

# Minnesota Ground Water Association

www.mgwa.org

## Newsletter

September 2014  
Volume 33, Number 3

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- Ethics Requirement for Professional Geoscientists, page 4



MGWA President  
Eric Mohring

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### President's Letter

Colleagues,

I hope the summer went well for you. I'm guessing you all have your ears to the rail more than I do, but just in case you don't, here's a rambling grab bag of interesting stuff.

In July, the Metropolitan Council released a [draft report on water supply in the north-east metro area](#). The draft report evaluates approaches to help restore the aquifer that supplies groundwater to northeast metro communities, as well as area lakes including White Bear Lake. The approaches all involve relying more on surface water from the Mississippi River in Saint Paul as a way to decrease reliance on groundwater and reduce the increase in withdrawals from the Prairie du Chien-Jordan aquifer. The report is available for review, and I encourage you to take a look at it.

Speaking of White Bear Lake, an interesting column appeared in the [Pioneer Press](#) written by the directors of 3 prominent environmental organizations. Also, The [White Bear Press](#) has released an article describing the start of the second phase of the project lead by USGS that will expand the study to other northeast Twin Cities Metropolitan Area lakes. The project included seismic surveys in White Bear and five other northeast Twin Cities Metropolitan Area lakes to look for changes in the geology of lake sediments that may influence seepage into lower aquifers.

The Department of Natural Resources (DNR) is "full-steam-ahead" on developing [Ground Water Management Areas](#). If you recall, the Minnesota legislature authorized the creation of groundwater management areas as a tool to

— continued on page 3

### McLeod County Geologic Atlas, Part B Hydrogeology and Pollution Sensitivity

By Todd Petersen, Minnesota DNR

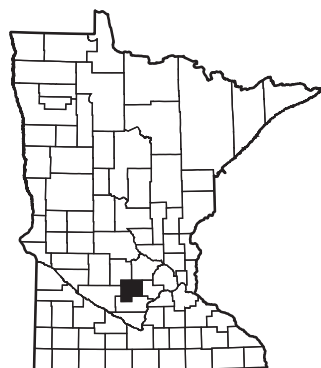
#### Introduction

Part B of the McLeod County Geologic Atlas was published in 2013. This report includes three map plates that describe the county's groundwater conditions and pollution sensitivity. This report joins the previous published portion of the report, Part A, prepared by the Minnesota Geological Survey that contains six map plates describing the county's surficial and bedrock geology.

The groundwater resources of McLeod County include several buried sand and gravel aquifers, which are found countywide, and sedimentary bedrock aquifers that are found only in the eastern portion of the county. Ninety-eight percent of wells in the county are constructed in Quaternary sediments and only two percent are constructed in sedimentary bedrock aquifers. However, because many of the large-volume groundwater users pump water from bedrock aquifers, approximately 10 percent of permitted water use comes from bedrock aquifers.

The downward recharge rate of water from the land surface to deeper aquifers is very slow in McLeod County. The vertical hydraulic gradient is very low, and the fine-grained till that forms most of the surficial geologic deposits has a low hydraulic conductivity. This fine-grained till does not allow much shallow groundwater to recharge deeper aquifers. Groundwater residence time for deep buried aquifers varies from hundreds to tens of thousands of years.

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LOCATION DIAGRAM

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### Newsletter Deadlines

Issue	Due to Editor
December '14	11/07/2014
March '15	02/06/2015
June '15	05/01/2015
September '15	08/01/2015

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### Retiring Gretchen Sabel took life lessons from pony poo

While Gretchen Sabel was growing up, her mother told her there are two kinds of people in the world. One kind gets a pony but becomes unhappy when it produces a big pile of you know what. The other kind sees the big pile and thinks happily, there must be a pony around here somewhere! "She always said I was insanely the second type," Gretchen says.

The ability to stay focused on the positive when dealing with the human version of pony poo has come in handy for Gretchen since much of her almost four decades of environmental protection work in Minnesota has been with the MPCA septic system program. She retired this summer after 36 years.

In addition to her personality, Gretchen's background also led her to where she is now. She was part of the team that worked to pass the historic Minnesota Groundwater Protection Act in 1989. "I'm a big picture person and that was big picture," she says. "People from all these different agencies put their heads together to answer the overall question of how much degradation/pollution should we allow in our groundwater. The answer was none." She said the act laid the groundwork for many groundwater protections that would be adopted by various agencies, including the MPCA.

Among other roles, Gretchen has also served in the feedlot program, state planning, the Environmental Quality Board (EQB), and stormwater. During one period she fought to keep Minnesota off the list of potential sites for storing nuclear waste. "My job was to stand at the borders and say 'no' to the reposi-

tory," she joked. But she says her legacy will likely be her contributions to the Groundwater Protection Act and moving the septic program to where it is today.

In 2003, the Legislature asked the MPCA to develop a 10-year plan for documenting all septic systems in the state, and identifying and correcting those that don't comply with standards. Since then, several counties have completed inventories of all of their septic systems and upgraded those that were non-compliant. Most also require septic system compliance checks when a home is sold or when a homeowner applies for a permit to add a bedroom. These and other measures have improved the compliance rate across the state, and greatly reduced the number of homes and small communities that were discharging untreated or under-treated waste directly to nearby waterways via "straight pipes."

Gretchen says Minnesota is different than other states when it comes to support for regulations designed to keep groundwater and surface water clean.

"I came from Pittsburgh and there we had a highly degraded environment where you just hoped things got less bad," she says. "So I left a place where you coped with pollution to one where you don't tolerate it. That really made me feel good about being here."

Gretchen is a Charter Member of MGWA, served as Treasurer from 1984 through 1986, and was elected to the three-year Presidency rotation in 1995.

### David Lowell retires from Liesch Associates

After 24 years as a hydrogeologist at Liesch Associates, I retired at the beginning of this year. I have been enjoying my leisure time and have developed a number of hobbies and activities. I am open to volunteer opportunities in hydrogeology and would like to give

back to the community for allowing me such a rewarding and varied career. If anyone would like to contact me, I can be reached at: [david.j.lowell@gmail.com](mailto:david.j.lowell@gmail.com).



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### Ruth MacDonald Joins the MGWA Newsletter Team

Ruth graduated from Iowa State University with a B.A. in Biological and Pre-medical Illustration, and spent her initial years as a medical photographer and media specialist at Gillette Children's and Abbott Northwestern hospitals. She married a geologist and spent a couple years in Alaska, then returned to the lower 48 to Wisconsin and entered forensic science. She served at the Wisconsin State Crime Laboratory as an imaging specialist, crime scene field response team member, and coordinator and trainer for the evidence technician training program for police officers throughout the state. She later went into the Peace Corps with her husband and served as a water sanitation volunteer in Mali (West Africa). Part of her training was to learn how to mix cement and dig wells and latrines by hand. Afterward she returned to Saint Paul, gained her Masters in Technical Writing and

Communication, and became a technical writer for American Medical Systems. In January she found a new home at the DNR as the Information Officer/Editor for the County Geologic Atlas program and was recruited (on her first day) to join the MGWA newsletter team.



Ruth in Tombouktu, Mali (West Africa)

### President's Letter, cont.

address difficult groundwater-related resource challenges. The DNR and partners are developing three pilot groundwater management areas, located in the North and East Metro, the Straight River area, and the Bonanza Valley. You can track developments via the referenced web site. The Ground Water Management Areas are a piece of the program described in the [Draft Strategic Plan for Minnesota DNR's Groundwater Management Program](#) released last October. I encourage you, if you haven't already, to take a look at this plan and take the web survey or provide email comments.

The DNR plan puts forth many ambitious goals. Two stood out for me as I wear my Board of Water & Soil Resources (BWSR) hat: 1) Work with land use authorities and other partners to adopt policies, practices, and procedures that preserve groundwater recharge areas, minimize risk of groundwater contamination and that ensure plentiful supplies of high quality groundwater; 2) Partner with local, regional, state, federal, and tribal governments and individuals, businesses, and institutions in the private sector to address the challenges of groundwater management.

Local government units (LGUs) including counties, Soil and Water Conservation Districts (SWCDs), Watershed Districts, Watershed Management Organizations, and cities have an increasing role in ground water protection and management. These roles have waxed and waned since local water planning began in the late 1980s, but now they are definitely on the upswing. Simply put, these organizations hold most of the cards in

terms of land use and practices to manage and protect groundwater. There are many examples of fruitful collaborations between LGUs the agencies charged with protection and managing groundwater, and I'm sure these collaborations will continue.

I'm excited about the fall MGWA conference (Superfund: Its Legacy and Future - November 12, 2014). The program includes speakers from Federal and state regulatory agencies, private consulting, and environmental organizations, who will explore, from a perspective some 30 years later, the questions: What is the enduring legacy of these efforts? Where have they brought us? What have we learned? Where are we going? It promises to be informative and fun. And don't forget to put the 14th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst (<http://www.sinkholeconference.com>) on your calendar - October 5-9, 2015 in Rochester, MN. This interdisciplinary biennial conference is an important international meeting on the practical application of karst science. It should be of interest to geologists, engineers, geographers, planners, and decision makers. And it's in our back yard!

Finally, I end this long-winded diatribe by encouraging you to check out, if you haven't already, the Minnesota Public Radio series [Beneath the surface - Minnesota's pending groundwater challenge](#) ([minnesota.publicradio.org/projects/2014/01/ground-level-beneath-the-surface/](http://minnesota.publicradio.org/projects/2014/01/ground-level-beneath-the-surface/)). This is a great example of the kind of in-depth journalism that informs and educates the public, in an intelligent way, on groundwater and the challenges of ground water protection and management.

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### The primary objectives of the MGWA are:

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



## MGWA's Corporate Members

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## Abbreviations and Acronyms

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

## MGWA WHITE PAPER NEWS

### White Paper Initiative – Work Group Update and Call for Topics

*By the MGWA White Paper Committee (Kelton Barr, Mark Collins, Bruce Olsen, Jeff Stoner)*

MGWA's White Paper Initiative continues to develop. Work is underway on the first MGWA white paper, "Manganese in Minnesota's Groundwater". The work group consists of the following volunteers: Bill Bangsund (Barr), Meghan Blair (Barr), Vanessa DeMuth (Dakota County), Mindy Erickson (USGS), Sarah Fossen-Johnson (MDH), Linse Lahti (DNR), and Dave Lowell (retired from Liesch). Jim Lundy (MDH) and Kate Sande (Ecolab) are likely additional participants, as their schedules allow. Mark Collins will serve as liaison to the White Paper Committee, and Bruce Olsen is the alternate liaison.

An organizational meeting of the work group was held in early July. Mindy Erickson was named to serve as the chair of the work group, and the group decided initially to meet on a monthly basis.

The work group is currently looking for persons with expertise, data, or other information that can be presented to the group or contributed to the paper. Please contact Mindy Erickson ([merickso@usgs.gov](mailto:merickso@usgs.gov)), Mark Collins ([mark.collins.mgwa@gmail.com](mailto:mark.collins.mgwa@gmail.com)), or Bruce Olsen ([sawdust2013@gmail.com](mailto:sawdust2013@gmail.com)).

Meanwhile preparations are underway for undertaking a second white paper. The White Paper Committee is again making a **Call for Topics** from MGWA members. If you have an idea for a white paper, just go to the White Paper website ([http://www.mgwa.org/whitepapers\\_topics.php](http://www.mgwa.org/whitepapers_topics.php)), fill out the nomination form, and send it to [office@mgwa.org](mailto:office@mgwa.org). All previously submitted topics will also be actively considered (good ideas never die—they just wait their turn). Deadline for submittal of white paper topics is December 1, 2014. We look forward to your ideas!

### New Ethics Requirement for Professional Geologist Licensing

*By Tedd Ronning, MGWA Newsletter Team*

The Minnesota Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience, and Interior Design statute has changes that are effective August 1, 2014. One modification that will impact those with a Professional Geologist license is the new professional ethics portion of the 24 professional development hours requirement.

In order to renew in 2016, licensees and certificate holders must report a minimum of two professional development hours of professional ethics. The total number of professional development hours required (24) has not changed. The ethics hours must have been earned during the biennium to which they are applied and shall not be used toward carryover. This means that two professional ethics hours are required for the 2016 renewal.

For details on the statute changes go to: [www.aelslagid.state.mn.us](http://www.aelslagid.state.mn.us)



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**New Geologic Atlas Available**

**Carver County Geologic Atlas, Part B, Completed**

by Todd Petersen, Minnesota DNR

Part B of the Carver County Geologic Atlas was completed in June 2014 by the DNR Ecological and Water Resources Division. It is now available for the public. The atlas includes four map plates that describe the county’s groundwater conditions and pollution sensitivity. A more detailed discussion will be provided in the next MGWA Newsletter.

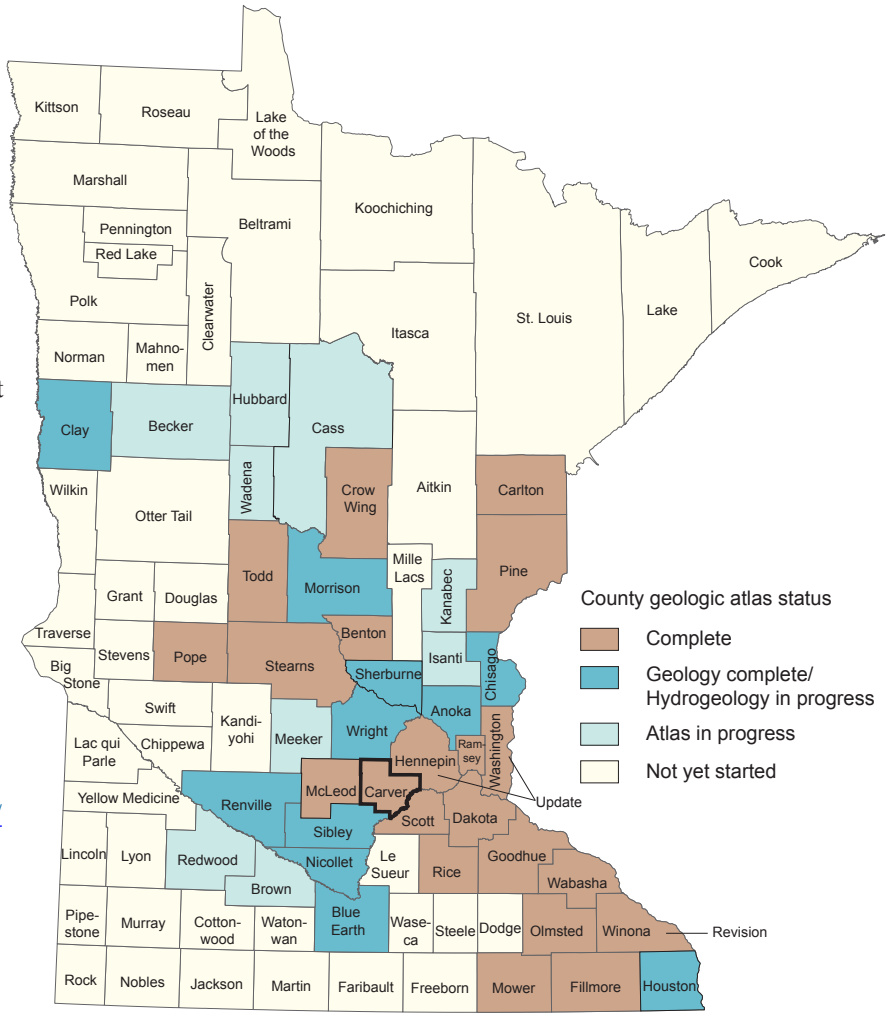
The Carver County Geologic Atlas is the 21<sup>st</sup> report in the County Geologic Atlas Series, a cooperative effort with the Minnesota Geological Survey (MGS). Part B completes the 2<sup>nd</sup> half of the atlas covering the hydrology of the county. This was built on and adds to the Part A information published by the MGS in 2009 on the surficial and bedrock geology.

To purchase a printed Part A and B County Geologic Atlas contact:  
Minnesota Geological Survey, Publications Office,  
2642 University Avenue, St. Paul, MN, 55114,  
(612) 627-4782.

To download PDF images and data of the atlas:  
[www.dnr.state.mn.us/waters/programs/gw\\_section/mapping/platesum/carvcga.html](http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/carvcga.html)

For questions call: Todd Petersen (651) 259-5698  
or Jan Falteisek (651) 259-5665.

To see the progress of the County Geologic Atlas -  
Regional Assessment Program:  
[www.dnr.state.mn.us/waters/groundwater\\_section/mapping/status.html](http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html)



Current Status of the County Geologic Atlas - Regional Assessment Program

**DNR Uses MPARS for 2013 Water Use Reporting**

By MGWA Newsletter Team

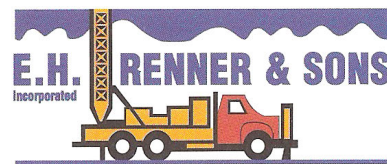
The DNR recently transitioned to an online system for permit applications, permit change requests, and water use reporting. This new system, called MPARS, supports three types of permits: water appropriation, public water works, and dam safety. MPARS also allows users to electronically enter water use information and features a secure banking system for online payments.

Use of the system for 2013 water use reports was very successful. Of 8226 water use reports submitted, 7435 were completed online — over 90%. MPARS is available online 24 hours a day, 7 days a week at: [www.dnr.state.mn.us/mpars/index.html](http://www.dnr.state.mn.us/mpars/index.html)



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McLeod County Geologic Atlas, cont.

Water Table

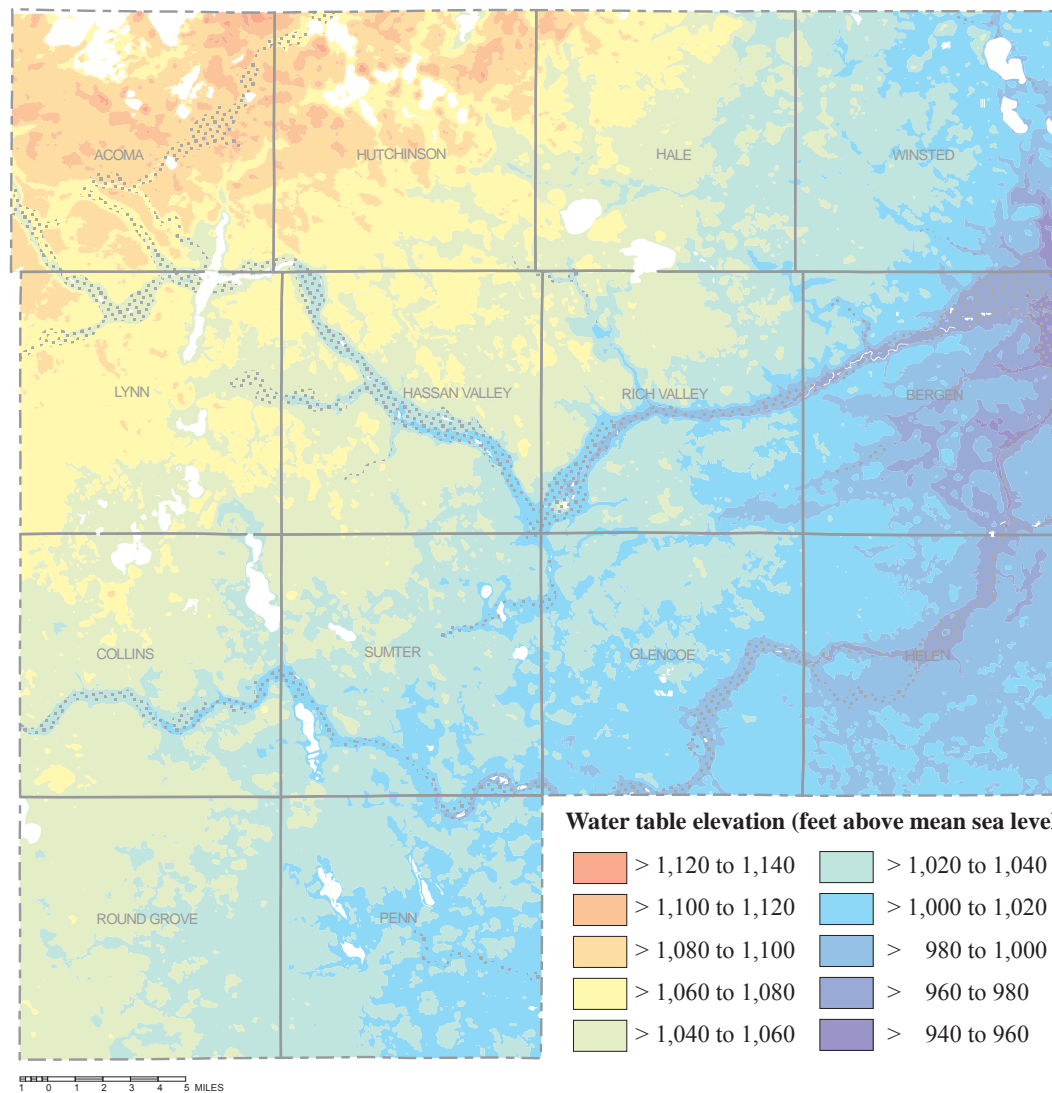
The water table generally occurs in both aquifer and non-aquifer sediments across McLeod County (Figure 1). Most of the county has fine-grained (non-aquifer) sediments at the land surface. Only 5 percent of McLeod County has sand at the surface, which is shown in stipple pattern on Figure 1. As a result, only 14 wells in the County are constructed in the surficial sand aquifer. The water table generally follows the surface topography. The elevation of the water table is highest in the northwestern part of the county (brown to yellow colors) and lowest on the east and southeast sides of the county (blue to purple colors).

Quaternary Buried Sand and Gravel Aquifers

Six Quaternary buried sand and gravel aquifers are mapped in McLeod County. Some areas have multiple buried sand and gravel aquifers that overlie each other. Other areas have only one or two mapped buried sand and gravel aquifers. Part of this lateral variation in the distribution of aquifers is the result of

non-uniform deposition and part may be due to insufficient data to identify them or determine their extent. The potentiometric surface is a contoured map of the water levels measured in wells constructed in a confined aquifer. For this review article only the shallowest mapped aquifer is described: the sdv buried sand and gravel aquifer. The potentiometric surface elevation of the aquifer is shown in **Figure 2**. Topography appears to have a strong influence on groundwater flow in all buried sand and gravel aquifers. All of the potentiometric surfaces for the buried sand and gravel aquifers exhibit relatively large lateral gradients that are related to surface topography. In McLeod County aquifers, groundwater generally flows from northwest to southeast.

Pollution sensitivity maps were made for each of the six buried sand and gravel aquifers mapped for this atlas. The pollution sensitivity map of the sdv aquifer is shown in **Figure 3** with colors that represent pollution sensitivity conditions: very high—hours to months, high—weeks to years, moderate—years to decades, low—decades to a century, very low—a century or more.



The elevation surfaces of geologic layers created by the Minnesota Geological Survey were used to calculate pollution sensitivity maps for each buried aquifer (Petersen, 2013). In the final step of the sensitivity evaluation, the thickness of the protective till layer that directly overlies the aquifer is calculated and a sensitivity rating is made. The sensitivity of the aquifer is inversely proportional to the thickness of this overlying till layer.

Bedrock Aquifers

Sedimentary bedrock aquifers are available as a source of groundwater in the eastern half of McLeod County. However, most water wells in McLeod County are drilled into shallower Quaternary aquifers because they provide an adequate water supply for most users without the additional cost of a deeper well. Most wells that are constructed into deeper aquifers are used by cities or large processing plants that need large volumes of water.

The bedrock aquifers in McLeod County are shown in **Figure 4**. The extent is not well known because only 46 wells have been constructed in bedrock aquifers.

Figure 1. Simplified water-table elevation map with surficial aquifer location (from Plate 7, Figure 1).

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## Featured Photo

### Borehole cuttings from dual-rotary reverse circulation drilling at South Washington Watershed District retention basin

By Ruth MacDonald, Minnesota DNR

#### Introduction

In June 2014, new observation wells were installed in Woodbury as part of the DNR's 11 County groundwater monitoring program. I went onsite with Jeremy Rivord to observe and learn about drilling methods. After discussing the mud-rotary drilling in progress, we went over the clean cuttings laid down the previous week from the dual-rotary reverse circulation drilling used for the deep Tunnel City/Wonewoc observation well. Following a tutorial about the geologic units represented in the cuttings, we discussed recording them in a panoramic photo. He had done this before, and I had done something similar with tire tracks on crime scenes (though it was before the digital age). I tried several methods and learned several lessons.

#### Methods

We laid a ruler beside the cuttings and moved it as I took the photos. I used the panorama feature on the camera while walking along the line. I also took conventional individual photos along the line at both wide angle and telephoto settings as a back-up.

#### Results

The moving ruler did not provide a linear reference to reassemble the photos. The panorama feature on the camera shut off periodically, so it was uncertain if all sections were recorded. Shooting downward while walking sideways on an uneven incline made the panorama strip rather wavy.

Shooting conventional photos at a telephoto setting provided the least distortion of all the methods, though it produced 10 times the number photographs than the panorama sections. Walking along the uneven surface still produced photos of different sizes and angles, though better than the panoramas.

After returning to the office, I learned we needed a 50 percent overlap in each photo for the Photoshop software to stitch them together automatically (thanks to the assistance and knowledge of Holly Johnson). The attempt with the wavy panorama photos and automatic stitching software produced something that looked like melted taffy. I created the resulting photo by manually placing the conventional telephoto versions together in Adobe Photoshop.

#### Conclusions

Combining this and my previous experience, my conclusion is that a best practice for ground panoramas is as follows (or at least, this is what works for me):

1. Lay one long continuous tape measure down the entire length of the line and do not move it. This provides a scale, reference for shooting and re-assembly, and something for software to easily recognize.
2. Use a tripod. This provides a consistent shooting height and keeps your camera parallel with the ground. This results in a consistent size for each photograph and minimal distortion.
3. Use the conventional photo option on a medium telephoto setting to minimize distortion, unless you have a very steady hand with panoramas.
4. If you are planning to use the automatic stitching software, provide a 50 percent overlap in each photo.

I would welcome an opportunity to try this again.

*The resulting graphic begins here and continues as the sidebar on pages 8, 10, 12 and 13. The newsletter team encourages members to send photos of groundwater related activities to feature in the newsletter.*

Link to image in: [Newsletter Extras](#)

Borehole cuttings from dual-rotary reverse circulation drilling at South Washington Watershed District retention basin



— continued on page 8



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McLeod County Geologic Atlas, cont.

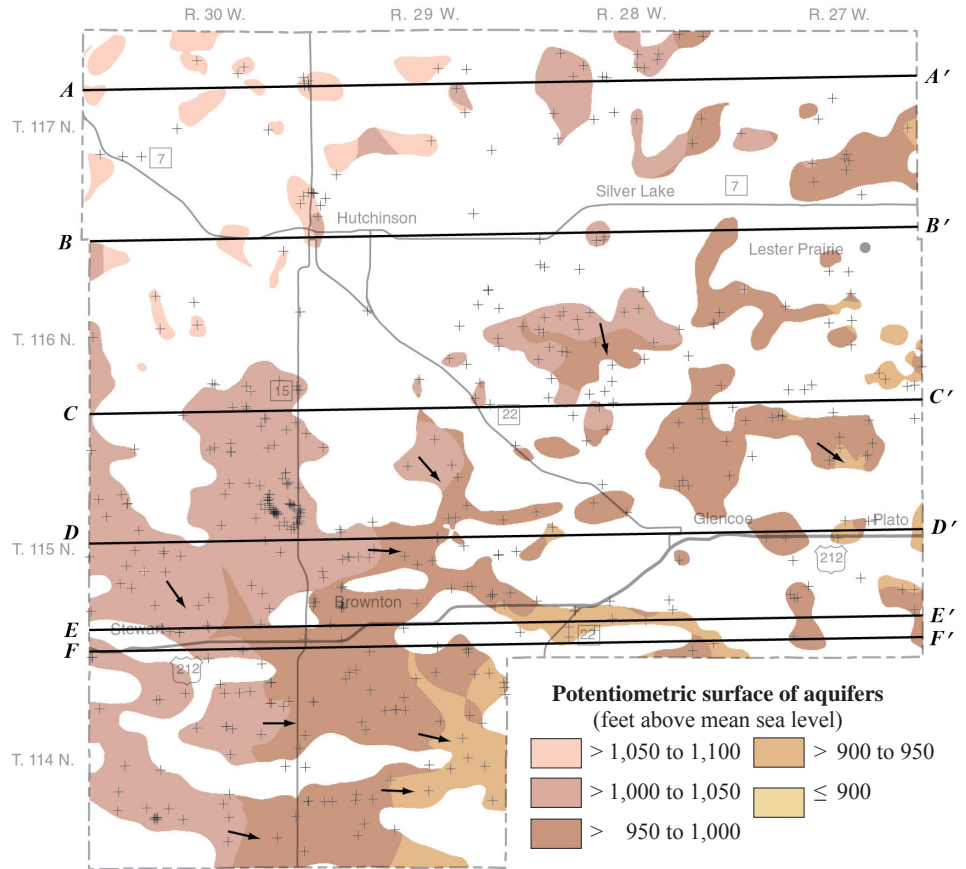


Figure 2. Potentiometric Surface of sdv buried sand and gravel aquifer (from Plate 7, Figure 2).

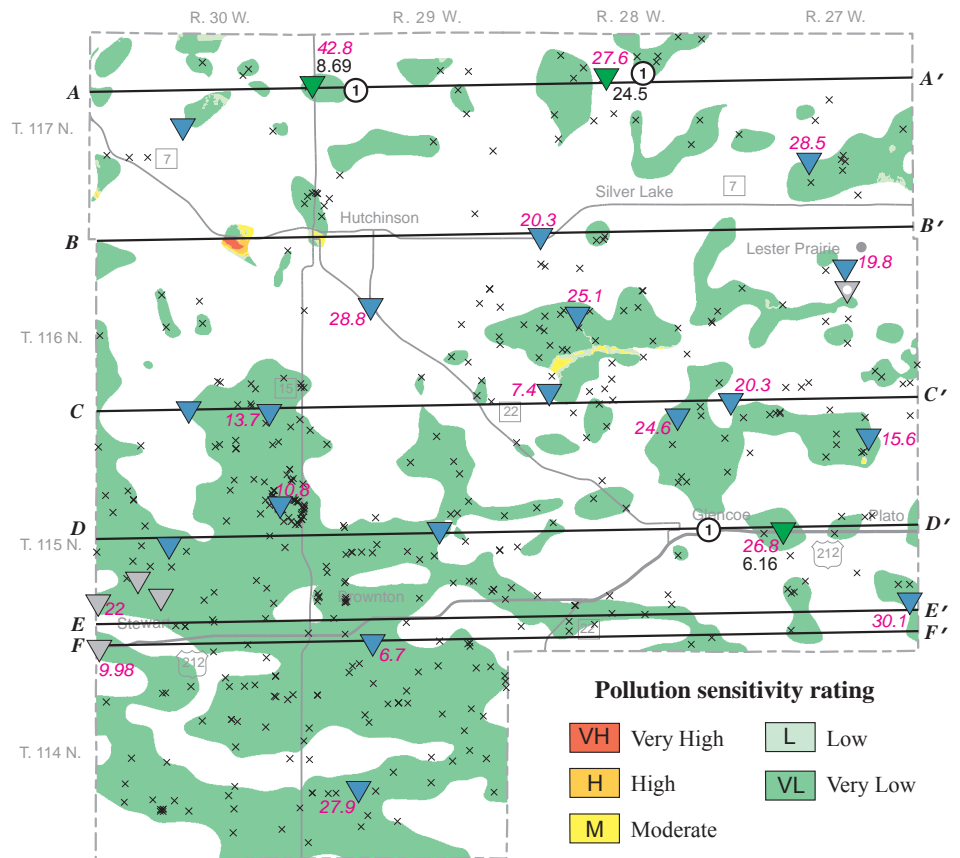


Figure 3. Sensitivity to pollution of sdv buried sand and gravel aquifer (from Plate 9, Figure 6).

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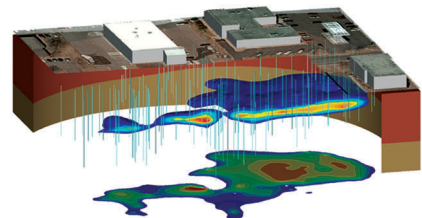
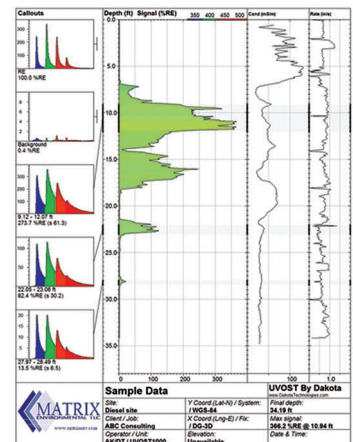
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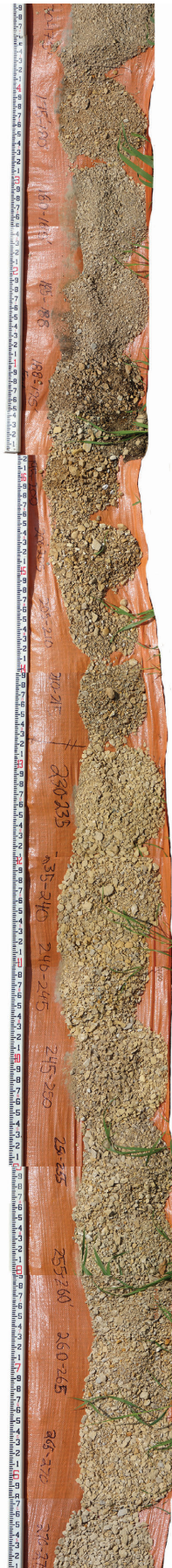


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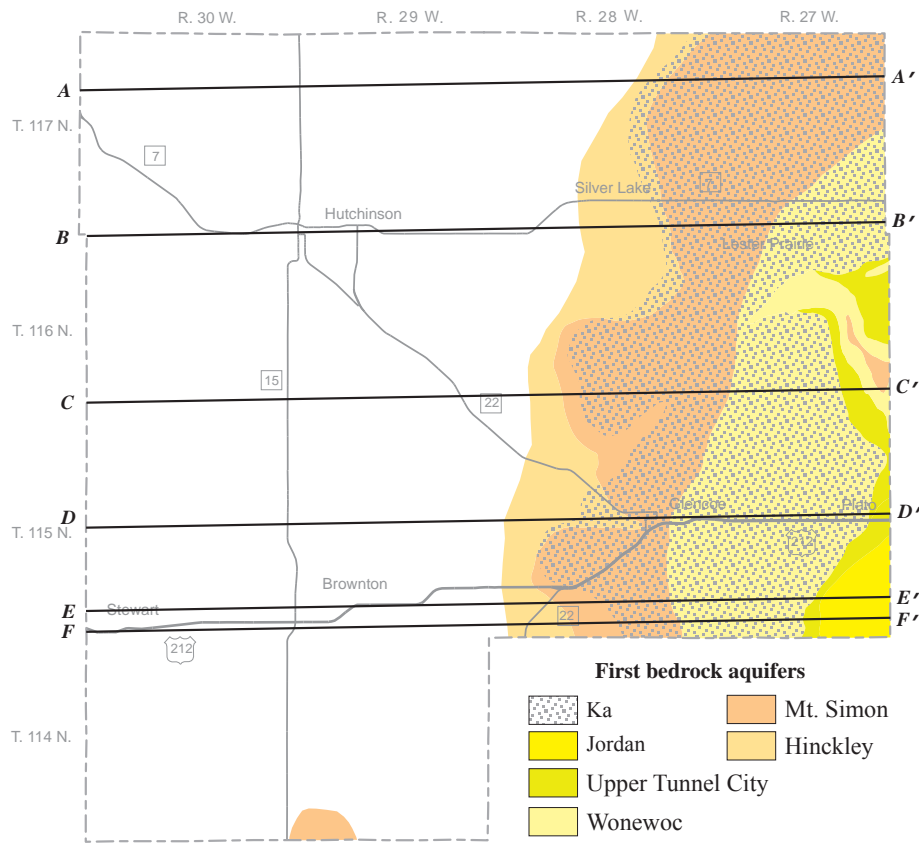


Figure 4. Simplified map of the bedrock aquifers (from Plate 7, Figure 8).

**Cross Sections**

Six hydrogeologic cross sections are shown in the McLeod County Geologic Atlas, Part B. Portions of two cross sections are shown in this article. The eastern third of cross section A-A' shows the Quaternary section overlying bedrock aquifers (Figure 5). The western third of cross section F-F' shows the Quaternary section overlying crystalline bedrock, which is not an aquifer (Figure 6).

The sand and gravel aquifers are shown by pattern on the cross sections. The Quaternary till units have limited permeability and are considered to be non-aquifer units; these units are shown in shades of gray. The sand percentage from the matrix texture of the less than two millimeter size fraction of the till units is used to estimate the relative hydraulic conductivity of the non-aquifer units. It is assumed that as sand content of the till increases, hydraulic conductivity also increases, and with greater hydraulic conductivity there is more potential for water movement through the till units. Lighter grays represent relatively higher hydraulic conductivities; darker grays represent relatively lower hydraulic conductivities.

The pink, green, and blue areas shown on these cross sections represent the groundwater residence time. This is the approximate length of time that has elapsed since the water infiltrated

the land surface to the time it was pumped from the aquifer. Groundwater residence time can be estimated by the amount of tritium (<sup>3</sup>H) that is present in the groundwater. Tritium is a naturally occurring radioactive isotope of hydrogen whose presence in water samples indicates that the water has infiltrated the land surface since the early 1950s. Concentrations of tritium in the atmosphere were greatly increased between about 1953 and 1963 by above-ground nuclear bomb tests (Alexander and Alexander, 1989). Because tritium decays at a known rate, the proportion of recently recharged water in a sample can be estimated by its tritium content. Water samples with tritium concentrations of 8 or more tritium units (TU) are classified as recent water that entered the ground since the early 1950s. Water samples with tritium concentrations of 1 TU or less are classified as vintage water that entered the ground before approximately 1953. Water samples with tritium concentrations greater than 1 TU and less than 8 TU are considered mixed waters because they are a mixture of vintage and recent waters.

Mixed tritium age groundwater was found in samples from the sdv aquifer to a maximum depth of 100 feet. In other areas of McLeod County, groundwater samples from shallow

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Featured Photo, cont.



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McLeod County Geologic Atlas, cont.

wells had a vintage tritium age, indicating very slow groundwater recharge. Groundwater infiltrates slowly from the surface into the shallow buried sand and gravel aquifers. Groundwater movement into deeper aquifers is very slow. The groundwater residence time for deep aquifers, as estimated by carbon-14 isotope analysis, ranges from 900 to 30,000 years.

Based on carbon-14 analysis, the water sample from the deep Mt. Simon aquifer well in the City of Winsted (Figure 4) had a groundwater residence time of 20,000 years. Water samples from the deep Quaternary sand and gravel aquifers near the City of Stewart (Figure 5) had residence times of 30,000 years.

**Arsenic**

Arsenic in concentrations greater than or equal to 10 parts per billion, the EPA standard in drinking water (U.S. Environmental Protection Agency, 2001), was found in 45 of the 81 sampled wells. These wells are distributed widely across the county and were constructed to varying depths in several different aquifers. All but one of the wells where elevated arsenic was found are constructed in Quaternary buried sand and gravel aquifers. Not all wells constructed in Quaternary sand and gravel aquifers have elevated arsenic, but all wells constructed in these aquifers in McLeod County should be tested for arsenic because the arsenic concentration cannot be predicted from stratigraphic correlation alone.

All of the wells near the City of Stewart that are constructed in buried sand and gravel aquifers have elevated arsenic (Figure 6). Wells in other areas that are constructed in the same aquifers often have relatively low arsenic concentrations.

**References Cited**

- Alexander, S.C., and Alexander, E.C. Jr., 1989, Residence times of Minnesota groundwaters: Minnesota Academy of Sciences Journal, v. 55, no. 1, p. 48-52.
- Petersen, T.A., 2013, Geologic atlas of McLeod County, Minnesota: St. Paul, Minnesota Department of Natural Resources, County Atlas Series C-20, Part B, 3 pls., scale 1:100,000.

**For More Information**

This atlas was funded in part by the Minnesota Environment and Natural Resources Trust Fund and the Clean Water Land and Legacy Amendment.

Electronic files of the Part B Atlas are available online at [http://www.dnr.state.mn.us/waters/programs/gw\\_section/mapping/platesum/mclecga.html](http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/mclecga.html).

PDF images and data of part A of the atlas can be downloaded from the MGS website at [http://www.mnngs.umn.edu/county\\_atlas/countyatlas.htm](http://www.mnngs.umn.edu/county_atlas/countyatlas.htm).

Printed versions of the Part A and B of the McLeod County Geologic Atlas can be purchased at the Minnesota Geological Survey, Publications Office, 2642 University Avenue, St. Paul, Minnesota 55114, (612) 627-4782.

For atlas or program questions contact: Todd Petersen (651) 259-5698 or Jan Falteisek (651) 259-5665.

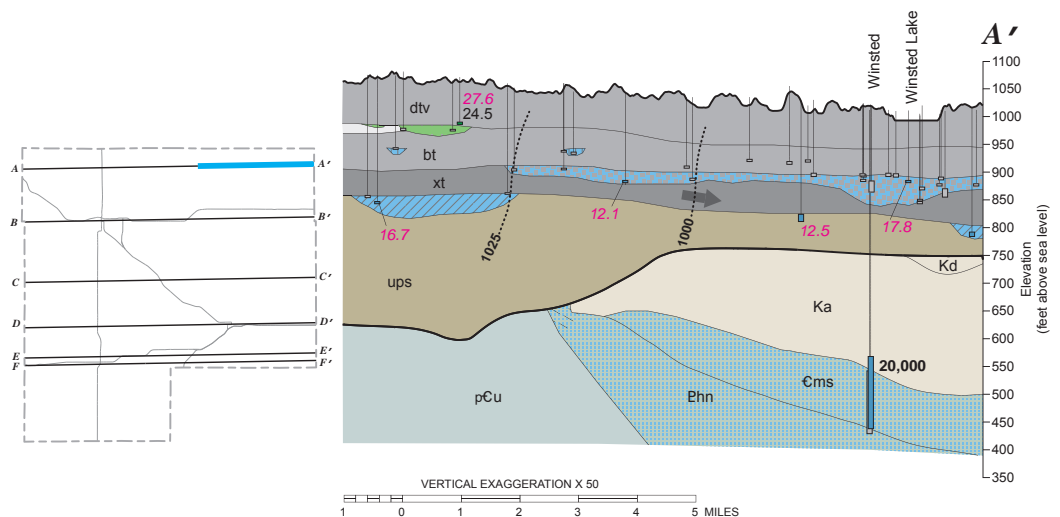
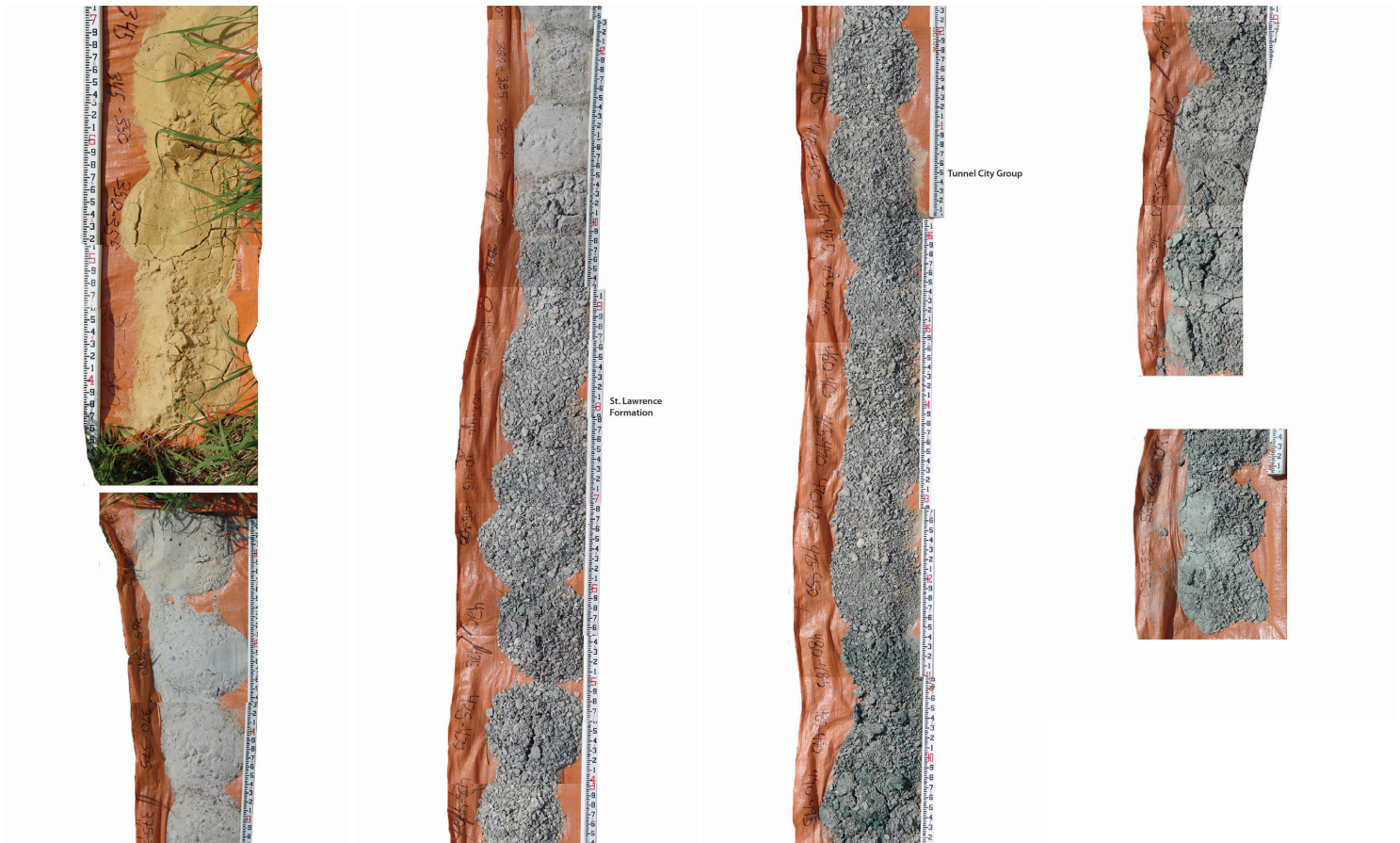


Figure 5. East third of cross section A-A' (from Plate 8).



Featured Photo, cont.



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# McLeod County Geologic Atlas, cont.

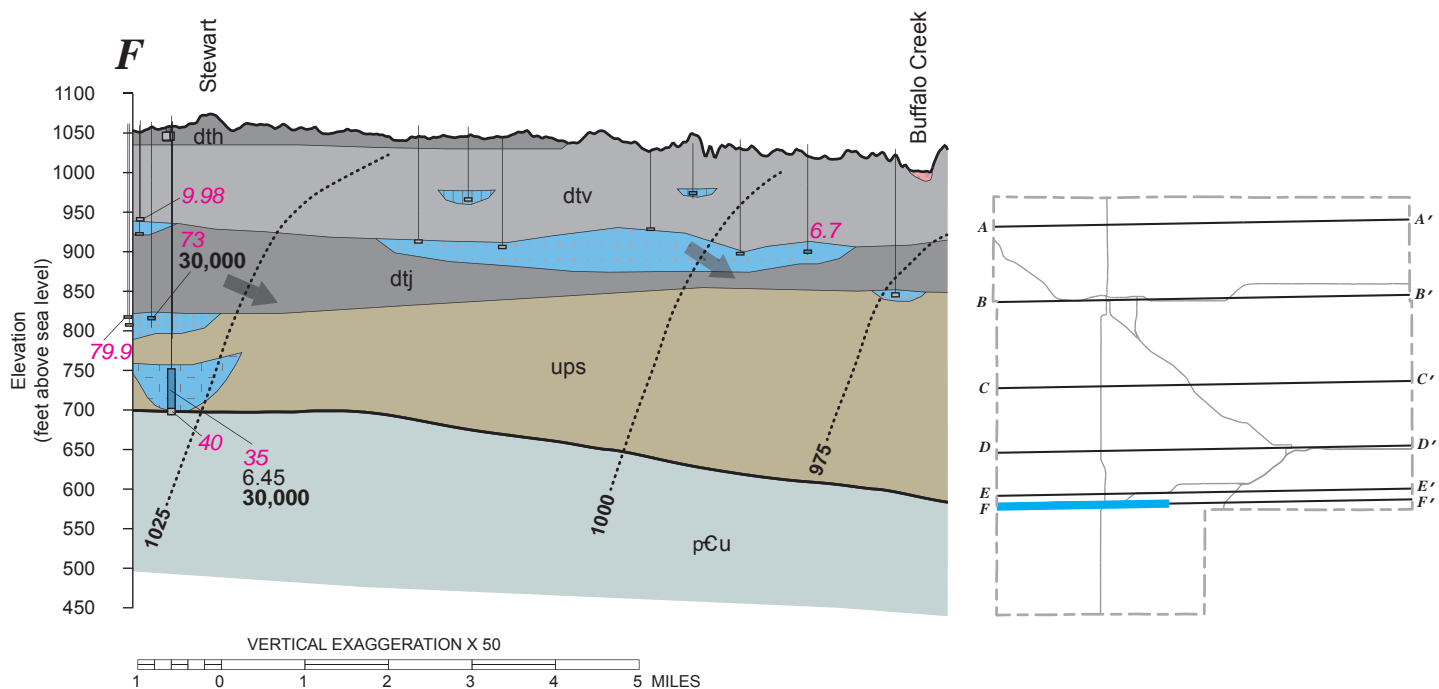


Figure 6. West third of cross section F-F' (from Plate 8)

### Aquifers - grouped by stratigraphy

Buried sand and gravel aquifers

sdv

sdj

sb

sx

su

Unnamed

Sedimentary bedrock aquifers

Ka Ka (probably low yielding)

ems Mt. Simon

Ehn Hinckley

Enhanced-permeability zone

### Quaternary non-aquifer units

Percent sand

dtv, bt > 40 and ≤ 50

dth, dtj, xt > 30 and ≤ 40

ups Texture unknown

### Bedrock non-aquifer units

Kd Dakota Formation

pCu Precambrian crystalline bedrock

### Tritium age

Recent

Mixed

Vintage

Not sampled for tritium

### Symbols and labels

14.0 Arsenic concentration ≥ 5 ppb

12.1 Chloride concentration ≥ 5 ppb

4000 Groundwater residence time in years

General direction of groundwater flow

1025 Approximate equipotential contour

Geologic contact

Land or bedrock surface

Legend for Figures 5 and 6.

# MGWA BOARD MINUTES

## Minnesota Ground Water Association Board Meeting Minutes

**Meeting Date: June 05, 2014**

**Location:** Fresh Grounds Café 1362 West 7th Street, St. Paul, MN  
**Attendance:** Eric Mohring, President; Lanya Ross, President-Elect; Bob Tipping, Past-President; Audrey Van Cleve, Treasurer; Avery Cota-Guertin, Secretary; Sean Hunt, WRI  
**Past Minutes:** Approved as amended.  
**Treasury:** Van Cleve provided the Board with copies of the financial report. Total income for the period of January 1, 2014 – June 3, 2014 is \$62,620; total assets as of June 3, 2014 are \$104,559. Net income is \$30,557. The 2014 Spring Conference brought in a net income of \$22,630. Van Cleve suggested that the Board discuss profits and potential uses at future Board meetings.  
**Newsletter:** The editorial team passed the newsletter materials to the production team, WRI; expected release of the newsletter will be in June.  
**Web Page:** Hunt added the audio from the past conference presentations to the MGWA web page. Audio from the 2014 Spring conference is being processed.  
**WRI Report:** WRI discussed a plan to with the Board to move the Foundation's unrestricted money into a separate Foundation account to make management of these funds less complicated. The Secretary will need to sign a resolution document to separate these funds. Tipping will coordinate with the Foundation and Leete to set up a meeting with the Foundation to discuss financial management moving forward.  
**Old Business:** 2014 Field trip. The Board discussed the feasibility of offering the "Minnesota River Tributaries" field trip that Carrie Jennings led. Mohring will contact Jennings and check if there is any interest in conducting the field trip.  
2014 Fall conference. Mohring reports to the Board that MPCA and Department of Agriculture superfund staff support the conference topics. Presentations may include the history of superfund through the federal perspective and Minnesota perspective. The Board discussed potential speakers and design layout.  
White paper documents and work groups. Tipping distributed the flowchart outlining the chronology document to the Board. Ross moves to post the chronology flowchart and document to the web page after some color modification is completed. The motion was approved. Tipping will send the flowchart and document to Hunt. The board discussed the web page layout and where to place generic informational documents and specific topic document. Only MGWA members may participate in a white paper work group. Ross moves to approve the recommended 5-8 people to be on the manganese white paper work group. The motion was approved.  
2015 Fall conference. MGWA is responsible for the conference registration; registration is expected to open around September 2014. Hunt is working on a draft of the registration form. This conference will only have one field trip. Organizing committees with financial components will need to get a draft of budgets to Leete. Looking for people to moderate rooms, manage technical equipment, and help with the front desk during the short courses. Hunt reported that they are working out the details in organizing posters, exhibitors, and sponsors. The Board discussed possibly forwarding the call for conference papers to non-karst hydrologists.

**Meeting Date: July 02, 2014**

**Location:** Fresh Grounds Café, 1362 West 7th Street, St. Paul, MN  
**Attendance:** Eric Mohring, President; Audrey Van Cleve, Treasurer; Avery Cota-Guertin, Secretary; Sean Hunt, WRI; Jeanette Leete, WRI; Tedd Ronning, Newsletter Editor.  
**Past Minutes:** Approved.  
**Treasury:** Van Cleve provided the Board with copies of the financial report. Total income for the period of January 1, 2014 – July 2, 2014 is \$62,563; total assets as of July 2, 2014 are \$104,625. Payment of 2013 Foundation money will be completed upon transfer of the restricted money into a separate account. Net income is \$30,410.  
**Newsletter:** Call for technical articles for the upcoming newsletters.  
**WRI Report** WRI provided the Board with the Business Manager's report. Leete filed tax filing extensions for the Foundation and MGWA. The newsletter is on the webpage and notifications will be sent to MGWA members.  
**Old Business:** 2015 Sinkhole Conference. Jeff Green is organizing the field trip and obtained bids for the buses. Organizing groups are to have draft financial budgets to Hunt and Leete by July 1, 2014. Hunt presented to the Board a draft registration form for the conference. Van Cleve will assist with tasks designated to the front desk and Mindy Erickson is helping to organize food for the event. The Board discussed the need for volunteers to assist with moderating the room sessions. Immediate needs are to get the online registration and ordering set up. However, this is depended on the budget which will be finalized in the next few months.  
2014 Fall Conference. Mohring reported holding two meetings to determine conference topics and agenda. The Board discussed the conference topics and speakers. Mohring will provide Hunt with a conference description, speaker list, and a draft of conference topics and titles for the web page by August 1, 2014.  
White paper topics. Members of the Manganese work group were added to the google drive to collaborate on the topic.

## MGWA 2015 Membership Dues

Professional Rate:	\$35
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Membership dues rates were revised at the October 1, 2010 meeting of the MGWA Board. They remain unchanged.

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