCA, detailed geological investigations by the Minnesota Geological Survey (MGS), and hydrologic evaluations by Barr Engineering. The MPCA and Washington County played a major role in enlisting both MGS and Barr to do much of the assessment work. The work of the MGS in particular allowed MDH and MPCA to carefully tailor their sampling programs, especially near the Woodbury disposal site, and is providing MPCA with detailed information to site monitoring wells in Lake Elmo.

To date, over 1,500 city, commercial, and private wells have been sampled in the eleven affected communities. From this sampling, MDH and MPCA have developed a fairly good understanding of the extent and magnitude of the contamination and have implemented a number of actions to protect public health and the environment. The major findings include:

- Perfluorobutanoic acid (PFBA) is the most prevalent of the PFCs, creating a widespread, low concentration plume (< 2 parts per billion, or ppb) that originates at the Oakdale and Lake Elmo sites, merges with a plume of PFBA associated with the Woodbury site, and extends all the way to the Mississippi and southern St. Croix rivers.
- Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are much less widespread, affecting relatively small areas of Lake Elmo and Oakdale and an isolated portion of Cottage Grove.
- The area of Cottage Grove (south of Highway 10 and west of the 3M plant) where PFOA and other PFCs are present may be the result of an additional source, which the MPCA is currently investigating.
- The highest levels of PFC contamination are located on and immediately downgradient of the disposal sites, immediately downgradient of Raleigh Creek and Eagle Point Lake, and along the major faults and bedrock valley that are located south of the Woodbury disposal site.
- All four of the major aquifers – St. Peter, Prairie du Chien, Jordan, and parts of the Franconia – have been affected.
- Sampling to date indicates that all of the PFC plumes are stable in concentration and size.

When well sampling began in 2004, MDH had established Health Based Values (HBVs) of 1 part per billion (ppb) for PFOS and 7 ppb for PFOA, the only PFCs in groundwater for which MDH was able to analyze. In 2006 those values were lowered to 0.3 and 0.5 ppb, for PFOS and PFOA, respectively, and promulgated as Health Risk Limits (HRLs) in 2007. Also in 2006, MDH's laboratory expanded its analytical list to include PFBA and four more PFCs. Without sufficient scientific research on which to base an HBV or HRL, a conservative "drinking water guideline" of 1 ppb for PFBA was established in May 2006. Using these values, by the end of 2007, drinking water advisories had been issued to 166 homes in Lake Elmo, 1 home in Oakdale, and 29 homes in Cottage Grove-Grey Cloud Island Township. In February 2008, based on studies completed in 2007, MDH issued an HBV of 7 ppb for PFBA. This higher value for PFBA means that many of the homes previously issued a well advisory no longer need to avoid use of their water, but no decision has been made by MPCA regarding the final disposition of systems already installed in those homes.

Three city wells in Oakdale also exceed state drinking water standards for combined PFC concentrations. Two of the wells are being treated with a municipal granular activated carbon (GAC) filter system built with funds from 3M. The third well was taken out of service and the city is working with MDH to locate a new, clean well north of the PFC contamination. MDH

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Engineers Without Borders: Making A Difference Around the World

Jeremiah Jazdzewski, Engineers Without Borders, University of Minnesota

A spring box for a community in the jungle of Guatemala, a solar-powered pump for a school in remote Ghana; a rainwater-harvesting system for an orphanage in rural Uganda - what do these things have in common? They are all projects completed by the University of Minnesota chapter of Engineers Without Borders (EWB-UMN) within its 3-year existence.

EWB-UMN is a volunteer student group, comprised of more than 50 highly motivated students encompassing all engineering disciplines as well as a variety of other fields. Their mission is to partner with disadvantaged communities around the world, and to improve their quality of life through the implementation of engineered projects that prove environmentally, economically, and culturally sustainable.

One of the biggest issues facing developing countries is the lack of clean, dependable water and proper sanitation. EWB-UMN has focused much of its efforts towards bringing clean drinking water and sanitation to the communities with which they partner. In January of 2007, an EWB-UMN project team traveled to Comalapa, Guatemala, to install a spring box, submersible pump and water distribution system. The result is a continuous supply of clean water to a village of about 600. A second project team has recently returned to Guatemala to begin addressing the water supply needs of a neighboring village of more than 2000.

In the summer of 2006, EWB-UMN sent an assessment team to Ghana to investigate options for bringing clean water and sanitation to the Minnesota Academy, a school in rural Ghana serving almost 500 students. Throughout the 2006-2007 school year, EWB-UMN members worked with a professional mentor and a capstone design class developing plans for a solar-powered system that would draw water from a borehole near the school. Last summer, six students and the project mentor traveled to Ghana and implemented the designs with the help of the school and local villagers.

While one group was implementing their water project in Ghana, another EWB-UMN group was conducting an assessment for a water project for an orphanage and vocational school in rural Uganda. Working with professional mentors throughout the past 9 months, the group designed a rainwater harvesting system that will provide water for 500 students. The group will also address the sanitation needs of the facility with the design of a new eco-sanitation toilet system. The group will travel this June to implement their design.

In August 2007, University of Minnesota students built a solar-powered well pump and water tower in Ghana as part of the Engineers Without Borders program.

Engineers Without Borders projects combine a high level of creativity with a unique style of field engineering. The conditions presented to the students while in country teach project management at a level not possible through traditional coursework. The projects challenge the students to think critically about sustainable and integrated engineering in a global environment.

EWB-UMN is always looking for professional mentors, equipment and financial support. Connecting mentors with students through EWB-UMN offers students the opportunity to work with professionals within their field, and offers companies the chance to meet some of the brightest and most motivated up-and-coming engineers. For more information and a chance to get involved, visit www.tc.umn.edu/~ewb/

Washington County PFC's, cont.

has also worked with Woodbury and Cottage Grove as they seek to expand their city water systems.

Meanwhile, MPCA and 3M have conducted additional investigations at all of the sites, including the Cottage Grove facility, and will be presenting the proposed remedies at a series of public meetings this spring. All of the sites already have groundwater extraction systems in place, which have helped to contain some of the PFCs on-site. While differing in specifics, the proposed remedies all involve some excavation of waste and soil and upgrades to groundwater extraction systems. The Cottage Grove facility cleanup will also include contaminated sediments in a shallow cove on the Mississippi River where the plant wastewater discharged.

For the foreseeable future, MDH and MPCA will monitor PFC concentrations in private and public wells. On-going sampling will be geared toward monitoring the size, shape, and concentration of the plumes. If changes are noted, the sampling program will be modified to track those changes and ensure that public health is protected. Looking forward, MDH established a Special Well Construction Area (SWCA) for the affected portions of Lake Elmo and Oakdale. New wells drilled in that area must draw from the Franconia Sandstone and will require special permitting and oversight by MDH during their construction. One new Franconia well has been drilled in Lake Elmo and tested clean.

For more information on these and other PFC investigations, please visit these websites:

www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html

www.pca.state.mn.us/cleanup/pfc/index.html

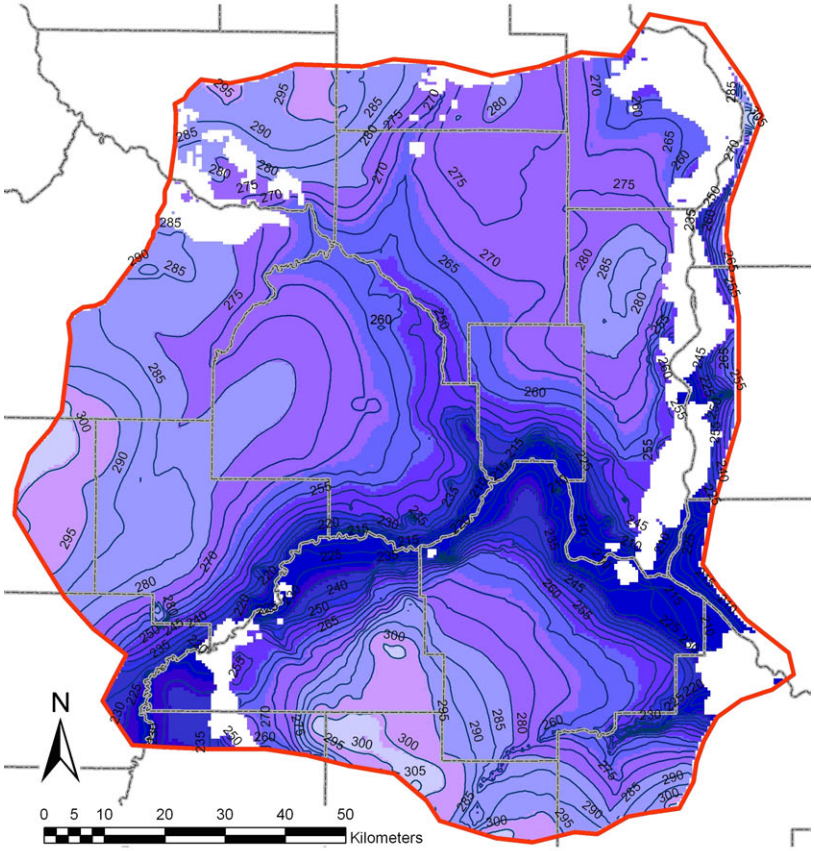
Groundwater Model to Aid Metropolitan Area Comprehensive Planning, Water Supply Management

By Lanya Ross, Metropolitan Council

The December 2007 25th Anniversary Issue of the MGWA Newsletter hinted at the Metropolitan Council's (Council) update of the Minnesota Pollution Control Agency's (MPCA) Metro Model. Consider this technical update more of a tease.

While the "final" product is still months away, a working, calibrated final draft of the Council's new regional groundwater flow model is available for download and use. Only minor changes are expected before the end of the year, and Council staff would welcome any input to help improve the model. Model files can be downloaded from the Council website at: www.metrocouncil.org/environment/WaterSupply/metrogroundwatermodel.htm.

The Council's regional flow modeling project began in late 2006 with the goal of developing a tool that can be used to assess water supply availability across the seven county metropolitan area as part of regional planning (www.metrocouncil.org/environment/WaterSupply/). Barr Engineering Company was contracted to construct and calibrate an updated Metro Model. Their modeling staff include Ray Wuolo, Evan Christianson, and Tim Brown. This new model is actually comprised of multiple models that will be applied to problems at a variety of scales. These models were specifically designed to help answer questions such as:



Calibrated regional model calculation of the long-term average potentiometric surface in model layer 3, which generally corresponds to the Prairie du Chien Aquifer. White areas denote cells which are inactive in this layer. Elevation units are meters above mean sea level.

- What is the likely maximum pumping capacity of a proposed wellfield or well?
- What will the drawdown be from a proposed well or wellfield, and what existing wells might be impacted?
- What will groundwater levels be in the future, given projected water demand?
- How will pumping affect important ecological resources such as calcareous fens and trout streams?
- How might land use and development patterns affect recharge and groundwater levels?
- How might climate change impact recharge and groundwater levels?

As much a translation as an update, one notable difference between the Council's Metro Model and the MPCA's earlier Metro Model is the use of the finite difference MODFLOW code instead of Multi-Layer Analytical Element Model (MLAEM) code. Other significant differences include the use of a new method for recharge estimation and the inclusion of additional model layers to represent previously combined aquifers such as the Prairie du Chien-Jordan aquifer as individual aquifers, in this case as the discrete Prairie du Chien and Jordan aquifers.

A technical advisory group has been convened to provide feedback periodically throughout the model development process and over 30 staff from several local, state and federal agencies are participating. The next meeting is scheduled for June 19, 2008. If you are interested in attending, please contact Lanya Ross, Metropolitan Council, for more information. Minutes and presentations from previous meetings can be found on the Council's website www.metrocouncil.org/environment/WaterSupply/metrogroundwatermodel.htm.

The new Metro Model has already begun to demonstrate its value. For example, the calibrated regional model has been used to support the DNR selection of new monitoring well locations. The regional model has also been refined to address sub-regional water availability issues in the northwest metropolitan area, chiefly how 2050 projected water demand might be accommodated by drilling new wells and the likelihood of this future pumping impacting aquifer levels and surface water features.

Information provided by the regional and sub-regional models is a critical component in the Council's development of a regional water supply master plan. This plan will be completed at the end of 2008, but it is not intended to be a static document. Instead, the Council intends the plan to be an iterative process for evaluating supply availability issues and options that will guide growth sustainability into the future.

A Research Agenda for the National Map

A nationally consistent geospatial framework is being developed by the United States Geological Survey (USGS) to serve a broad range of uses by scientists, communities, government officials, and the public. Called The National Map, the project was the focus of a recent report by the National Research Council (NRC) of the National Academies. The report, A Research Agenda for Geographic Information Science at the United States Geological Survey, advocates the integration of data from state and local agencies into a consistent, national framework as a unique feature of The National Map that distinguishes it from other online geospatial data sources.

One element of The National Map that would be of interest to groundwater practitioners - the National Hydrography Dataset (NHD) - is an example of a nationally standardized dataset that is not available from any other online geospatial data source. The NHD was built, and is beginning to be maintained, in partnership with its users who understand the local hydrography and who also require precise, current data to meet their business needs. These contributing partner stewards manage data maintenance activities in their geographies while the USGS facilitates the overall process, providing national coordination, standards, training, quality assurance, archival, and data distribution.

The NRC study calls for further research to advance automated integration, fusion, and generalization of data at widely varying scales, resolutions and qualities. The report also calls for new high priority research in user-centered design of Web map interfaces, re-invention of topographic maps in electronic form, and robust data characterization that conveys geographic context.

The NRC report is available online for free download at www.nap.edu/catalog/12004.html.

submitted by Eric Tollefsrud, AMEC Geomatrix Consultants, Inc.

Minnesota Statewide Conservation and Preservation Plan (SCPP) Update

A consortium of the University of Minnesota Institute on the Environment, Bonestroo Consulting and CR Planning continues to make progress toward the goal of completing a statewide conservation and preservation plan for Minnesota by July 2008. Funded in part by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) through the Environment and Natural Resources Trust Fund, the project has been ongoing since early 2007. A Preliminary Plan was delivered to the LCCMR in July 2007, and is posted on the University of Minnesota web site at: http://environment.umn.edu/scpp/progress.html

The Institute on the Environment is seeking public input to the Preliminary Plan through forums being held around the state. The purpose is to engage the public in helping to finalize recommendations of the SCPP and to facilitate collaboration around the issues and trends addressed in the plan. The Ground Water section of the plan identifies four key "drivers of change":

- Hydrologic Modification
- Consumptive Use
- Contaminant Loading (with focus on pesticides)
- Nutrient Loading

To participate and to submit comments, visit the web site listed.

The Interstate Technology Regulatory Council web based environmental technologies resource

Among the many web-based information sources available for scientists working in the area of contaminated groundwater and groundwater remediation is the Interstate Technology Regulatory Council, or ITRC. Established in 1995, IRTC is a state-led coalition working with industry and stakeholders to achieve regulatory acceptance of environmental technologies, including those for groundwater. Tom Higgins at the Minnesota Pollution Control Agency is the ITRC contact for the MPCA. The ITRC provides relevant web-based training and guidance documents for groundwater investigation (e.g., construction of direct-push wells), groundwater sampling (e.g., use of passive sampling devices), remediation (e.g., in-situ chemical oxidation, permeable reactive barriers, enhanced attenuation of chlorinated solvents, and remediation process optimization among others). For more information, visit the ITRC website at www.itrcweb.org

submitted by Eric Tollefsrud, AMEC Geomatrix Consultants, Inc.

Ground Water Nitrate Contamination Costs in Minnesota

Four local researchers published an article in the current Journal of Soil and Water Conservation. Their research involved surveying 800 private well owners in the central sand plains of Minnesota. Sixty percent of recipients returned surveys and were sent water sampling kits. Of these, 77 percent were returned. About six percent of the samples contained nitrate levels above the standard of 10 mg/L. Less than one-third of the respondents had tested their well water for nitrate within the past three years. Average remediation costs were $190/year to buy bottled water, $800 to buy a nitrate removal system plus $100/yr for maintenance, and $7,200 to install a new well. Where nitrate-nitrogen exceeded 10 mg/L, 24 percent of well owners bought bottled water, 21 percent installed treatment systems, 24 percent installed a new well, and 31 percent took no action. For reference: A. M. Lewandowski, B. R. Montgomery, C. J. Rosen and J. F. Moncrief, 2008, Groundwater nitrate contamination costs: a survey of private well owners, JSWC 63(3)153-161.

Ann Lewandowski is a research associate and Carl Rosen and John Moncrief are professors in the Department of Soil, Water and Climate at the University of Minnesota, and Bruce Montgomery is a soil scientist for the Minnesota Department of Agriculture.

MDH Releases Drinking Water Report for 2007

The Minnesota Department of Health (MDH) released its annual drinking water report in May. MDH is the lead agency in administering the Safe Drinking Water Act in Minnesota, and this report presents the result of its various activities in 2007 to protect public drinking water supplies. Protection efforts in 2007 involved a series of complementary programs involving prevention, treatment, and monitoring.

The drinking water annual report includes test results for 726 city water systems throughout the state. Also included were 239 non-municipal systems that provide drinking water to people in their place of residence, in locations such as manufactured home parks, apartment buildings, housing subdivisions, colleges, hospitals, prisons, and child care facilities.

Monitoring test results for 2007 tend to reinforce the conclusions of previous years. Generally, the quality of Minnesota's drinking water is very high, but there are systems for which individual water quality issues are a concern. The full report is available at: www.health.state.mn.us/divs/eh/water/com/dwar/report07.html

The Lake Elmo Downhole Logging Project

Minnesota Geological Survey (MGS) Open File Report 07-5 "The Lake Elmo Downhole Logging Project: Hydrostratigraphic Characterization of Fractured Bedrock at a Perfluorochemical Contamination Site" is available from the MGS. The report documents the efforts of MGS staff to characterize bedrock properties and groundwater flow in an area where numerous private wells had been contaminated with perfluorinated compounds (PFCs). As part of the effort, MGS staff collected downhole geophysical data from nearly 200 domestic wells, most of which extract water from either the lower St. Peter Sandstone or the upper Shakopee Formation. The downhole data helped to characterize intrinsic rock properties and associated groundwater flow conditions in the stratigraphic intervals to which the wells were open.

New USGS Publications

The May/June issue of Journal of Environmental Quality features in-depth USGS investigations in five agricultural watersheds across the U.S.

Findings highlight how natural environmental processes and agricultural practices interact to determine the transport and fate of agricultural chemicals in the environment. The holistic study design focuses on the catchment scale and addresses several environmental compartments, including surface water, ground water, the unsaturated zone, the streambed, and the atmosphere. The study areas were selected to represent major agricultural settings and, therefore, findings are relevant throughout much of the nation.

The papers can be accessed at:

http://jeq.scijournals.org/content/vol37/issue3/. Click on "Special Submissions."

Crow Wing County Geologic Atlas, Part B, now available

Ground water and pollution sensitivity maps for Crow Wing County are now available on-line in PDF format. The maps are part of the Crow Wing County Geologic Atlas, Part B, recently published by the Department of Natural Resource, Division of Waters (DNR Waters). The atlas includes three plates of maps, cross sections, and other information that describe ground water systems of the area. The atlas also includes a plate that discusses the interaction of the lakes and ground water of the county. This atlas joins the previously published portion of the report, Part A, prepared by the Minnesota Geological Survey that contains five map plates describing the surficial and bedrock geology of the county. Access to data for both parts A and B is available through the link www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/crowcga.html. Paper copies are available through Crow Wing County Planning and Zoning (218-824-1125) and the Minnesota Geological Survey map sales office (612-627-4782). Data files and geographic information system (GIS) layers for the Part B report will be available on-line soon. Data files and layers for the Part A report are available on-line and may be downloaded from ftp://mgssun6.mngs.umn.edu/pub3/c-16/. For the status of other counties see www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html.

For more information contact Jan Falteisek at (651) 259-5665 or Todd Petersen at (651) 259-5698.

submitted by Jan Falteisek, MGWA Newsletter Team.

Hydrology Prior to Wetland and Prairie Restoration in and around the Glacial Ridge National Wildlife Refuge, Northwestern Minnesota, 2002 - 2005

Scientific Investigations Report No. 2007-5200, 2008, Cowdery, Timothy K.; Lorenz, David L.; Arntson, Allan D., USGS Minnesota Water Science Center, vi, 68 p

The Nature Conservancy (TNC) owned and managed 24,795 acres of mixed wetland, native prairie, farmland and woods east of Crookston, in northwestern Minnesota. The original wetlands and prairies that once occupied this land are being restored by TNC in cooperation with many partners and are becoming part of the Glacial Ridge National Wildlife Refuge. Results of this study indicate that these restorations are likely to have a substantial effect on the local hydrology.

Water occurs within the study area on the land surface, in surficial aquifers, and in buried aquifers of various depths, the tops of which are 50 to several hundred feet below the land surface. Surficial aquifers, former beaches of Lake Agassiz (Figure 1, page 14) are generally thin (about 20 feet), narrow (several hundred feet), and long (tens of miles). Estimates of the horizontal hydraulic conductivity of surficial aquifers were 2.7–300 feet per day. Buried aquifers underlie much of the study area, but in-

continued on page 14

Glacial Ridge Project, cont.

teract with surficial aquifers only in isolated areas. In these areas, water flows directly from buried to surficial aquifers and forms a single aquifer as much as 78 feet thick. The surface-water channel network is modified by several manmade ditches that were installed to remove excess water seasonally and to drain wetlands. The channels of the network lie primarily parallel to the beach ridges but cut through them in places. Back-beach basin wetlands delay and reduce direct runoff to ditches.

Recharge to the surficial aquifers (10.97–25.08 inches per year during 2003–5) is from vertical infiltration of rainfall and snowmelt (areal recharge); from surface waters (particularly ephemeral wetlands); and from upward leakage of water from buried aquifers through till confining units (estimated at about 1 inch per year). Areal recharge is highly variable in space and time. Water leaves (discharges from) the surficial aquifers as flow to surface waters (closed basins and ditches), evapotranspiration, and withdrawals from wells. Unmeasured losses (primarily discharge to ungaged (closed) basins) were 53–115 percent of areal recharge during 2003–5, while discharge to ditches that leave the study area was 17–41 percent. Discharge over 100 percent of areal recharge indicates a loss in ground-water storage. During the dry year of 2003, substantial ground water (about one-third of annual areal recharge) was released from aquifer storage but was replenished quickly during the subsequent normal year. Shallow ground-water flow is complex, with water in surficial aquifers, ditches, and wetlands part of a single hydrologic system. The ages determined for surficial ground-water samples were less than 15 years old, and one-third (8 of 24) were less than 5 years old, substantiating the close connection of surficial ground water to the land surface.

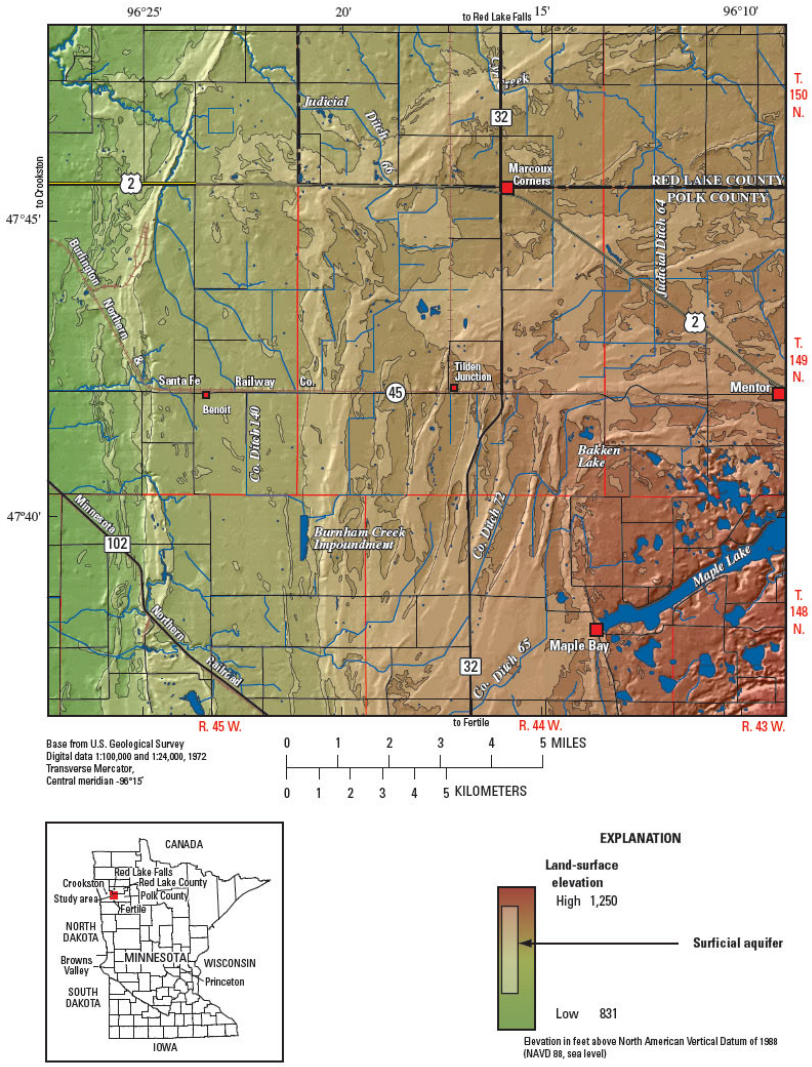


Figure 1: Topography and surficial aquifer extent, Glacial Ridge study area, northwestern Minnesota

During the study, 68–81 percent of water left the area through unmeasured surface-water losses (primarily evapotranspiration), which is 2- to 4-times that leaving through the ditch system. Base flow in ditches (ground-water discharge) was 30 to 71 percent of all ditch flow. Mean annual runoff in all gaged basins except SW3 (2.26 inches per year) was similar (3.69–4.12 inches per year).

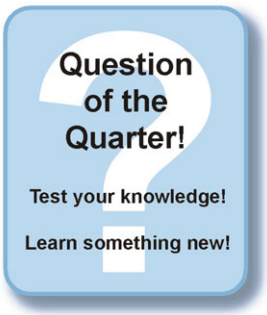
The quality of water samples from surficial aquifers and surface water collected in the study area was generally suitable for most uses but was variable. Most ground- and surface-water samples were dominated by calcium, magnesium, and bicarbonate ions. About one-quarter of surficial ground-water samples contained nitrate at concentrations greater than the U.S. Environmental Protection Agency's (USEPA) Maximum Contaminant Level for human consumption. The median concentration of dissolved phosphorus ranged from 0.0108 milligrams per liter as phosphorus (mg/L-P) to 0.0293 mg/L-P. Nutrient concentrations in ditches were generally above the USEPA nutrient guidelines for reference streams in the area. Water samples contained detectable concentrations of atrazine, acetochlor, metolachlor, pendimethalin, prometon, and terbutryn in 11 of the 19 degradates analyzed. In general, degradates were found more frequently and at higher concentrations than were the parent herbicides. No herbicide or degradate was detected in water samples from buried aquifers, reflecting the protection that clay-rich confining units afford these aquifers.

The restoration of wetlands and prairies in the study area likely will result in more water retained on the land and improved water quality. Increased water retention could raise ground-water levels, but the rise likely would be very local and short-lived. Restorations likely would substantially change ditch-flow characteristics in the study area, but the changes would be insubstantial further downstream. Reduction in agriculture should result in a net decrease in nutrient and pesticide load to the study area.

Effects of the wetland and prairie restorations could be measured in the future, when restorations are complete and the hydrologic system has had time to equilibrate. A comparison between a future assessment and the one documented in this report would quantify the hydrologic changes resulting from wetland and prairie restorations in the Glacial Ridge study area.

The report is available at http://pubs.usgs.gov/sir/2007/5200/pdf/sir2007-5200.pdf.

QUESTION OF THE QUARTER



Subsurface life: How deep is it?

In the March 2008 issue of the Newsletter we challenged your knowledge of subsurface life in Minnesota ground waters by asking the following question:

How deep can microbial life be found in Minnesota ground waters?

a) 16 inches
b) 16 feet
c) 16 meters
d) 16 rods
e) 16 kilometers
f) 16 miles

The answer is revealed in the following article (page 16) prepared by Scott Alexander, Department of Geology and Geophysics, University of Minnesota and also the current MGWA President-Elect. (Hint: For those of you that just can't wait, the answers are e) almost certainly 16 kilometers in the Mid-Continent Rift valley of eastern and southern Minnesota and f) possibly as much as 16 miles in the continental crust that underlies all of Minnesota. Read on for details.)

Email your suggestons for new questions to: editor@mgwa.org

Microbiology of Minnesota Ground Waters and Beyond

Scott C. Alexander, Department of Geology & Geophysics, University of Minnesota

Introduction

Hydrogeologists have always made simplifying assumptions about the flow of ground water. As our knowledge and understanding of the subsurface environment improves these assumptions have been frequently challenged. Up until the early 1960's the dissolved solid load was considered unimportant unless you were dealing with dense brines (Meinzer, 1923). By the end of the 1960's most hydrogeologists understood that the water chemistry, of even dilute waters, could have large effects on the hydrology. Dilute waters may dissolve cements thus increasing permeability or saturated waters can deposit additional cements that clog the formation.

More recently hydrogeologists have come to understand that the simplifying isotropic and homogeneous assumptions are not always valid. Heterogeneities within aquifer materials, from relatively minor up to outright discontinuities, as at fractures and conduits, decidedly alter the overall aquifer permeabilities (Runkel et al, 2003).

One of the major realizations by scientists of the last decade is that the bulk of life on planet Earth is not located in the surficial environment. Human experience is very familiar with, and largely subsists on, the biomass emerging from the soil zone and extending to the treetops. Similarly, it was assumed most of the world's ocean productivity was based in the photic zone, or the depth to which sunlight can penetrate. What we are now realizing is that microbial life extends deep into the subsurface and is independent of solar energy. While modern plants and animals that evolved at the start of the Cambrian appear to dominate the surface, microbial life is still the dominant life form on Earth (Gorbushina, 2007). Microbial single-celled life forms dominate in terms of mass and overwhelmingly in terms of biological diversity. In fact, "overwhelmingly" grossly understates this dominance. It is estimated that there are a billion times more bacteria on Earth than stars in the sky (Curtis et al, 2007).

The reason life first evolved in the Earth's subsurface is that in many ways it is a much friendlier environment. Early on in Earth history there was frequent bombardment by meteorites and intense UV radiation at the surface. The subsurface represented a much more stable environment with relatively constant temperatures and numerous sources of chemical and thermal energy. Beyond the basic need for water we know four essential things about life on Earth: 1) Life is tough (extremophiles), 2) Life is tenacious (long survival times), 3) Life is metabolically diverse (it eats anything, breathes anything!), and 4) when conditions get tough, life moves inside the rocks! (J. Gralnick, personal communication).

The three main branches of life can be divided into single-celled bacteria and archaea and multi-celled eucarya as shown in Figure 1. The bacteria are by far the oldest life forms on Earth followed closely by the archaea. The eucarya, which includes plants and animals, are the relative newcomers. Archaea were only recognized as a distinct biological group in 1977 and their

continued on page 17

Subsurface Life, cont.

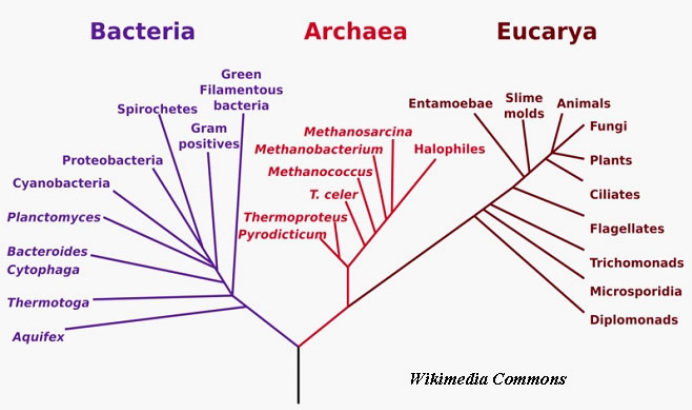


Figure 1. Phylogenetic Tree of Life (from Wikimedia Commons).

assignment to entire domain, as in Figure 1, has occurred within the last ten years (en.wikipedia.org/wiki/Archaea).

Microbiology in the Minnesota subsurface

Minnesota, located in the middle of the North American Continent, has a thick crustal environment. Some of the thickest accumulations of sediment occur in the Mid-Continental Rift Valley, which can be seen in Figure 2 extending across Minnesota and Iowa. This geology creates two main deep crustal environments.

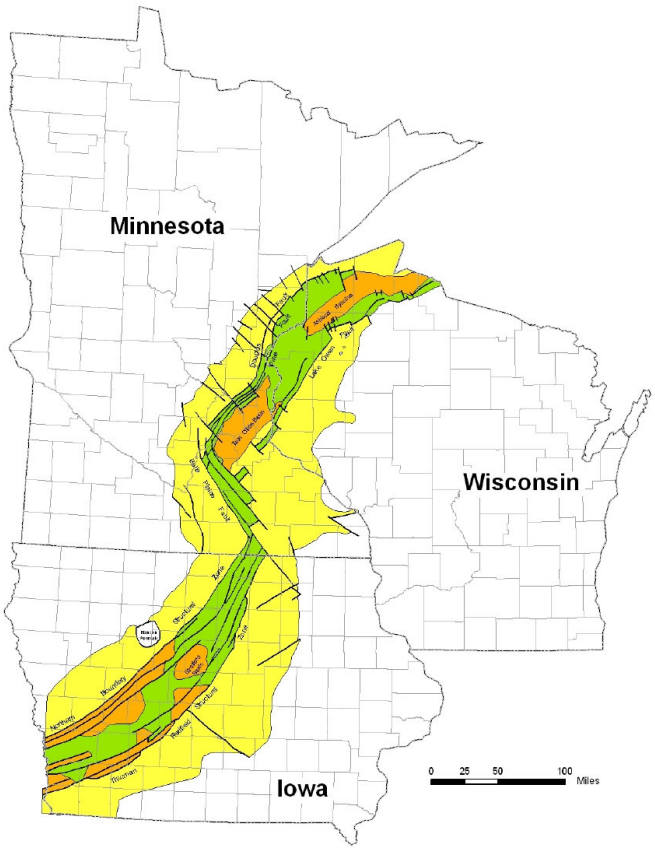


Figure 2. Extent of Midcontinent Rift rocks in Minnesota, Iowa, and Wisconsin, sandstone-dominated Bayfield Group in yellow, more gravel-rich Oronto Group in orange, and volcanic rocks in green from Chandler et al (1989).

The first are igneous and metamorphic terrains of the Canadian Shield and the second are Rift Valley basalts with interbedded sediments. Within the thick continental crust of the Canadian Shield liquid water, and associated microbiology, may persist at depths upwards of sixteen miles.

Geophysical modeling by Allen (1994) suggests the Rift Valley in Minnesota may be as deep as ten miles (sixteen kilometers). This package of interbedded sediments and basalts creates pathways for water to permeate the rock formations. Liquid water being the only true limit on the range of life on Earth, the entire Rift Valley is almost certainly infested with bacteria and archaea. Access to these environments, however, is relatively difficult. Within the Minnesota portion of the rift valley there are only a dozen wells deeper than 2,000 feet and none deeper than 4,000 feet (Thorleifson, 2008). Microbial life in Minnesota therefore probably extends to depths of at least 16 kilometers and may reach depths of 16 miles.

Fortunately we do have good access to the relatively deep subsurface at one Minnesota location courtesy of the Department of Natural Resources. The Soudan Underground Mine State Park near Ely, Minnesota, provides an easy descent to the 27th level of the mine 2,341 feet below the surface. The Soudan iron mine was actively mined into the 1960's for its high-grade iron ore to make specialty steels. Over the last 25 years scientists from the University of Minnesota have also utilized this deep environment to conduct experiments in high energy physics (www.soudan.umn.edu). Efforts to expand the current scientific research brought together geologists from the Natural Resources Research Institute in Duluth, hydrogeologists and microbiologists from the University of Minnesota along with numerous scientists from around the U.S.

The Soudan mine is generally referred to as a "dry" mine (Brady, 2008). To a mining engineer, this means that they are not pumping out millions of gallons per day. Further investigation led to the admission by mine staff that there are a "few drips and seeps" throughout the mine workings. Most of the infiltrating water is drained off via adits in the upper levels. At depth, these drips and seeps add up to several thousand gallons per day over the nearly one mile length of the 27th level. And more interestingly from our new perspective, we know that where there is liquid water there will be life.

Figure 3 is a photo of a feature called "the bubbler" which is found at the end of the 27th West Drift. The round object in the center of the photo is a wooden plug placed into the top of an angled diamond drill hole (DDH). This was an exploratory borehole for planning a potential 28th level of the mine. The water emerging from this borehole is highly reduced explaining the black color surrounding the plug. This reduced iron-rich water is rapidly oxidized producing bright orange iron hydroxide minerals. The bubbles have a significant component of methane gas. Samples collected for modern genetic testing revealed abundant and diverse microbial life in both the black, reduced sediments and the oxidized orange sediments (Edwards et al, 2006). Chemical analysis for major cations and anions revealed that these waters are more than twice as salty as seawater, representing a calcium-sodium-chloride brine. Calcium-chloride brines have been frequently reported from deep continental shield areas but

continued on page 18

Figure 3. "The bubbler" at end of 27th West Drift (photo by S.C. Alexander).

their formation is poorly understood at present (Fritz et al., 1994).

As these waters seep into the mine drift they drain down-drift towards a collection sump near the hoist shaft. In Figure 4 you can see additional reduced water flowing from a second, more vertical borehole (note the remnants of a rusty pipe around the pH electrode), which then strongly interacts with oxidized water flowing from the left. Where these reduced and oxidized waters mix the disparate microbial communities battle for supremacy creating a polysaccharide-rich foam of dead cellular materials forming bubbles in the middle of the photo and a light colored mass on the right. The inset photo in Figure 4 is a Scanning Electron Microprobe (SEM) photo of microbes cultured from this second borehole. An interesting note is that many of the species present at this site are from the *Marinobacter* family, which, as the name implies, are marine bacteria. Either these ocean-going

Figure 4. 27th West Drift below "The Bubbler" (photo by S.C. Alexander, inset photomicrograph by R. Lesniewski and J. Gralnick, Dept. of Microbiology, University of Minnesota.).

bacteria have traveled a long way from home or they have been living in the area of the Soudan Mine for a very long time. Remember that the iron formations of northern Minnesota were originally shallow marine stromatolitic deposits. This persistence over hundreds of million or billions of years is due in some part to the slower pace of life in the subsurface. The life of a single-celled microbe from division of a parent to division of itself may be measured in years and decades instead of seconds and minutes. The implication here is that *Marinobacter* living in a billion-year-old terrain have undergone an enormously smaller number of cell divisions than their relations living the fast life in high-energy surface environments. They are literally the great^{n}-grandparents of surface organisms where the exponent n is some unimaginably large number. This would be akin to discovering some living dinosaurs except these microbes could be genetically much older even than dinosaurs.

Perhaps it should not be a surprise that various iron minerals are being deposited at the bottom of an iron mine. However, iron is an excellent electron donor and receptor that produces energy for a wide range of iron oxidizing and iron reducing microbes. Figure 5 is an SEM photo illustrating the biological materials produced by some of these microbes from DDH 951. The entire surface is draped with ferrihydrite filaments composed of chains of small spherules. Ferrihydrite (Fe_2O_32 ● $FeOOH2$ ● $6H_2O$) is

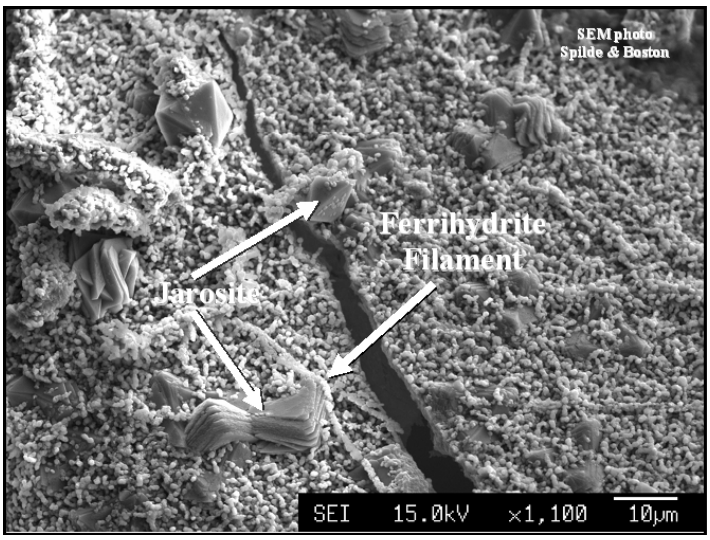


Figure 5. SEM photo by Spilde and Boston of biological residues

a metastable nanocrystalline mineral that is found throughout the surficial and sub-surface environment. Because ferrihydrite is unstable, easily re-crystallizing into hematite or goethite, it must be constantly replenished to maintain its ubiquity. The other mineral of note in Figure 5 is jarosite ($KFe^{(III)}_3(OH)_6(SO_4)_2$) which forms nice octahedra and more platy crystals.

Figure 6 shows the effects of a slow seep of very reduced waters from a horizontal borehole (DDH 962) on the 27th East Drift. As

continued on page 19

Figure 6. Ferrihydrite drapery and rimstone dams at DDH 962, 27th East Drift.

at the bubbler, there is probably a wooden plug driven into the end of borehole that has allowed a slow seepage of water since the hole was completed in 1961. Water seeping past this plug has created a drapery-like structure on the wall and a series of rimstone dams on the floor. An old iron pipe lying on the floor has interrupted the rimstone dam formation on the left side of the image. Typical cave formations in carbonate rocks are composed of calcite or aragonite while these are composed largely of ferrihydrite. Similarly, most terrestrial rimstone dams, like those of Mammoth Hot Springs in Yellowstone National Park are composed of carbonate minerals. The basic process of rimstone dam formation, whatever the mineralogy, depends on flowing water. Where there is rapid flow, and turbulence, de-gassing of the mineral rich fluid leads to precipitation. The precipitating solids create a self-leveling mechanism that fills in the low spots eventually allowing a large dam to form.

Everywhere we as scientists have had access to the subsurface environment and taken a serious look at the microbiology, be it in the form of a well borehole, underground mine, cave or bedrock outcrop we have found strong evidence of microbial life. The implications of persistent and pervasive microbiology are just beginning to be explored. Current work outlined by Horner-Devine and Martiny (2008) explore the formerly under-appreciated role of bacteria and archea in the global nitrogen cycle.

Subsurface Microbiology Beyond Minnesota

While these are important and exciting results there is a whole world of interest beyond the Soudan Mine. In particular, there is growing evidence for persistent liquid water on the planet Mars. Figure 7 is an image from the Mars Orbital Camera capturing a series of gullies flowing down a crater wall. At the foot of the slope, in the dashed ellipsoid, is what appears to be a rimstone dam. The real conceptual problem with water on Mars is what form it should take. What we all learned in school was that water freezes at 0°C (32°F). The average equatorial surface tempera-

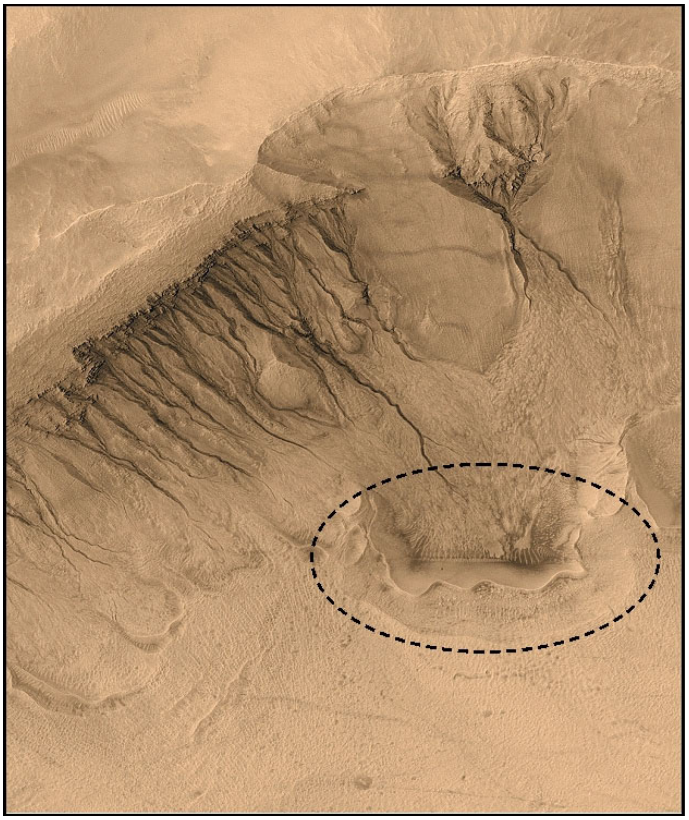


Figure 7. Mars Orbital Camera image 39S, 166W MOC Release MOC2-320.

ture of Mars is below -50°C with temperate highs of only -25°C. This makes it very difficult for pure liquid water to persist at the Martian surface for any length of time. Without persistent liquid water, over billion year time frames, it is very difficult to imagine how life could have evolved, let alone persisted, to the present day.

Once again the Soudan Mine offers some clues to how liquid water might persist, even in a frigid Martian environment. The key is shown in Figure 8, which is a phase diagram for water. The

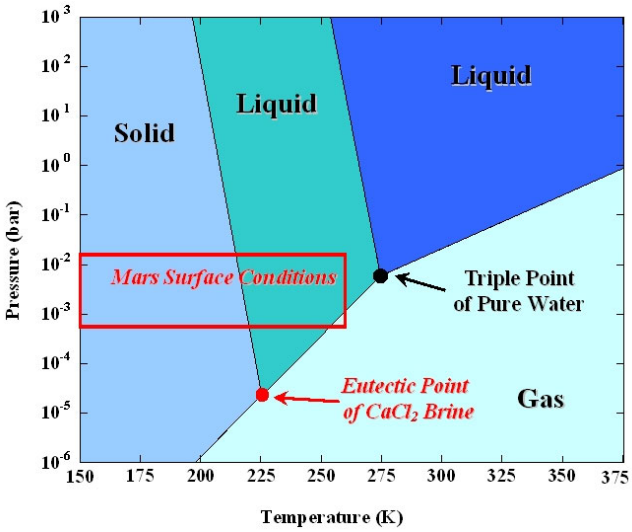


Figure 8. Phase diagram of pure water and eutectic point of $CaCl_2$brines relative to the Martian surface.

continued on page 20

Subsurface Life, cont.

freezing point of pure water is shown as the triple point at 273°K (0°C). The rectangular area shows the normal range of surface conditions on Mars, which would seem to preclude liquid water under normal Martian conditions. As we add dissolved ions to pure water the freezing point is depressed to cooler temperatures. In Minnesota we experience this every winter as rock salt (halite) is applied to roads to allow melting of accumulated snow and ice. Unfortunately the freezing point depression for NaCl bottoms out around -20°C. Calcium-chloride brines, however, have a eutectic point near -53°C (220°K). This large freezing point depression produces liquid water under normal Martian surface conditions as shown in Figure 8. Beyond simply lowering the freezing point, calcium-chloride brines represent stable geologic fluids. As water evaporates concentrating the brine towards its eutectic point a self-perpetuating fluid is created where the brine can begin to absorb water from the atmosphere or hydrated minerals. This makes it very difficult to completely crystallize these fluids except under the coldest and most arid conditions such as found only in the Dry Valleys of Antarctica. Once formed, these eutectic brines may persist for millions or billions or years, whether they are found on Earth or Mars. These persistent fluids may allow liquid water to persist in environments, as on Mars, that would not otherwise be favorable to the development and long-term evolution of life.

Conclusions

All of this evidence suggests that if life has evolved on Mars it probably started in the subsurface and has had little opportunity to explore the surface. While we are waiting for the next generation of planetary explorers to reach Mars, the Soudan Mine offers us to chance to better understand continental shield brines and the evolution of life here on Earth.

Acknowledgements

The staff at the Soudan Underground Mine State Park has provided invaluable assistance in guiding both hydrogeologists and microbiologists around the mine.

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Looking for Water

The Mars Phoenix Lander landed on May 25, 2008. Phoenix is designed to study the history of water and search for complex organic molecules in the ice-rich soil of the martian arctic. Discoveries made by the Mars Odyssey Orbiter in 2002 show large amounts of subsurface water-ice in the northern arctic plains. The Phoenix lander targets this region; a robotic arm will bring both soil and water-ice to the lander platform for scientific analysis. The project web site is phoenix.lpl.arizona.edu.

CALENDAR

Regional and Local Events

July 7-24, 2008

Field Hydrology and Geomorphology for Teachers, University of Wisconsin-River Falls. Contact Kerry Keen kerry.l.keen@uwrf.edu.

September 20-24, 2008

AIPG 45th Annual Meeting, Flagstaff Arizona. *Changing Waterscapes and Water Ethics for the 21st Century.* Abstracts due by April 15. ***Website:*** www.aipg.org

September 27, 2008

Gunflint Trail Field Trip, Mesabi Range Geological Society. Contact rpatelke@polymetmining.com.

September 29-October 2, 2008

53rd Annual Midwest Ground Water Conference, *Grand River Center Dubuque, Iowa.* Abstracts due June 6, 2008. ***Website:*** www.igwa.org

October 27-28, 2008

2008 Minnesota Water Resources Conference
Rivercentre, St. Paul. Information is posted at: wrc.umn.edu/waterconf/index.html

November 13, 2008

MGWA Fall Conference Advances in Field Data Collection.
www.mgwa.org

Guidelines for Submission of Newsletter Articles

Have an idea for an article?
Contact the editor at editor@mgwa.org

The newsletter team appreciates the efforts of article contributors, without whom our newsletter would not be possible. To make the process easier on the author, the newsletter team and production staff, we have established some guidelines we would like authors to follow. For a complete list of guidelines, please see the MGWA web site:

- Submittals should be complete and ready for publication.
- The text of the article should be submitted as a Microsoft Word document in an attachment to an e-mail or on disk.
- Tables, captions, figures and graphics should be submitted as separate high quality files.
- A version of the article with embedded tables, figures, and graphics may be submitted as an additional file to indicate the preferred layout of the tables, figures and graphics within the article.
- The contributor should include the contributor's name and affiliation following "By" below the title of the article.
- The contributor should secure permission to print or reprint if applicable and provide the required text to be included with the article.
- Materials should be submitted before the deadline.
- If there is any question about the suitability of a proposed article's content for the MGWA newsletter, it is advisable for the contributor to call the editor before investing significant time in article preparation.

MGWA 2008 Newsletter Advertising Policy

Advertising Rates to Increase in MGWA Newsletter

The MGWA Board has voted to increase advertising rates for display ads in the MGWA Newsletter beginning with the June 2008 issue. The increase is due to increasing costs for the production and publication of the newsletter. The new rates are for four issues and will be as indicated below. Advertisers provide significant support in the publication of this newsletter. With their support we are able to produce a higher quality newsletter of which we can all be proud. The MGWA Board has also voted to increase advertising rates in the MGWA Directory as indicated below.

Many thanks for the support of MGWA newsletter advertisers

Display ads:

Size	Inches Horiz. x Vert.	Quarterly Newsletter 4 issues	Membership Directory 2 issues
Business Card	3.5 x 2.3 or 1.9 x 3.5	$100	$50
Quarter Page	3.5 x 4.8 or 5.4 x 3.5	$150	$100
Half Page	7.5 x 4.8	$250	$200
Full Page	7.5 x 9.75	$500	$400
Inside Cover	7.5 x 9.75	not available	$500

There are no commissions on ads. Advertising copy must be received by the publication deadlines as published in the newsletter. Advertisers should submit material as a digital file in TIFF, GIF, JPEG or PCX format at 300 to 600 dpi.

Please make checks payable to "Minnesota Ground Water Association" or "MGWA." Direct your orders and questions concerning advertising rates to Jim Aiken, Advertising Manager, c/o MGWA, 4779 126th Street, White Bear Lake MN 55110-5910; (952)832-2740; jaiken@barr.com. The complete advertising policy is available on the MGWA web site at www.mgwa.org/newsletter/adrates.html.
Questions concerning advertising policy should be directed to the MGWA President.

Join the Minnesota Ground Water Association!

If you are reading this newsletter secondhand, we'd like to take this opportunity to invite you to become a member of MGWA for 2008. Annual dues are $30 for professional members and $15 for students (for corporate membership, see www.mgwa.org).

Members receive e-mail notice of the availabilty of the quarterly newsletter for downloading from the MGWA web site. If desired, members may subscribe to a printed edition of the newsletter (4 issues for $10).

Members are also entitled to purchase a paper copy of the annual membership directory for $7; an electronic version will be available on the website for paid members.

Tax deductible contributions to the MGWA Foundation scholarship fund will be gratefully accepted.

Dues paid to MGWA are **not** deductible as charitable contributions for federal income tax purposes. However, dues payments are deductible as ordinary and necessary business expenses to the extent allowed by law.

Just complete the form below and mail to: MGWA, c/o WRI, 4779 126th St. N, White Bear Lake, MN 55110-5910 or visit our web page and join on-line at www.mgwa.org.

- -

Name ______________________________

Affiliation/Employer ______________________________

Work Address ______________________________

Work City, State, Zip Code______________________________

Work Telephone Number______________________________

E-mail Address______________________________

Fax Number ______________________________

Home Address ______________________________

Home City, State, Zip Code ______________________________

Home Telephone Number ______________________________

Which Address should we use for Mailings? Directory Listing?______________________________

Which Telephone Number should we use for Directory Listing? ______________________________

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MGWA Foundation Grant Request Deadlines are quarterly:
March 1
June 1
September 1
December 1

MGWA FOUNDATION NEWS

Big Backyard Update

The Ground Water Exhibit (GW Exhibit) at the Big Backyard (BBY) at the Science Museum of Minnesota (SMM) opened for the 2008 season on Saturday, May 24. A hand pump which was broken last summer has been replaced with a new pump which is more durable and should stand up to the wear and tear of kids who love to pour buckets of water on the bedrock boulders. The MGWA Foundation partially funded the costs for the replacement hand pump.

In addition, this year two large sand tank type models will be included in the GW Exhibit. One model will have a flowing well and a second well which can be pumped to demonstrate both how wells work and how the pumping of one well can influence the ground water conditions in a nearby well. The other tank will demonstrate water table conditions as well as interactions with a river and a shallow well. Educational placards which provide general information on the bedrock formations and the flow of ground water within the subsurface will also be posted.
Finally, at some point in 2008 an acknowledgement panel which lists those entities which contributed $100 or more to the development of the GW Exhibit should be added to the Big Backyard. Come on out and play in the water!

Minnesota Ground Water Association Foundation Board Meeting Minutes

Meeting Date:	Tuesday, March 11, 2008
Location:	Metropolitan Council - Metro 94 Building
From:	Cathy Villas-Horns (Secretary)
Attending:	Gilbert Gabanski, Amanda Goebel, Jeff Stoner and Cathy Villas-Horns, Board Members, Sean Hunt, MGWA Management Staff
Minutes:	The meeting minutes for the December 18, 2007 meeting were unanimously approved on January 15, 2008 and provided via e-mail to the MGWAF Board and the MGWA Newsletter staff.
Treasurer's Report:	Foundation balance to date is $79,748.85. Total credits of $1,537.52 were added to the accounts. Interest in the amount of $920.26 was accrued from 12/18/07 to 3/11/08. This interest was swept into the endowment. The cumulative total of the quarterly income from interest on MGWAF investments equals approximately $3,700 a year. No new certificates of deposit will be needed until May of 2009.
Old Business:	Spring Conference 2008 – Jeff stated that the spring MGWA conference will be on Thursday, May 8 and the theme will be Biofuels and Water Resources. Sales Tax Exemption – The Dept of Revenue again denied granting tax-exempt status to the MGWAF. Gil will ask Jennie to research how much sales tax the MGWAF has paid to determine the level of any future efforts toward gaining this status. Tabled Grant Request from Science Museum of Minnesota (SMM). Discussion ensued of previous SMM request for $3,889.02. Motion made by Amanda to grant funding of $2,100 towards a new pump, materials and required modifications. Motion seconded by Jeff. Motion approved.
New Business:	No new grant requests received. Legislative Citizen Commission on Minnesota Resources (LCCMR) – Current and former MGWA and MGWAF board members and others had an informal meeting with LCCMR staff the week of March 3, 2008. The field trip provided by the MGWA to the LCCMR will be repeated, possibly followed by a series of presentations. Transmittal of Meeting Minutes – Jeff stated that he would be willing to forward the MGWAF meeting minutes to the MGWA board. Jeff also mentioned that student membership in MGWA is not increasing. Bylaws – Formal discussion tabled until the June meeting. Gil would like to finalize and approve the MGWAF bylaws at the June meeting. Cathy asked questions and provided several comments based on her review, which were addressed at the meeting. Education links on MGWA website – Amanda is working with Sean to update the live links to educational resources and activities on the MGWA website.

MGWA BOARD MINUTES

Minnesota Ground Water Association Board Meeting Minutes
Regular Monthly Meetings

The MGWA Board of Directors meets once a month.

All members are welcome to attend and observe.

Meeting Date March 24, 2008

Place	Fresh Grounds, 1362 West 7th Street, St. Paul, Minnesota
Attending	Stu Grubb, President; Jeff Stoner, Past President; Craig Kurtz, Treasurer; Norm Mofjeld, Newsletter Editor; Sean Hunt, WRI; Jennie Leete, WRI.
Past Minutes	The February 21, 2008 minutes were approved as written.
Treasury	No significant activity for this past month so will plan on a full report next meeting.
Newsletter	A draft color print of the spring issue was circulated. The main job left was to reformat Board minutes in the back. This issue will be thick (40 p) with the minutes and revised bylaws and should be ready for publication by the end of March.
Web Page	Calendar was updated. Process of moving to the new server has been slowed by quality assurance checks and with a possible glitch with the online store section. Therefore move to server may be delayed until after the spring conference.
WRI Report	Answered questions about group membership and focus on final newsletter.
Membership	Paid are 473 members thus far, which is slightly below normal trend for this time of year. The 2nd renewal notice and conference registration should help.
Foundation	Board approved support to replace hand pump at the Science Museum ground-water outdoor exhibit. On behalf of the Foundation, Jeff suggested that after each meeting, the MGWA Board minutes be circulated (even if in draft form) to the Foundation Board to improve communications more frequently than waiting for official postings in the quarterly newsletter. This process was agreed upon as long as the MGWAF does not circulate before published in the newsletter. Jeff will discuss with the MGWA Secretary.
Old Business	Legislative: Meeting with LCCMR on March 3, 2008, went well in promoting a ground-water field trip some time this summer with a focus on relations between surface and ground waters, nonpoint contamination of ground water and maybe springs. Attendees from MGWA and MGWAF included Grubb, Pollock, S. Alexander, Reeves, Gabanski, and Liverseed. They met with Susan Thornton and John Velin of LCCMR staff. WRI Contract: Need to track signature for final execution of contract. Spring Conference: Most presenters have been contacted to participate. Need to finalize announcement brochure with final registration cost and follow-up with presenter logistics.
New Business	Darcy Lecture: Discussed possibility of inviting this year's NGWA Darcy lecturer, but decided that the topic overlapped with a MGWA Spring Conference presentation. So the Board decided it best to explore GSAs Birdsall-Dreiss lecture for 2008. Stoner will obtain more information for next meeting.
Next Meeting	Set for April 25, 2008, at 1130 at Fresh Grounds at 1362 West 7th Street, St. Paul, Minnesota. Meeting adjourned at 13:15.

Send your comments to editor@mgwa.org

Meeting Date April 25, 2008

Place	Fresh Grounds, 1362 West 7th Street, St. Paul, Minnesota
Attending	Stu Grubb, President; Scott Alexander, President Elect; Jeff Stoner, Past President; Craig Kurtz, Treasurer; Sean Hunt, WRI; Jennie Leete, WRI.
Past Minutes	The March 24, 2008 minutes were approved as written.
Treasury	Reviewed copy of Treasurer's balance sheet and income/expenses as of April 24 showing net income to date of $12,980.
Newsletter	Editor Mofjeld had sent an e-mail reminding contributors of may deadline for submittals to make the June Newsletter. Board members briefly discussed the length of the newsletter and decided to table that discussion until next meeting.
Web Page	Posted the announcement for the Spring Conference and March Newsletter.
WRI Report	Detailed report submitted. Highlights include prepared final dues notice, cross-check of advertisement records with ads paid and issued invoices accordingly, circulated spring conference brochure for President's review, commented that many changes for the last newsletter were not related to layout process.
Membership	Have 571 paid members thus far, which is 43 below last year for this time of year. The conference registration should help.
Old Business	Legislative: No more progress on LCCMR outreach planning. WRI Contract: Need to track signature for final execution of contract. Birdsall-Dreiss Lecture: Stoner discovered that the GSA Birdsall-Dreiss lecture for 2008 had no time slots. The Board decided to plan for this and (or) the Darcy lecture

Minnesota Ground Water Association Board Meeting Minutes, cont.

series for 2009.
Spring Conference: All presenters were confirmed to participate including ethanol industry representative and schedule was completed.

New Business Clean Water, Land, and Legacy Amendment: President had been approached about whether the MGWA wishes to present an official position on this State Constitutional Amendment that basically requests 3/8ths percent of state sales tax for activities in natural resources (85%) and the arts (15%). Board members discussed that this might be a good opportunity to use this proposed legislation to educate people, such as through the MGWA Newsletter, the importance of and need for fiscal resources to better understand and manage ground water as a natural resource in Minnesota. That newsletter article, to be written by the President, would also ask the Membership to respond to the MGWA endorsement of this amendment.

Summer field trip: Alexander proposed an aquifer test day near Deep Portage Conservation Reserve, Hackensack, which all believed to be a good idea. Alexander will investigate a feasible weekend in September or October and have that available for announcing during the Spring Conference.

Next Meeting May 23, 11:30 a.m. at Fresh Grounds at 1362 West 7th Street, St. Paul, Minnesota.

Meeting adjourned at 13:05.

Bylaws Amended

The balloting to approve changes to the MGWA bylaws ended at the end of May. The results were tallied as follows:

Voting to approve the changes to the Bylaws	**=**	**130**
Voting against approval	**=**	**7**

Both electronic and paper ballots were counted. The new Bylaws will be posted on the MGWA website.

Members can access the current year's newsletters in the 'Members Only' area of the web page.

The user name is mgwa and the password is emailed to members with each announcement of newsletter availability.