Minnesota Ground Water Association
www.mgwa.org
Newsletter

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Featured:

MGWA President Dale Setterholm

Inside:

Communicating About Ground Water Contamination

By Tannie Eshenaur, Minnesota Department of Health

My phone rings. It's the father of a 10 month old who lives in a suburb of the Twin Cities. Their family already used bottled water before trace levels of contamination were found in the municipal water supply. Now he's concerned that even washing their dishes, or more specifically the child's bottles, will expose the child to unhealthy levels of contamination.

It's the "Question and Answer" segment following multi-agency presentations about detections of contamination in private drinking water wells. A person in the back of the meeting room stands up and suggests that the speakers are creating panic over chemicals that are harmless as part of a scheme to force municipal water on the neighborhood.

While watching my daughter's fast pitch softball game, another mother leans over and asks if I know anything about pollution in wells in their suburb. She's heard about it from neighbors and is wondering if it could happen to their well and how the situation might affect their property value.

For those of us who work with drinking water, communicating with people about contamination is a complex and difficult part of our jobs. We've all had the experience of widely differing reactions from people facing similar risks and situations. Unfortunately, there is no magic list of words or special formula that answers every situation. There are, however,

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President's Letter

By Dale Setterholm, MGWA President

To begin, I would like to congratulate Laurel Reeves on her productive year as our President. The conferences she organized on Ground Water Sustainability and Geochemistry for Scientific Investigations and the ground water field trip for legislators are obvious highlights, but the positive and professional manner in which she led the organization is equally impressive. I have already benefitted from the talent and commitment that Jeff Stoner brings to the job of President Elect and the great continuing service of Craig Kurtz as Treasurer, Jon Pollock as Secretary, and Norm Mofjeld as Editor.

In my opinion, the strength of our organization is derived from the many different perspectives on ground water our members contribute. My personal perspectives include those of well owner and geologist. In anticipation of my term I had my well water tested for a broad spectrum of natural and anthropogenic components. Considering the cost of such testing I was almost disappointed to learn that my relatively shallow Prairie du Chien well has no significant contamination other than iron bacteria. While I'm pleased that my water supply shows no contamination, I do not interpret that to mean that my water supply is not at risk.

In fact, I have designed our MGWA Spring Conference (April 12) to review the practices, conditions, and technologies that we apply to waste water treatment, agriculture, turf management, water usage, stormwater management, and other potential contaminant sources to evaluate such risks. I will be interested to learn if those practices are still appropriate in light of today's higher demand for ground water, greater load of potential contaminants, diminishing supply of fossil energy sources, and the societal desire for clean and abundant water.

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2006 Deadlines

Issue	Due to Editor
June	05/12/2006
September	08/11/2006
December	11/09/2006

MGWA NEWS

New MGWA Officers

Jeff Stoner, Director for the U.S. Geological Survey (USGS) Water Science Center of Minnesota, has been elected President-Elect of MGWA. **Jon Pollock**, President of Frontline Environmental, LLC, has been re-elected Secretary of MGWA. Congratulations to Jeff and Jon!

New MGWA Representative to MGS Mapping Committee

Jon Pollock will be the new representative from the MGWA on the State Mapping Advisory Committee (SMAC). The SMAC is a requirement of the National Cooperative Geologic Mapping Act. The act created federal funding to match state funding for geologic mapping. The Minnesota SMAC consists of five members, one from the Minnesota Exploration Association, two from state agencies (currently Minnesota Department of Health and Minnesota Department of Natural Resources, Lands and Minerals Division), one from the American Institute of Professional Geologists and one from the Minnesota Ground Water Association. The committee reviews mapping plans and proposed projects put forward by the Minnesota Geological Survey (MGS) and chooses those projects they feel are most worthy of funding. The membership changes on an irregular basis. **Jim Piegat** served previously as the MGWA representative.

MGWA Members Become AIPG Officers

Election results for the Minnesota Section American Institute of Professional Geologists (AIPG) for 2006 indicate Damon Powers as President-Elect, **Pat Terhaar** as Vice President and **Trey Howard** as Treasurer. **Charles Tiller** is the incoming President. Pat, Trey and Chuck are members of MGWA. The Minnesota Section of AIPG will be hosting the National AIPG convention in St. Paul September 25 through 28, 2006. There are still volunteer and sponsorship opportunities available. **Michael Ruddy** and **Jane Willard**, both MGWA members, are co-Chairs of the 2006 Planning Committee. Information about the convention is located on the "Minnesota Rocks in 2006" website www.aipg2006.org.

Member News

Dr. Daniel DeJoode recently joined Barr Engineering Co. as an Environmental Review Specialist where he will be involved in environmental assessment and permitting. Dr. DeJoode has expertise in wetlands, plant ecology and plant taxonomy, with emphasis on assessing ecological impacts from human disturbance. His recent work includes botanical studies of calcareous fens, applying Minnesota Department of Natural Resources technical guidelines for identification of calcareous fens, and predicting impacts of highway construction on fens and associated wetlands.

Mr. Mark Johnson has joined Peer Engineering, Inc. as Senior Environmental Specialist and Project Manager in the firm's Bloomington office. Mr. Johnson has 17 years of experience coordinating, conducting and managing all phases of environmental due diligence, assessment, agricultural and brownfields-related work.

Matt Erickson has been employed in the Bloomington office of the environmental consulting group of Braun Intertec Corporation since September of 2004. Matt is a supervisor and coordinates Phase I Environmental Site Assessments and client liaison.

Dr. James Arndt has accepted a position as senior environmental consultant at Natural Resource Group, Inc. Jim will develop and implement Agricultural Impact Mitigation Agreements and Plans along pipeline rights-of-way. He will also prepare soils, wetland, and geology resource reports prepared for pipelines and ethanol plants. In addition, he will be involved in wetland delineation, restoration and monitoring, and various aspects of ground and surface water hydrology and geochemistry. He can be reached at (612)215-6095; jlarndt@nrginc.com.

President's Letter, cont.

One of my goals is to provide better support for decision-makers at local, regional, and state levels. To achieve that goal ground water professionals must demonstrate more clearly the cause and effect relationship between human endeavors and ground water quality and abundance. Monitoring, as a direct line of evidence, must be conducted over shorter intervals of time and distance to provide timely feedback on specific practices. We should be monitoring what we are putting into the ground water system, as much as what we are getting back. I have asked our spring conference speakers for their ideas on the effective monitoring of our waste treatment and land use practices. Because many of our supply wells continue to produce uncontaminated water, there is a common assumption (perhaps misconception) that our practices are not degrading ground water. We should use age-dating of ground water to clearly separate monitoring of recent recharge from analyses of water that entered the ground decades, centuries, or millennia ago, and therefore provide no useful feedback on the effectiveness of our current systems or laws.

To adequately advise our decision-makers on the issue of water abundance we must first map the aquifers. In the last 25 years we have completed geologic atlases in the County Atlas Series for only 14 of Minnesota's 87 counties. This comprehensive geologic mapping is also essential for interpretation and design of monitoring and ground water protection plans.

Finally, I would like to break down the misconception that ground water protection and the economic well-being of the state are competing concerns. In fact, they are both essential components of any bright future. I see complete congruence in Minnesota providing the highest quality food in the world, the highest standard of healthy living, and clean and abundant ground water.

Communicating About Ground Water Contamination, cont.

some helpful tools and hints that enable us to provide responsible risk communication for the people we serve.

Classifying the listeners

As a community health educator, one strategy I've found helpful is to classify listeners by whether or not they will be impacted by the contamination and their level of concern. As displayed in the simple matrix below, people can be grouped into four categories; impacted and concerned, impacted and unconcerned, not impacted and concerned and not impacted and unconcerned.

Clearly, those in the "not involved" category require little attention, although they may hear messages intended for the other groups. That's why it's always productive to include our routine messages about protecting public health and water as part of communication about site-specific contamination issues.

The group that displays high concern but is not impacted by contamination are the equivalent of the "worried well patient" in a medical clinic setting. Sometimes they simply need reassurance that, to the best of our knowledge, they will not be impacted by the contamination. Often describing the flow of ground water for that site, the well monitoring system, or the role of sentry wells is enough to provide that reassurance. In some cases, however, many conversations with multiple staff still do not satisfy their concern. In these cases, congruent and consistent messages from various staff are essential.

People who are unconcerned but impacted by contamination are a challenge to engage in the communication process. They are often unaware of the site contamination and unlikely to respond to news releases or invitations to public meetings. They are more likely to respond to repeated phone calls and face to face

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Classifying listeners	**Impacted by contamination**	**Not impacted by contamination**
Concerned	Engaged, need education	Need reassurance, education
Unconcerned	Need to be engaged first	Not involved

2006 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.

conversations. Also, they are more receptive to learning in informal situations, listening to their neighbors and friends. One of the implications of this informal network is that our messages need to be simple and repeatable from neighbor to neighbor.

The final group is those who are concerned and impacted by the contamination. Even among this group there can be a wide variety in reactions. They are engaged, to be sure; some are even outraged by the situation. The challenge with this group is to acknowledge their outrage and provide education about the situation that enables them to make good decisions about actions needed to protect their family's health. In Minnesota, many residents take clean water for granted. The discovery of contamination in their drinking water is a rude awakening.

Tuning in to listeners' perceptions of risk

Why is it that people's responses to risk are so different? Some is attributable to variation in personal beliefs and values, differing attitudes toward the environment and technology and individual health status. A well-researched influence on people's reaction to risk is that of risk perception. Often, even if we could quantify the risk with precision, it would not relieve people's fears. Perceptions of risk overrule scientific explanations. Looking at a few of these factors can help us understand and communicate more effectively with those who are impacted by contamination.

Daily, all of us choose to take risks. We zoom through a yellow light, ski down a black diamond run or skip regular exercise. For most of us, risks we chose for ourselves are acceptable; those imposed on us are not. Contamination in drinking water is not something most people would choose.

Risks that are natural are more acceptable than those that are manmade. Arsenic in drinking water from natural geologic formations is less likely to provoke outrage than chemicals from industrial spills, Superfund sites or dumps.

Risks that are distributed evenly throughout the community are more acceptable than those that only affect certain households. Neighboring wells screened in two distinct aquifers may result in one home requiring a carbon filter system, while the other does not. Likewise, knowing in which aquifer wells are screened may lead us to sample one well and not the next-door neighbor's. This can lead to community perceptions that we are not doing a thorough investigation.

Risks that lead to dreaded diseases are less acceptable than those that lead to less dreaded diseases. When the contaminant of concern is a known human carcinogen or linked to birth defects, people are much more emotionally involved than if it were bacteria and might cause gastric distress. Risks that affect children more than adults are also less acceptable.

There is a higher perceived risk when the government authorities and responsible parties are seen as being unresponsive. Because of this, sometimes it's valuable to take initiative and communicate with the public before all the sampling results are known or before a plume map can be constructed. Then, updates should be provided as new information becomes available. The benefits of being responsive to people's questions outweigh the lack of information about the site, particularly when site investigation is prolonged.

Key concepts

Effective risk communication in non-crisis situations educates as well as informs. Be aware that the people with whom you are communicating will have varying levels of understanding and scientific knowledge. The concepts below are key to understanding ground water contamination and public health.

Exposure pathways. Many people are familiar with an informal version of the infectious disease "chain of transmission" from the common cold. A similar "chain" exists for environmental exposures. An environmental exposure pathway for ground water contamination includes five points:

- the source of contamination – chemicals from spills, dumps, Superfund sites
- a medium to transport the contamination - water
- a point of contact – wells, taps, showers, laundry
- route of entry – ingestion, inhalation, skin absorption
- receptor population – people

As in the case of infectious disease, the exposure stops when the chain is interrupted. Picturing this chain assists people in understanding how we target our public health interventions. For example, it clarifies why we encourage the proper sealing of wells in contaminated aquifers. Though water containing non-volatile chemicals might be safely used to water lawns, it also leaves a complete exposure pathway intact for potential future exposure. Or, if the contaminant of concern is volatile, both the inhalation and the ingestion routes of entry into people's bodies must be prevented; and even non-household uses could involve exposures.

In Minnesota, many residents take clean water for granted.

Dose and duration. Most people associate the presence of contaminants in drinking water with harmful health effects. However, the mere presence of a contaminant does not mean someone will experience adverse health effects. The average person is unacquainted with dose-response relationships, exposure thresholds, or relative source contributions. Yet these are all factors in determining drinking water standards that protect public health. While the public may not thoroughly understand these concepts, examples of what is considered in the process of deriving standards can be helpful. For example, it's reassuring to know a standard is based on a lifetime of drinking two liters of water a day or that the level is calculated to take into account the unique vulnerabilities of children.

Plume maps and models. The people with whom we are communicating may have a limited understanding of hydrogeology. When they see a plume map or model of ground water flow, it may appear as though there are no uncertainties in mapping the site contamination. In educating about ground water contamination, we must be careful to discuss the limits of our ability to "see" underground. That our information comes from piecing together sampling results from a discrete

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Your Newsletter has a New Look

With this issue we are introducing an updated look for the MGWA Newsletter and we hope that it will provide you a more enjoyable reading experience. The stories, news, and articles that you look forward to four times a year are not changing, but you will note a greater use of color and what we hope is a more open, clean, and easier-on-the-eye layout.

The look you see on the pages of this issue is the culmination of several years of development. We began in 2004 with a survey of readers to collect information and suggestions from readers. That survey told us that most members were quite satisfied with the newsletter. It also told us how you read your newsletter, which we thought important when considering any changes.

The last printed and mailed newsletter was the December 2002 issue. Since then, most members get their newsletter on-line as a PDF document. We've taken advantage of on-line distribution over the past several years by adding more color photographs and color illustrations. But the rest of the page remained black and white.

So after a lengthy period of discussion, review of other newsletters, and plain old trial and error, we are at last proud to present the "new" MGWA Newsletter. The most noticeable change is the use of colored sidebars, color-coded sections, and color bars above article titles. Where possible, the pages include more white space for eye-ease. Every effort will be made to arrange articles on pages in a way that will make them easier to scan and read on-line.

We hope you enjoy the "new" newsletter. The newsletter team would like to hear what you think about the updated look, so please use the link below and send us your thoughts.

Send your comments about the new look to:

editor@mgwa.org

Communicating About Ground Water Contamination, cont.

number of wells, the potential for flow through fractures, or variation in effectiveness of confining layers are all examples of limitations in our understanding of the site. Candidly acknowledging these unknowns helps us maintain trust with communities when we encounter unanticipated results in the course of site investigation.

Some other helpful hints:

Avoid " techno talk." Not only does technical language create barriers between you and your listeners, specialized terms often carry a different or opposite meaning in normal conversation. For example, to say the number of cases of cancer in a zip code area is "insignificant" conveys a different meaning to a statistician than to a young mother who perceives there is an excess of cancer in her neighborhood.

In the context of a national news broadcast, a "conservative" estimate of damage for a natural disaster means to the listener it's a quick guess that will likely change and increase as time passes. On the other hand, when we talk about our Health Risk Limit (HRL) standards for ground water as being "conservative" we mean that they are protective of even vulnerable populations such as children, women of childbearing age and the elderly for exposures over a lifetime.

Stay clear of comparisons. Often I am asked to provide comparisons about risks or levels of contamination. Comparisons should be avoided because they often backfire on the speaker or muddy issues. When trying to explain parts per million, to say 'it is like a drop in a swimming pool" minimizes contamination and may be perceived by the listener as an attempt to excuse pollution. Likewise, comparing the risk of an adverse health outcome (one excess case of cancer in a million) to voluntary or natural risks of daily life (being struck by lightening) is not reassuring or satisfying to listeners because of the risk perception principles outlined above.

Provide practical alternatives. Even after the most eloquent risk communication, some listeners will still want to reduce their exposure to contaminants. People vary in their tolerance of risk. When possible, be sure to include appropriate ways that they can prevent or reduce their exposure such as using a granular activated carbon pitcher, running a bathroom exhaust fan or buying bottled water.

Promote environmental health. When there is concern over contamination and listeners are engaged, it's a opportune time to remind them of steps they can take to protect their drinking water, such as regular testing for bacteria and nitrates, disposing of old medicines in the trash rather than the toilet, or properly sealing abandoned wells.

Conclusion

Whether "educator" is a part of our job title or not, most of us whose work is related to drinking water will talk with the public about contamination at some time. Some of the most effective education takes place in informal, unplanned settings. An example is when an employee goes to a home to take a water sample and talks with the resident. It may occur when a staff member calls to make an appointment and the resident has questions about why the sampling is necessary.

As our technological capability to detect chemicals at lower levels improves, being able to communicate about levels of contamination below drinking water standards is going to be a challenge. Our communication should relieve needless anxiety and increase understanding of the situation. At no time do we want our educational efforts to make people casual about contamination. On the other hand, fear and alarm make for poor decisions. Our goal is to enable our listeners to make wise decisions about actions they can take to protect their health.

MGWA Thanks Our Corporate Members

Interpoll, Inc.

Environmental Strategies Consulting LLC

Liesch Associates, Inc.

TestAmerica, Inc.

BUSINESS NEWS

AET acquires GME Consultants

Effective January 1, 2006, American Engineering Testing, Inc. (AET) of St. Paul, Minn., and GME Consultants, Inc. (GME) of Minneapolis, Minn., have entered into an agreement to purchase certain assets of GME. Combining both firms will result in additional expertise, market sectors, and geographic presence, setting the stage for continued growth and success.

AET is an employee-owned company with headquarters in St. Paul. The firm and its affiliate, American Petrographic Services, Inc. (together comprising American Consulting Services) specialize in geotechnical, environmental, materials, concrete petrography, and forensic services for public and private sector clients in the Upper Midwest. The combined organization has offices in Minnesota, Wisconsin, South Dakota and Florida. (From press release dated January 4, 2006, from American Engineering Testing, Inc.).

Four Keys to an Internet Portal for Minnesota Ground-Water Information —

A Four-Part Series Highlighting the Minnesota Ground-Water Information Guide

— By Tim Thurnblad, Minnesota Pollution Control Agency

This is the first in a series of four articles about the Minnesota Ground-Water Information Guide. The guide is made up of four components. This article focuses on the "Current Topics" component. To access this component, first visit the guide's home page, then click on the "Current Topics" icon in the left margin.

Current Topics Web Review for Minnesota Ground-Water Projects

The Current Topics component was developed to help readers find a select (limited) subset of web pages and online documents that address topics considered to be special, emerging, important or otherwise popular within the category of 'Minnesota ground water'. It features study approaches, example projects, selected contaminants, issues, concepts, and best management practices for ground-water projects, including planning and management. The following topic areas are included in this component:

- Ground-Water and Surface-Water Interactions
- Karst
- Ground-Water Pollution Sensitivity and Time of Travel
- Wellhead Protection
- Ground-Water Supply and Sustainability
- Stormwater
- State and Federal Monitoring Activities
- Arsenic
- Nitrate
- Pesticides
- Solvents and other Organic Chemicals
- Emerging Contaminants
- Selected Ground-Water Publications Lists

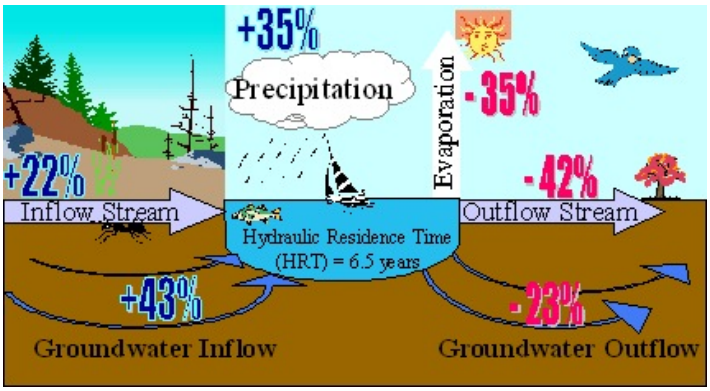
Now it's time for a pop quiz to see if you are paying attention. Let's see how you answer these questions (yes or no):

- Would you like to quickly check what new approaches investigators are applying to today's challenging ground water problems?
- Would you like to find out who has experience working in karst areas or investigating ground-water and surface-water interactions?
- Would you like to find out how new stormwater regulations and water sustainability issues relate to ground water?
- Are you wondering what the most troublesome and newest contaminants of concern are for Minnesota ground water?

If you answered 'yes' to all the questions, then congratulations! You are a diligent, upstanding, caring ground water person and you'll probably find the "Current Topics" component very useful.

Part of the rationale for publishing this article in the MGWA newsletter is to familiarize readers with the guide so you will know when to use it to help with your ground-water projects, studies, or questions. To that purpose, the remainder of this article features examples (excerpts) of what you will find in the 'Current Topics' component:

Siseebakwet Lake ground water and surface water interaction study (MPCA)



This detailed report (in PDF format) answers questions such as the following:

- Is it possible to calculate what percentage of lake water comes directly from ground water?
- How can local hydrogeology and climate change control lake transparency?
- What else besides algae can cause lakes to change color?
- What is a marl lake and how is it created?

Karst features of Minnesota

This web site is about karst features of Minnesota. Southeastern Minnesota is part of the Upper Mississippi Valley Karst that in-

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Four Keys to an Internet Portal for Minnesota Ground-Water Information, cont.

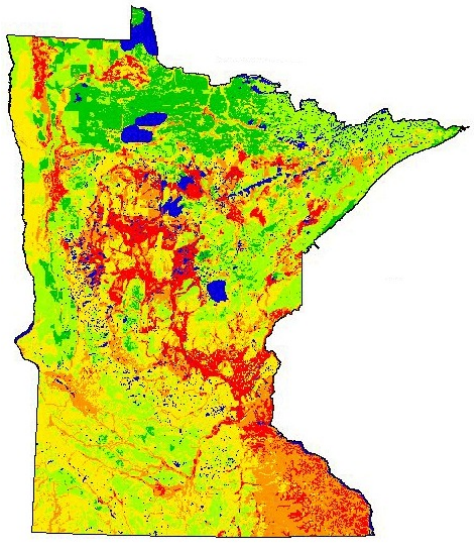
cludes southwestern Wisconsin and northeastern Iowa. Karst lands in Minnesota are developed in Paleozoic carbonate and sandstone bedrock. A significant sandstone karst has developed in Pine County. Most surficial karst features such as sinkholes are found only in those areas with less than fifty feet of sedimentary cover over bedrock surface.

Ground water becomes iron-stained surface water as it exits a rock formation with karst features in Pine County, Minnesota. Photo Tim Thurnblad

Since the early 1980s, the Minnesota Geological Survey and the Department of Geology and Geophysics at the University of Minnesota have been mapping karst features and publishing various versions of results in their County Atlas Series. Now, a karst feature database of southeastern Minnesota has been developed that allows sinkhole and other karst feature distributions to be displayed and analyzed across existing county boundaries in a Geographic Information System (GIS) environment.

Ground water pollution sensitivity

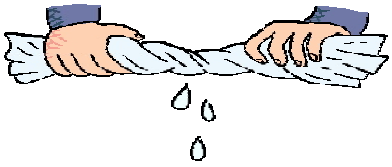
The Minnesota Department of Natural Resources (DNR) defines a sensitive area as a geographic area characterized by natural features where there is significant risk of ground-water degradation from activities conducted at or near the land surface. Sensitivity assessments are based on the geologic and hydrogeologic factors that affect the ability of geologic materials to restrict the downward migration of contaminants to the ground water of interest. The result is called geologic sensitivity.



Ground water sensitivity to pollution in Minnesota

Sustainability of Minnesota's ground water

Much of Minnesota is naturally endowed with good supplies of ground water. However, those supplies are not evenly distributed in the state nor are they limitless. Overpumping of wells causes continued declines of ground water levels in aquifers, local impacts on streams and wetlands, and the potential that needed ground water resources would not be available for future use. Ground water withdrawal that results in unacceptable impacts on the resource is not sustainable.



This web page includes hypertext links to a (June 2005) "Statement of Issues and Needs" and a series of supporting fact sheets about the sustainability of Minnesota's ground water. The DNR publication, Minnesota's Water Supply: Natural Conditions and Human Impacts, published in 2000, highlights the following topics:

- current water budget and human impacts;
- an overview of water resource management concerns that are being addressed statewide and by geographic and hydrogeologic areas;
- current strategies for water supply management, and planning and development suggestions.

Emerging contaminants in the environment

The United States Geological Survey (USGS) Toxic Substances Hydrology Program has a wealth of information on its "Emerging Contaminants In the Environment" web page.

Environmental researchers are documenting with increasing frequency that many chemical and microbial constituents that have not historically been considered as contaminants are present in the environment on a global scale. These "emerging contaminants" are commonly derived from municipal, agricultural, and industrial wastewater sources and pathways. These newly recognized contaminants represent a shift in traditional thinking as many are produced industrially yet are dispersed to the environment from domestic, commercial, and industrial uses. The major goal of the USGS Emerging Contaminants Project is to provide information on these compounds for evaluation of their potential threat to environmental and human health.

For Minnesota-related studies on this topic, see the USGS web page entitled "Emerging Contaminant and Endocrine Studies in Minnesota."

Until the next edition

Future editions of the MGWA newsletter will feature other components of the Minnesota Ground-Water Information Guide. You can view the guide at the following addresses on the World Wide Web:

www.mgwa.org/gwig/index.html or

www.geo.umn.edu/mgs/gwig/index.html

If you have questions about the guide, please contact Tim Thurnblad at (651)296-8582 or tim.thurnblad@pca.state.mn.us.

Climate Trends in Minnesota: Some Indicators and Implications

— By Dr. Mark Seeley, University of Minnesota Extension Meteorologist and Climatologist

In contrast to those who live in equatorial or coastal environments Minnesotans recognize that climate behavior is not stable or reliable, but highly dynamic and ever changing. There have been periods of great climatic variability when each year was distinctly different from those that preceded or followed. Conversely there have been multi-year periods when somewhat similar patterns of temperature, moisture, or storminess were prevalent. We do not live in precisely the same environment our ancestors did. Rather each generation in Minnesota seems to experience somewhat different patterns and extremes of climate.

During the last 25 years our Minnesota climate has exhibited several significant trends. Two in particular have had obvious impacts and are statistically detectable in the data of most Minnesota climate stations: (1) warm winters (both in persistence and amplitude of the positive temperature departures); (2) greater annual precipitation (most profoundly in seasonal snowfall and thunderstorm rainfall). A closer look at these trends helps us understand some observable indicators of their effect.

That Minnesota has warmed over the past century is evident in the data and widely acknowledged in the scientific community (see Figure 1). What's interesting is that among the four seasons of the year, the primary contributor to this warming trend is winter. The statistical signal for warm winters appears in a number of ways. An examination of the statewide monthly mean temperature values since 1895 reveals that ten of the warmest twenty November-through-March periods have occurred since 1980-1981 (see Table 1 on page 10).

During the last 25 years we find three of the most significant monthly temperature aberrations in state history. The largest negative departure by far occurred in 1983 which brought the coldest December of the 20th Century with a mean statewide temperature that was 14.8 degrees colder than normal. February of 1998 produced a mean monthly temperature statewide that was 16.2 degrees F above normal, while January of 2006 brought a mean monthly statewide temperature that was 17.0 degrees above normal. Seven of the last eight winters have been significantly warmer than normal with numerous occasions when daytime mean values of temperature were 20 to 30 degrees F warmer than the historical average. Both January of 1990 and January of 2006 brought not a single day of below zero F temperature readings to the Twin Cities area, something that had not happened since 1846 when readings were taken at Fort Snelling.

Observable indicators of this warm winter trend are evident even to the casual observer. Golf courses have been open at times in every month of the winter (depending on the absence of snow cover). The outdoor construction season has lingered well into the winter months with relatively minor weather obstructions to pouring concrete, welding, excavating, or re-roofing endeavors. Minnesota soils are

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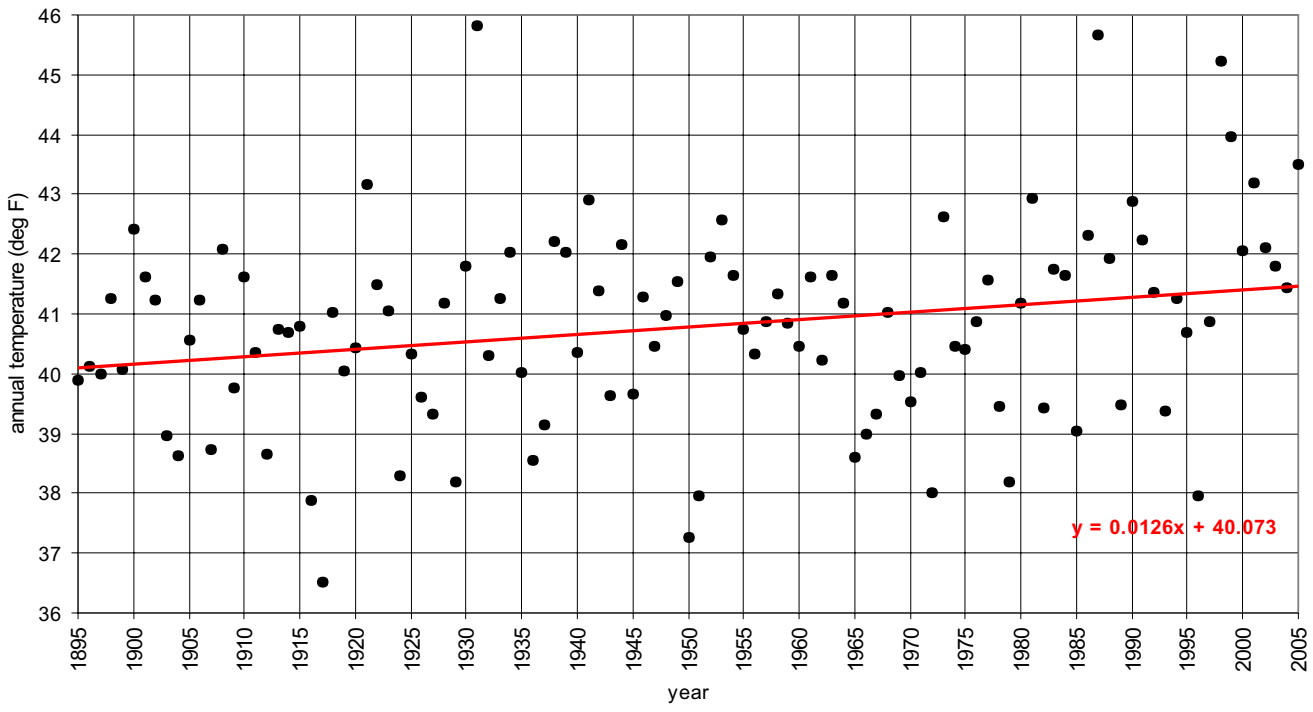
Figure 1. Minnesota State-Averaged Annual Temperature (from Midwestern Regional Climate Center)



Climate Trends in Minnesota: Some Indicators and Implications, cont.

frozen for fewer days and there have been shortened ice-fishing seasons. Many more soil microbes, plant pathogens, and insects more commonly survive Minnesota winters. Wildlife biologists suggest that animal migration, hibernation, and winter foraging behaviors have been altered by warmer winters as well. On a positive note, there has been reduced consumption of energy for residential and commercial heating, as Heating Degree Days (HDD) have been consistently averaging less than normal in the winter months.

The second, but certainly no less significant recent Minnesota climate trend is an increase in annual precipitation. The statistical details are a bit disconcerting. Most climate stations in the state show an increase in average annual precipitation that ranges from 1 to 4 inches over the past 50 years. Some cases are more extreme than others (see Table 2).

These are significant increases. Two precipitation features contribute significantly to this increase: greater winter snowfall; and more frequent and intense thunderstorm rainfall. A study of the seasonal snowfall records from 46 locations across Minnesota, covering the period from 1890 to 2000 revealed that 41 of these climate stations show an increase in average annual snowfall, as much as 10 to 20 inches in some cases. But can this really translate to more water on the Minnesota landscape since snow density (water content of the snow) varies so much? Indeed for the most part it does mean more water. Examining the monthly precipitation (liquid

— *continued on page 11.*

Table 1. Rank of the Warmest Twenty Statewide November through March Periods Since 1895 (Note: the median value of the historical distribution is 17.8 degrees F)

Rank	Winter	Mean Temp	Rank	Winter	Mean Temp
1.	1999-2000	26.1 F	11.	1994-1995	22.0 F
2.	2001-2002	24.9 F	12.	1920-1921	21.9 F
3.	1986-1987	24.5 F	13.	1918-1919	21.6 F
4.	1930-1931	24.4 F	14.	1944-1945	21.6 F
5.	1997-1998	24.2 F	15.	1957-1958	21.4 F
6.	1941-1942	23.1 F	16.	1907-1908	21.4 F
7.	1998-1999	23.0 F	17.	2004-2005	21.3 F
8.	1982-1983	22.6 F	18.	1952-1953	21.2 F
9.	1980-1981	22.6 F	19.	1960-1961	21.0 F
10.	1991-1992	22.2 F	20.	1953-1954	20.8 F

Table 2. Changes in Average Annual Precipitation Among Minnesota Communities.

Location	Average Annual Precipitation 1921-1950	Average Annual Precipitation 1971-2000	Percent Change
Grand Rapids	**24.64 in.**	**28.78 in.**	**17%**
Ada	**20.53 in.**	**23.91 in.**	**16%**
Morris	**22.48 in.**	**25.45 in.**	**13%**
Twin Cities	**24.73 in.**	**29.41 in.**	**19%**
Waseca	**27.53 in.**	**34.69 in.**	**26%**
Red Wing	**28.63 in.**	**34.45 in.**	**20%**
Rochester	**28.60 in.**	**31.40 in.**	**10%**

Climate Trends in Minnesota: Some Indicators and Implications, cont.

equivalent value) trends at Willmar where mean seasonal snowfall has risen over 20 inches shows that the average precipitation for the November through March period has increased by over 25 percent since 1921 (from 4.08 inches to 5.18 inches). A similar comparison at Two Harbors where mean seasonal snowfall has increased by over 15 inches shows an increase of over 20 percent in November to March precipitation since 1921 (from 5.38 inches to 6.53 inches). The added snowfall has indeed meant greater runoff potential for spring snowmelt events, and indeed many Minnesota watersheds have shown this in more consistent measures of high volume flows on stream gages in the spring.

An increase in thunderstorm frequency and intensity can be found in the data of many climate stations. The recurrence interval for a 24-hour rainfall of 3.5 inches across southern Minnesota is once every 5 years. Many communities in recent decades have reported a frequency greater than this. For example from 1990 to 2005 Albert Lea reported seven 24-hour rainfall events of 3.5 inches or greater, Rochester reported six, and Waseca and Winnebago reported five. Further, some storms have brought rainfall intensity that surpasses the 100 year 24-hour recurrence value, such as the 6.97 inches at Albert Lea on September 15, 2004 or the 5.71 inches at Baudette on June 10, 2002. This trend has produced a number of flash flood events in recent years.

Observable impacts from this wetness trend are widespread. Many communities have redesigned storm sewer runoff systems to make them more capable of discharging a larger volume of rainfall. Resort owners have seen many lake levels rise and some water tables have risen as well. Farmers have decreased the spacing in their tile lines (called pattern tile drainage) to more quickly shed the surplus water from their croplands. In addition many farmers are using conservation tillage practices or the planting of field border areas with perennial grasses to reduce erosion and slow the rapid runoff generated by intense thunderstorm rainfall. Several communities and local watershed districts have conducted studies to find ways of mitigating the detrimental effects of flash floods or spring snowmelt floods. The Minnesota Department of Transportation has embarked on a statewide program to make better use of snow fences (both constructed and vegetative) in mitigating blowing and drifting snow that forces repeated road closures.

What do these two climate trends have in common? They may be manifestations of higher water vapor in the atmosphere over Minnesota. The combined attributes of being a source of latent heat and a greenhouse gas imply that increased water vapor presence favors warmer winters, and greater precipitation potential. A critical research question for today's atmospheric scientists is "what is the source of this increase in water vapor?"

There are many theories yet to be tested.

Mark Seeley is author of Minnesota Weather Almanac published by the Minnesota Historical Society Press and available in all bookstores this April.

Minnesota's Air, Water and Waste Environmental Conference Held February 15-16

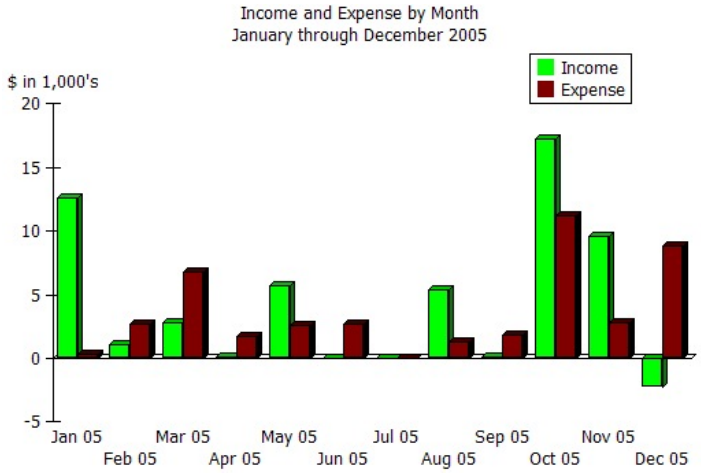
Nearly 2000 attendees and 91 exhibitors made the Minnesota Pollution Control Agency's annual environmental conference the biggest ever. The conference was the first since the merger of the Minnesota Office of Environmental Assistance and the MPCA, authorized during the 2005 legislative session. It was also the first time that the annual Governor's Environmental Awards Program was made a part of the conference, held after lunch on the first day of the conference. The conference keynote speaker, Bruce Vincent, an "environmental logger" from Montana was well-received. With wit and humor, he described a program of intelligent use of natural resources based on coalition-building rather than confrontation and conflict.

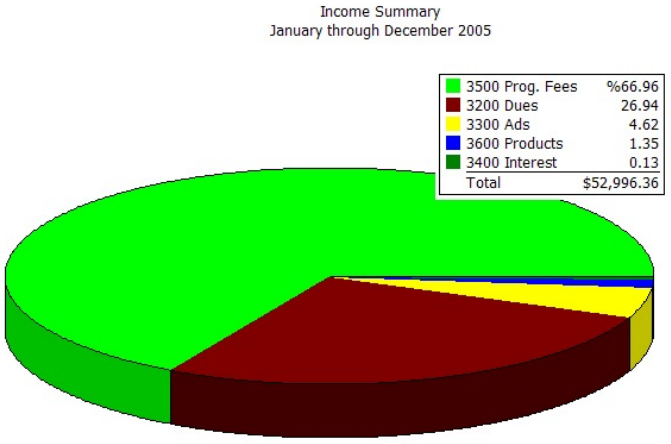
Nine breakout sessions over the two-day conference provided plenty to choose from. Talks in the Water Quality and Stormwater tracks were well-attended. Especially popular were discussions of wastewater emerging contaminants, an update on a retooled Clean Water Legacy proposal to partially fund water resource protection programs to be introduced during the upcoming legislative session, and balancing water quality and agricultural production. On the stormwater side, sessions on thermal impacts of stormwater, source water protection and stormwater infiltration, and an information session on the new Minnesota Stormwater Manual proved popular.

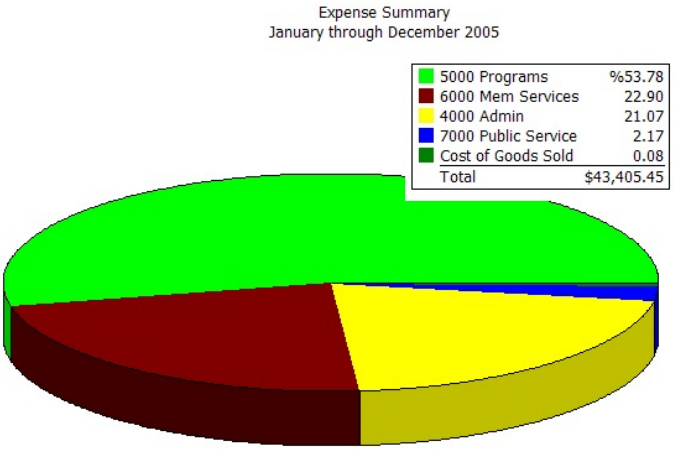
Dr. Timothy LaPara of the University of Minnesota gave a fascinating talk on the increased resistance to antibiotics in bacteria. He studied wastewater influent and effluent throughout Minnesota for resistant bacteria. The implications of this area of study are far reaching. Ground water investigation and cleanup were the focus of several talks. These included remedial technology, field techniques and Superfund case studies. Perhaps the best-attended of all sessions was State Climatologist Dr. Mark Seeley's talk on Significant Climate Trends in Minnesota: Assessing Economic and Natural Resource Implications (see also the article by Dr. Seeley, page 9).

2005 Financial Report

	Jan - Dec 05
Income	
Total 3100 Contributions	pass through
Total 3200 Dues	14,278.00
Total 3300 Ads	2,447.25
3400 Interest	70.13
3500 Program Fees	
3510 Spring Conference	10,940.75
3520 Fall Conference Fees	18,910.00
3530 Workshop/Field Trip Fees	5,637.00
Total 3600 Products	713.23
Total Income	52,996.36
Total COGS	36.55
Gross Profit	52,959.81
Expense	
4000 Administration	
Total 4100 Financial Admin.	3,455.90
Total 4300 Correspondance	114.72
Total 4400 Board of Directors	946.60
Total 4500 Dues Billing	1,747.08
Total 4600 Database Maint.	2,880.00
Total 4000 Administration	9,144.30
5000 Programs	
Total 5100 Spring Conf	6,276.47
Total 5200 Fall Conf	12,072.93
Total 5300 Workshop/Field Trip	4,962.08
Total 5500 LCMR Tour	33.35
Total 5000 Programs	23,344.83
6000 Member Services	
Total 6100 Newsletter	5262.21
Total 6200 Directory	972.97
Total 6300 Member Corresp.	3703.93
Total 6000 Member Services	9,939.11
7000 Public Service	
Total 7200 MGWAF	599.40
Total 7300 Public Education	341.26
Total 7000 Public Service	940.66
Total Expense	43,368.90
Net Income	**9,590.91**

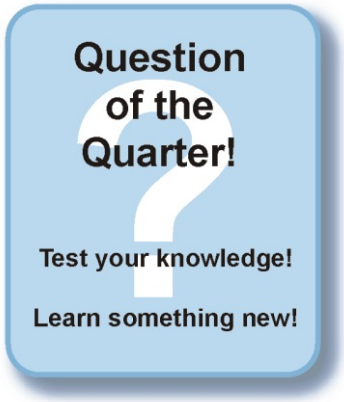






QUESTION OF THE QUARTER

How Many Wells?



The Question of the Quarter is a continuing feature in our newsletter. Each quarter a different question is posed and all members are invited to respond. The March Question of the Quarter is:

Approximately how many wells are constructed in Minnesota each year?

a. 5,000

b 15,000

c. 25,000

d. 35,000

Email your answer and your "two cents worth" to: editor@mgwa.org

Answer to the December '05 Question of the Quarter

Your task was to match the following cave dwellers to the appropriate description. The correct answer is:

Stygophile	D/ Aquatic species which occur in caves and can complete their entire life cycle there, but which are also found in similar habitats above ground.
Stygoxene	C/ Aquatic species occurring commonly in caves, but must leave the cave at some point in their life cycle, typically for feeding.
Stygobite	B/ Aquatic species which are obligate cave dwellers adapted so completely to caves that they are restricted to this environment
Phreatobite	A/ Obligate ground water inhabiting species - most often envisioned as species found in slower moving, interstitial ground water

Biospeleology is the biology of caves, karst and ground water. A good source of links to biospeleology web sites can be found here: www.utexas.edu/depts/tnhc/.www/biospeleology/links.htm. Read on to learn more:

Ground Water and Biospeleology: Life in the Twilight Zone

Excerpts from "Biospeleology - Illinois Natural History Survey"

"In the twilight zone, a little farther into the cave, available light is greatly reduced, and thus plants are no longer able to grow.

Within caves a diverse biota may be found, exhibiting varying degrees of adaptation to the subterranean environment. Accidental species, which fall, wander, or are washed into caves, do not linger long in this environment. These animals either return to the surface, or die in the caves - where they provide an important source of nutrients for the cave community. Trogloxenes occur commonly in caves, but must leave the cave at some point in their life cycle, typically for feeding. Species which occur in caves and can complete their entire life cycle there, but which are also found in similar habitats above ground, are referred to as troglophiles. And finally, troglobites are those species which are obligate cave dwellers adapted so completely to caves that they are restricted to this environment.

...Two other common groupings of cave inhabiting animals are edaphobites, obligate deep-soil

continued on page 14.

Ground Water and Biospeleology: Life in the Twilight Zone, cont.

dwellers which may occur in caves, and phreatobites, obligate ground water inhabiting species - most often envisioned as species found in slower moving, interstitial ground water."

Please refer to the following web site for reference and for more details: www.inhs.uiuc.edu/~sjtaylor/cave/critters.html

Troglobitic isopod in Missouri, probably Caecidotea antricola. Reprinted with permission.

Ground water biota in Minnesota? — yes or no?

According to Warren Netherton, Interpretive Naturalist Supervisor at Forestville State Park, cave adapted fish (those that live and reproduce in caves) are only found south of Pleistocene glaciation. He has identified spring tails (small wingless insects of the order Collembola) in Mystery Cave, Minnesota. And he also suspects amphipods (small crustaceans) in Mystery Cave. Crayfish are the largest known aquatic residents of Minnesota caves, but they may not be reproducing in the cave environs.

And if this awakens in you an interest in biospeleology, here is one of the best web sites available, and the source of the two images reprinted here: www.inhs.uiuc.edu/~sjtaylor/cave/biospeleol.html

Researched by Tim Thurnblad, Minnesota Pollution Control Agency and Kurt Schroeder, MGWA Newsteam.

Amphipods, probably Gammarus sp., in a Missouri cave stream. Photo by Jeff Swayne. Reprinted with permission.

Minnesota's Environment 2005: How Are We Doing? Focus on Drinking Water

A team at the Minnesota Pollution Control Agency (MPCA) has recently completed a report for the general public, "Minnesota's Environment 2005: How Are We Doing?" The report summarizes the status and trends of key indicators for the state's most important environmental resources. Lakes and streams, wetlands, drinking water, air pollutants, mercury, climate change and solid waste are discussed. The last "state of the environment" report done by MPCA was completed in 2000.

The new report rates the status of each area on a qualitative sliding scale from "poor" to "good" and discusses recent trends. A statewide summary for each is presented, along with a discussion of things to watch or special concerns. MPCA intends to publish this kind of report for the public about every five years so Minnesotans can have an idea of where things in our environment may be getting better or worse, and what they may be able to do to help. The complete report may be accessed on the MPCA web site at: www.pca.state.mn.us

Following is a summary of the part of the report on Minnesota's Drinking Water, much of which is, of course, supplied by ground water. This section was prepared with the assistance and review of the Minnesota Department of Health (MDH).

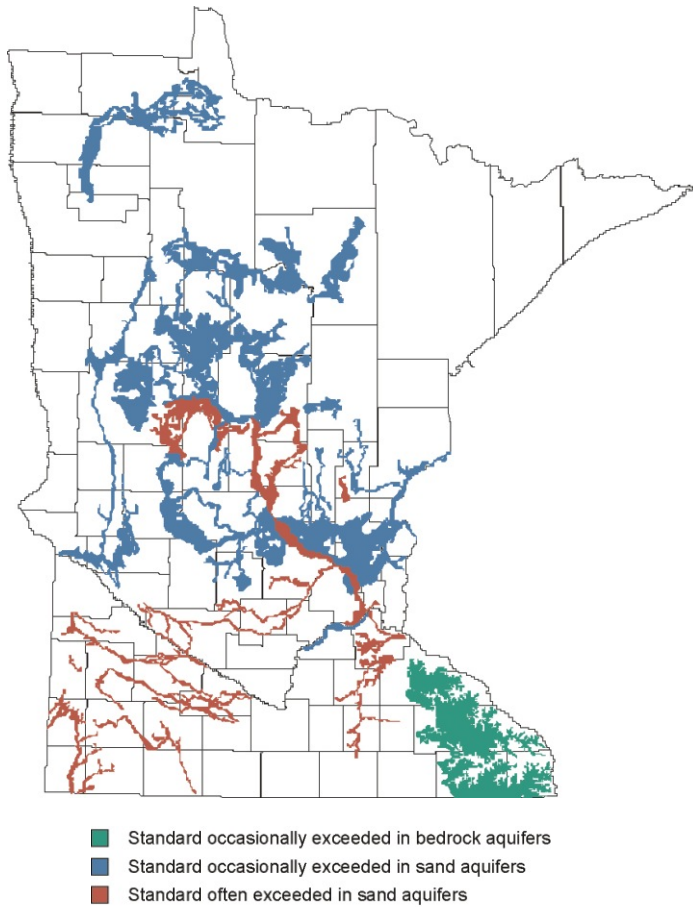


Figure 1. Sand and bedrock aquifers in Minnesota in which nitrate concentrations are occasionally or frequently above the drinking water standard.

- Drinking Water Status: Good
- Trend: Steady; drinking water continues to meet health standards.
- Summary: Nearly all of Minnesota's public drinking water supplies meet health standards after treatment. Sampling of private drinking water wells found nitrate as the only widespread human-caused contaminant in drinking water.

Minnesota's drinking water is generally of very high quality. No matter the source — lakes, rivers or ground water — Minnesotans can have a high degree of confidence in drinking water from public water supplies.

Minnesota's 8,300 public water supplies — those serving communities, businesses, schools, restaurants and public rest stops — are all routinely tested for nitrate and bacteria, and many are also tested for pesticides, industrial chemicals and metals. Nitrate can cause health problems in infants and bacteria can cause intestinal illness. Figure 1 shows where concentrations of nitrate are occasionally or frequently above the drinking water standard before treatment.

Since 1998, only a handful of instances of nitrate and bacteria contamination exceeding health standards have been found in public water supplies, and the problems were corrected quickly. Contamination of community water supplies by pesticides and industrial contaminants by pesticides and industrial contaminants is rarely found; the last time a city water supply violated a health standard was in 1999.

Public water suppliers are required to send out a "report card" (consumer confidence report) on the quality of the public water supply. The report cards provide detailed information about chemistry of city water supplies.

Minnesotans also use individual (private) wells as a drinking water source. Today, nitrate is the most widespread human-caused chemical in ground water. A recent statewide study of Minnesota's ground water found approximately three percent of the wells tested exceeded the drinking water standard for nitrate of 10 parts per million. In areas where ground water is susceptible to contamination, however, a much higher percentage of wells exceed the nitrate drinking water standard. The figure shows where the most likely areas for this to occur are in the state.

Things to Watch/Concerns

- Pesticides such as chemicals used to kill insects and weeds, may become a concern. Although use has declined recently, Minnesota currently uses 28 million pounds of pesticides annually. Pesticides have been found in ground water, but generally not at levels considered to be unsafe.
- Arsenic, a naturally occurring element, is found in about 15 percent of individual wells, primarily in west-central and northwest Minnesota, at levels above the drinking water standard of 10 parts per billion. Arsenic is part of the earth's crust and works its way into ground water from underground rocks and soil.

— Submitted by Tom Clark, Senior Hydrologist, Minnesota Pollution Control Agency.

Minnesota Stormwater Manual Released

The Minnesota Stormwater Manual is a comprehensive (718 page) document that espouses practical approaches to stormwater management in the state. It was released in December 2005, as a collaborative effort of 40 members of the Stormwater Steering Committee, a group that included representatives of various state agencies, local governments, businesses, and a variety of environmental, educational, and water-protection groups. The manual was produced with technical help from a consultant team of Emmons and Olivier Resources (Minnesota consultant) and the Center for Watershed Protection (Maryland), a non-profit known nationally for its work in stormwater management.

Of particular interest to ground-water professionals, are chapters on Minnesota Rules, Regulations and Programs (Chapter 5), Hydrologic and Water Quality Evaluation Methods/Models (Chapter 8), Details of Stormwater Best Management Practices (BMPs) (Chapter 12; 12-5, in particular discusses infiltration techniques), and Guidance for unusual geologic situations including shallow bedrock and karst conditions (Chapter 13). Appendices contain engineering drawings showing examples of various BMPs and various stormwater control structures and devices.

With this new manual, Minnesota stormwater managers can find answers to their cold-climate concerns and find solutions for special Minnesota conditions — from shallow karst in the southeast to the broad floodplains of the northwest. While the emphasis throughout the document is on surface water, the document preparers certainly understand the potential interplay between ground water and surface water resources. For instance, infiltration practices are promoted generally as a means of attenuating peak flows and regulating flow volumes, but are discouraged in wellhead protection areas or when draining land areas that may generate runoff of questionable water quality (these are called potential stormwater hotspots).

Chapter 13 addresses a number of important issues relating to proper stormwater management in Minnesota. The common thread in most of the issues discussed in Chapter 13 relates to protecting ground water and designing sites and stormwater practices as a function of ground water-related constraints. These topics involve several challenging stormwater management issues that do not always have clear or universal answers and, as such, are not always appropriate for a strict regulatory approach.

The manual may be downloaded at: www.pca.state.mn.us/water/stormwater/stormwater-manual.html or request a copy on CD from the same site. Questions may be directed to Brian Livingston Brian.Livingston@state.mn.us at the Minnesota Pollution Control Agency or call (651)296-5426.

— adapted from MPCA press release and MPCA fact sheets.

Washington County Project Wins "Seven Wonders of Engineering" Award

A recent ground water study in southern Washington County received a prestigious award from the Minnesota Society of Professional Engineers. Funding for the project, *'Intercommunity Groundwater Protection, Sustaining Growth and Natural Resources, in the Woodbury/Afton Area,'* was recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environment and Natural Resources Trust Fund, coupled with funding from project partners. The engineering consultant was Barr Engineering, Inc. and the grant was administered by the Washington County Department of Public Health & Environment. Project partners included the City of Woodbury, City of Afton, South Washington Watershed District, Valley Branch Watershed District, and the Minnesota Department of Natural Resources.

The primary purpose of the project was to develop a ground water model to evaluate the "sustainability" of ground water withdrawals in the Woodbury/Afton area. The ground water flow model was used to predict the future effects of pumping the City of Woodbury wells on ground water levels and base flows into Valley Creek (a designated trout stream).

The Minnesota Society of Professional Engineers Seven Wonders of Engineering Awards Competition is conducted annually to recognize outstanding achievements in the field of engineering. The program is designed to acknowledge and publicly recognize those organizations that have advanced the profession and prestige of the entire engineering community.

Entries in the Seven Wonders of Engineering Awards competition were judged on the engineering methods, systems and skills utilized; the extent that the project advances the engineering profession; project complexity; the significance of the project to society; and the extent to which the project meets the needs of the market, client, or owner.

— press release from Washington County Public Health and Environment.

Friends of the Pleistocene

The 52nd Midwestern Friends of the Pleistocene Field Conference, co-sponsored by the North Dakota Geological Survey and North Dakota Geological Society, is to be held in Bismarck and New Town, North Dakota on June 3rd and 4th, 2006. The themes for this field conference will be the geological observations of Lewis and Clark along the Missouri River, the glacial stratigraphy of ice-walled lake plains, and the structural interpretation of glaciotectonic ice-thrust features in north-central North Dakota. Registration deadline is April 28, 2006. Details at: www.state.nd.us/ndgs/FOP/Pleistocene2nd.pdf or contact Lorraine Manz at lmanz@state.nd.us, (701)328-8000.

Little Minnehaha Falls: The Great Subterranean Spring of Minneapolis

— By Greg A. Brick, Geology Instructor, Normandale College

In his 1974 book, Minnesota Caves of History and Legend, Roger Kehret wrote, "When cavers think of remote hard to reach caves it brings to mind scenes of high mountains of the Pacific Northwest or the steaming jungles of the Amazon. The most remote and hard to get to cave that I have ever reached is found on Fourth Street near Marquette Avenue in downtown Minneapolis, Minnesota." He tells how the Rovers, an outing club, explored this cave, variously referred to as the "Loop Cave," "Farmers & Mechanics Bank Cave," or "Schieks Cave," far below the streets of Minneapolis. "Schieks Palace Royale" now occupies what had been one of the former locations of the Farmers & Mechanics Bank, accounting for two of those names. Schieks was once facetiously billed as a "bottomless" nightclub because of the underlying cave (Miller 1989)! In May 2000, I was able to visit this deep cave, and viewed therein a large subterranean spring, one that may have played a role in creating the cave, and which may have something interesting to say about urban ground water generally.

Schieks Cave, as I have referred to it in past publications (Brick 2004), is the largest cave under downtown Minneapolis (though not the city as a whole), underlying half a city block. The cave was discovered in 1904 by Carl Illstrup, city sewer engineer, who described it as a "cave shaped like an inverted bowl," and its discovery ranked among his most outstanding professional experiences, according to Fitzsimmons (1931). But Illstrup's description will seem strange to anyone who has actually seen the cave, because it's a maze cave in the St. Peter Sandstone, with a ceiling of Platteville Limestone supported by natural pillars (called "stone islands" on some maps). The cave was kept a secret for years because city officials feared the public would think that downtown Minneapolis rested on a thin shell that might give way at any moment. Another concern was that burglars might bore into the bank vaults above!

The first document regarding Schieks Cave (or its spring) is the 1904 Lund map, rather crude and incomplete, but rich in hydrologic details such as "creeks" and "lakes." At the location of the spring it notes "WIDE CRACK IN LEDGE, LARGE BODY OF WATER COMING THROUGH." Upon first entering the cave in 1904, Illstrup stated that "Dripping from the ceiling at one place there was a regular curtain of water 30 feet in width. The water in the middle was 20 feet deep at one point and tapered down to inches at the shore line. It was a beautiful sight but we had to drain it to remedy the troubles in the Fourth street tunnel" (Fitzsimmons 1931). This appears to be the first published description of the great spring. The 1929 Lawton map, based on a more detailed survey, depicts Schieks Cave extensively modified by the construction of piers, walls, and artificial drainage systems, the latter to prevent further erosion of the soft sandstone. The ceiling spring now figures as "WATER FALLS," but this time enclosed in its own polygonal, concrete-walled room, provided with two floor drains. Both cave maps can be found in Kress and Alexander (1980).

The first person to refer to the ceiling spring as "Little

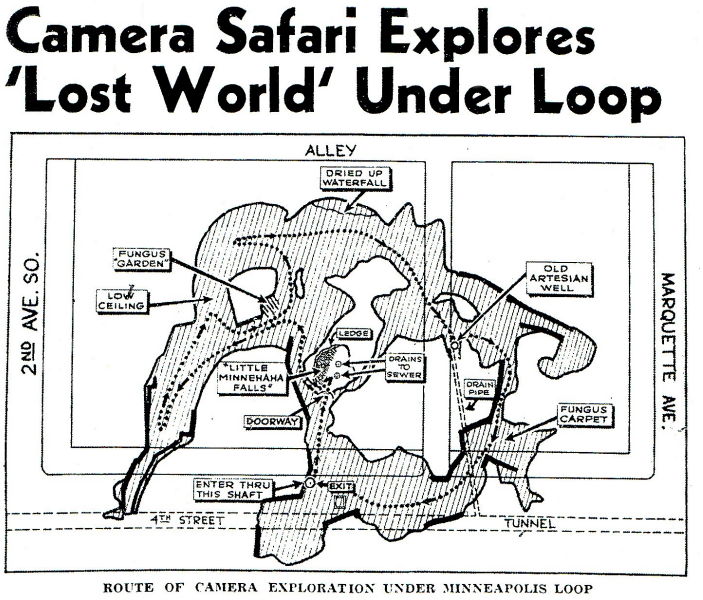


Figure 1. Illustration from 1939 account of the exploration of Schieks Cave beneath downtown Minneapolis (Dornberg, 1939).

Minnehaha Falls" in print, however, was David Dornberg, a photographer for the Minneapolis Journal, who in 1939 took a "Camera Safari," as he called it, through Schieks Cave (Dornberg 1939). "In the cave," he wrote, "is a small waterfall, dubbed by sewer workers who discovered it in 1904 the 'Little Minnehaha Falls.' Like its famous namesake, it is slowly drying up. But in the hollow reaches of its underground cave, the falling water echoes and re-echoes until a high-pitched scream is swallowed up in its roar like a college boy swallows goldfish." He reports that "There's a doorway in the sandstone that leads into a chamber where the water pours off an eight-foot ledge." The cave map accompanying his article is the only one to label Little Minnehaha Falls as such (see Figure 1).

In 1953, Joseph Zalusky, a founder of the Minnesota Geology Society, visited Schieks Cave (Zalusky 1953). He also mentioned Little Minnehaha Falls, and the same story behind the name, adding that it was "a falls which I estimated in the darkness to be about 10 feet wide and a drop of 5 feet." So Illstrup's 30-foot curtain of water had dwindled to a third of its former length. Kress and Alexander (1980) state that "In view of the almost complete cover of the surface by buildings or pavement and the inevitable disruption of the near-surface groundwater flow by the excavation of building foundations, it is not surprising that 'Little Minnehaha Falls' is drying up." There are more references to the spring in the literature, but they all derive from the accounts just discussed. No new information about the spring was forthcoming until my own visit in 2000, which I shall now describe.

continued on page 18.

Ground Water History, cont.

Schieks Cave is normally accessed by a 75-foot shaft from Fourth Street and traffic must be blocked off in one lane to raise the lid, immediately in front of the nightclub, which is why the Minneapolis Sewer Department rarely visits the cave. At the bottom of the ladder, lid fragments lie scattered about—lids that have tumbled down the shaft and smashed like cookies at the bottom over the years.

Schieks Cave is extensive, but rather low, so we were obliged to go about like apes, balancing on our gloved knuckles. Some areas are flooded with stagnant sewage that has leaked from sewer connections, and perhaps from overflows from the underlying Fourth Street Tunnel, which is a segment of the North Minneapolis Tunnel, the great sanitary sewer of the downtown area. Past visitors remarked upon the swarms of cockroaches in the cave, but fortunately none were seen at the time of our trip!

We came to the concrete chamber containing Little Minnehaha Falls, which resembled a baseball dugout. Inside, we could stand on a sandbar and get up close to the spring. Judging from Dornberg's 1939 photos, the discharge did not appear to have diminished much since then. The water pours from a bedding plane in the Platteville Limestone, depositing vertically striped, black and white, or "zebra," flowstone, on the walls of the room (Figure 2). Since the water fell as an extended sheet (matching Zalusky's dimensions of half a century earlier) it was difficult to quantify the discharge, although I would estimate it was on the order of 100 gallons per minute. The water collects in a pool of rust-colored silt, which drains through holes in the floor, thence by pipes to the North Minneapolis Tunnel.

Upon equilibrating a high-quality mercury thermometer in the spring orifice, I was surprised to note that the groundwater temperature was 19 C, more than twice the expected 8 C at this latitude, and higher even than most surface water for the month of May. Years ago, I reported a similar thermal ground water anomaly for Chalybeate Springs, which also issues from the Platteville Limestone, with a temperature of 14 C (Brick 1993). While we've all heard of the microclimatic "urban heat islands" generated by cities, does the same concept apply to urban ground water? Does an "anthropogenic thermal anomaly" exist under cities? Is it thermal pollution owing to leakage from boiler rooms, pipes, or whatever (see, for example, Lerner 1986)? Exothermic chemical reactions are another possible source of heat, but the amount of heat here seems too great to be accounted for so easily.

I collected water samples at the spring for Calvin Alexander to analyze at the University of Minnesota. He decided, however, that the samples were too compromised to yield viable data (I had neglected to keep them on ice). This was unfortunate, as the chemical analysis might have said something about the source of the water. It would be nice to make a return trip someday to collect new water samples, accurately determine discharge, and take additional temperature readings of this feverish spring.

Beyond Little Minnehaha Falls we followed a trench in the floor of the cave. To either side there were linear concrete drip basins, aligned with joints in the limestone ceiling above, to intercept the exuding water. The feature depicted as "Dried Up Waterfall" on Dornberg's map appeared to me as merely an ordinary cave ledge, and indeed it is not shown as a waterfall on the 1904 map.

We next examined Dornberg's "Old Artesian Well," a feature associated with the controversy surrounding the origin of Schieks Cave. All investigators agree that the cave was formed by the mechanical erosion of the soft St. Peter Sandstone by flowing water, a process known as piping. However, one view, reported by McGuire (1978), is "that the cave was formed 10,000 to 15,000 years ago," and is "a relic of the Ice Age." The contrasting theory, based on the testimony of sewer engineer Illstrup, reported by Schwartz (1936), and adopted by Hogberg and Bayer (1967), is that the cave "may have been formed by water escaping from an abandoned artesian well and washing the sand into the sewer." The sewer referred to is the North Minneapolis Tunnel, on which construction began in 1889 (Rinker 1910), providing a maximum age for the cave in the "artesian" scenario. Kress and Alexander (1980) adopt an intermediate view with regard to the cave's age, pointing out that, "If the cave developed naturally in response to the hydraulic gradient established by the upstream movement of St. Anthony Falls," then it may be "less than a few thousand years old." Quite true. When Father Hennepin first saw the falls in 1680, for example, the river gorge, with its steep hydraulic gradient, was farther away from downtown Minneapolis than it is today. In any case, natural flows, such as that from Little Minnehaha Falls, would have helped carve the cave. Datable speleothems would resolve the age controversy.

We also examined the "M.L.& T. Co. Well Hole" (the abbreviation stands for Minnesota Loan & Trust Company), depicted only on the 1929 map. The 10-inch steel casing, which passed through the cave, emitted a distant humming sound. The well is located dead center under what is now a 4-story parking ramp. Oddly enough, there was once a proposal to convert the cave itself into a parking garage!

We also encountered comparatively pristine areas in Schieks Cave, places where the glutinous black sewer mud gave way to clean, dry sand. The walls, elsewhere coated with gunite to retard erosion, are bare sandstone here. It gave you a feel for what Illstrup's "inverted bowl" must have looked like when it was

continued on page 19.

Figure 2. Little Minnehaha Falls, ground water discharging from Platteville Limestone, beneath downtown Minneapolis.

Ground Water History, cont.

first discovered. A good place to sit down and eat a snack!

Having made the full circuit, I proceeded to explore a major peninsula of Schieks Cave on my own. It extends under the 11-story Title Insurance Building, which is heavier than the adjoining 4-story Farmers & Mechanics Bank. Consequently, there are more of the pyramid-style concrete piers here than in all the rest of the cave combined, providing an Egyptian motif of sorts. The bone-white pyramids sat in a bubbling pool of black sewage that stretched as far as my light beam. Fortunately, I was wearing a good pair of waders, as I sank in with every step!

Reportedly, Schieks Cave is one of an archipelago of more than a dozen caves under Minneapolis (Quarfoth 1962). For many additional references, see Kress and Alexander (1980) and Brick (2004).

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14th National Nonpoint Source Monitoring Workshop

The theme of the workshop to be held in Minneapolis, MN September 24 - 28, 2006 will be "Measuring Project and Program Effectiveness."

The Conservation Technology Information Center of Purdue University, the U. S. Environmental Protection Agency and the Minnesota Pollution Control Agency are the co-sponsors of this annual national conference which this year comes to Minnesota. The workshop brings together land managers and water quality specialists to share information on the effectiveness of best management practices in improving water quality, effective monitoring techniques, and statistical analysis of water data. The focus this year is on the successes of the Clean Water Act Section 319 National Monitoring Program projects and other innovative work from throughout the United States. For more details, see: http://www.ctic.purdue.edu/NPSWorkshop/NPSWorkshop.html

The Ground Water Communiqué

The Ground Water Communiqué is a bi-monthly email newsletter containing information on internal projects of the Ground Water Protection Council (GWPC). The GWPC is a national association of state agencies that deal with ground water protection. The newsletter also contains national news affecting ground water protection and regulation. If you would like to subscribe or obtain the most recent edition, please contact Dan Yates, GWPC Communications Director, at (405)516-4972 or dyates@gwpc.org.

MGWA Spring 2006 Conference:

Registration for "Better Ground Water By Design" is still possible.

Register on-line at www.mgwa.org

Sign up as soon as possible if lunch is something you like!

Better ground water by design
A review of practices and systems that impact ground water

MGWA's Spring Conference will be held Wednesday, April 12, 2006 at the University of Minnesota Continuing Education and Conference Center on the St. Paul Campus.

History has shown that humans can and do impact the quality and quantity of ground water. Some ground water related practices that were acceptable in the past, such as open dumps, are now regarded as inappropriate and dangerous. The cultural and natural conditions at the time (smaller and less dense population, abundant alternative water sources, ignorance or tolerance of contamination) were an integral part of the decision-making process.

This conference is an opportunity to review the practices, conditions, and emerging technologies of today and consider our present and future problems and solutions. Today's conditions include a much higher demand for ground water, a much higher load of potential contaminants, a diminishing supply of fossil energy sources, and a society that values clean and abundant water.

Topics for the upcoming conference include on-site wastewater treatment systems, pharmaceuticals in ground water, impact of agricultural practices on Minnesota's ground water, effects of degraded air quality on precipitation and recharge quality, stormwater management and ground water, landscape/turf management and water usage.

Speakers include:

Dr. Jim Anderson, University of Minnesota, Dept. of Soil, Water, and Climate

On-site Wastewater Treatment Systems

Dr. Bill Arnold, University of Minnesota, Dept. of Civil Engineering and Holly Dolliver, Dept. of Soil, Water, and Climate, University of Minnesota

Pharmaceuticals in Groundwater: Fate, Transport, and Effects

Dr. Gyles Randall, University of Minnesota, Southern Research and Outreach Center, Waseca

Impact of Agricultural Practices on Minnesota's Ground Water

Dr. Matt Simcik, University of Minnesota

Effects of Degraded Air Quality on Precipitation and Recharge Quality

Camilla Correll, and Jennifer Olson, Emmons and Olivier Resources, Inc

Stormwater Management and Ground Water: Are They Compatible?

John Barten, Three Rivers Park District

Landscape/Turf Management

Tim Crocker and Julie Ekman, MN DNR Area Hydrologists

Ground Water Usage In Minnesota

Senator Mike Jungbauer

How Legislators Receive Scientific Information to Support Decision-Making

Professional Development Hours:

This conference is designed to meet the criteria for continuing education for professionals registered with the MN Board of AELSLAGID* and for well contractors as specified by the MN Department of Health.

Logistics:

Registration includes pre-meeting continental breakfast (7:30 am), mid-morning coffee break with fresh fruit, buffet luncheon and afternoon snacks and beverages.

The conference fee is $135 for members and $170 for non-members. The Minnesota Ground Water Association Foundation has provided funding to allow the ten full-time students to attend this meeting free of charge.

For assistance with registration, call Jeanette Leete at (651)276-8208; for information about conference content, call Dale Setterhom at (612)627-4780x223.

*The Minnesota Board does not pre-approve courses and activities, however to the best of our knowledge this course/activity meets the continuing education requirements outlined in MN Statute 326.107. Final discretion is up to the Board.

MGWA FOUNDATION NEWS

MGWA Foundation Board Meeting December 19, 2005

Place: Keys at Lexington & Larpenter in Roseville
Members Present: Cathy Villas-Horns, Christopher Elvrum, David Liverseed, Gilbert Gabanski, and Al Smith
MGWA Management Present: Jeanette Leete, Sean Hunt
Treasurer's Report: Dave submitted the treasurer's report. Grants this quarter include:

- U of MN Hydrogeology Field Camp for $630
- Student tuition at Fall MGWA Conference for $600,
- Hill-Murray High School Dye Trace Project for $740.

We received $12,445 (a minimum of 50% to be placed in the Endowment Fund) from MGWA. Dave will be moving the money from Capital Shares to 29-Month Odyssey in the Unrestricted Fund to get a better return on our fund.
Our beginning balance was $44,040.99. Our ending balance is $54,558.99.
We discussed how much money should be given out each year based on the amount of money coming into the foundation.

Old Business:
Gil presented a summary of the Foundation Board activities over the last year at the 2005 MGWA Fall Conference. It was well received.
Plans are underway for the Spring Conference with a possible theme of "Better Ground Water Quality by Design".
New Business:
Chris Elvrum was appointed Foundation Board Director.
Motion was made by Gil to appoint Amanda Goebel to the MGWA Foundation Board. The motion was seconded by Cathy. Motion passed.
We discussed whether we should have a budget for 2006.
We also discussed setting deadlines for request for grant submittals at four times a year.
Gil suggested we develop written procedures and policies for the Foundation. We should include a policy manual, operational manual, and financial manual. Discussion is to continue at future meetings.
Science Museum of Minnesota staff in charge of their ground water exhibit are planning to have professional representatives at the Science Museum to answer questions and enhance the visitor experience.

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Amanda Goebel of the Washington County Department of Public Health and Environment was recently appointed to the MGWA Foundation board.

MGWA BOARD MINUTES

The MGWA Board of Directors meets monthly.

All members are welcome to attend and observe.

Call President Dale Setterholm for the date, location and time of the next meeting.

December 8, 2005

Place: Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending: Laurel Reeves, President; Dale Setterholm, President Elect; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Norm Mofjeld, Newsletter Editor; Jennie Leete, WRI; Sean Hunt, WRI; Gil Gabanski, MGWA Foundation
Treasurer: $18,794.12 in total checking/savings. Net income of $9,933.59. $14,740.00 in dues. $1,976.00 in advertising. Gross profit of $52,719.39. It was noted that MGWA conferences are a good value compared to the National Ground Water Association conferences that can cost $850.00 for a two-day conference.
Membership: Receiving memberships. Will have a report next meeting.
Web Page: Have been checking for membership renewals, working with Foundation on the Foundation's page, had a few inquiries about posting open positions on website. Will post openings on website for no charge for members.
Foundation: By consensus the Board approved Chris Elvrum as Foundation Director for 2006. Foundation feels bylaws for appointments to the Foundation are vague. Foundation will look at revising bylaws in 2006. Foundation will also evaluate the need for adding another Director to the Foundation at their December meeting and will present this issue at the January 2006 Board meeting.
Education: Considering a training station at a camp with monitoring wells, staff gauge, water level meter, and sampling for inorganic parameters. Discussing an aquifer testing camp. Will be looking into writing policy for funding students at MGWA events.
Newsletter: One week before draft December issue is ready for review. Board had approved $1800.00 for revising newsletter, December issue will go out in current format, but can use the December issue to test other formats.
Old Business:
Fall Event: One person signed up as a retiree. 196 signed up for conference and 62 for workshop.
Legislative Information: Good attendance, approximately 30 people. Tried to explain interaction between surface water and ground water. Development moving into areas where there is less water than downtown and into areas where aquifers are more sensitive.
Minnesota Environmental Partnership: They want someone from MGWA to talk to their Board about what the MGWA does. MGWA President will follow-up with them through email.
Officer Candidates: Jeff Stoner to be President Elect and Jon Pollock to be Secretary.
New Business:
Spring 2006 Conference: Handout from President Elect on Progress.
Operations Manual: Newsletter editor will email comments.
Conference Registration Policy: Motion: Attendance fees for MGWA events are to be waived for invited speakers. Motion passed.
WRI: Agreement between WRI and MGWA due.
Fall Conference Timing: President will work with WRI on Fall Conference date. AIPG National meeting is scheduled for September 2006.

January 11, 2006

Place: Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending: Dale Setterholm, President; Laurel Reeves, Past President; Jeff Stoner, President Elect; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Norm Mofjeld, Newsletter Editor; Jennie Leete, WRI; Sean Hunt, WRI.
Treasurer: $26,999.04 in total checking/savings. Net income of $9,377.65. $14,308.00 in dues. $2,447.25 in advertising. Gross profit of $52,933.20. Net Income thus far in 2006 is $5,404.00.
Membership: 340 members thus far. Renewal sent to corporate members in December and 2nd notice sent last week.
Web Page: 2005 Fall Conference information such as agenda, speakers and some presentations are on web page. Officer ballots for 2006 election were emailed. December newsletter is up. Employment page is available.
Education: President will look into the status of the Education Committee.
Newsletter: Editor will send out draft changes to Operation Manual. Will leave numbers in manual. Progressing on new layouts for newsletter. Discussion of articles for March issue. Changes to Operations Manual will be made annually. Changes will be noted in parentheses as to who made the change and when, such as (BOD 1/6/05).
Old Business:
Spring 2006 Conference: Currently 7 speakers for 7 topics (on-site wastewater treatment systems, pharmaceuticals, agriculture, effect of degraded air quality on precipitation and recharge, stormwater management systems, landscape/turf management, water usage). Conference Name: Better Ground Water By Design.
New Business
WRI Contract: Motion: Approve WRI Independent Contractor Agreement MGWA/WRI 2006. Motion passed.
MGS/USGS: State Mapping Program is currently looking for MGWA member to represent MGWA. Time commitment would be 1 hour of review and one 3 hr meeting per year (4 hours per year). Jon Pollock expressed interest.

Send your comments to editor@mgwa.org

MGWA BOARD MINUTES

February 10, 2006

Place: Keys Café, Lexington and Larpenteur in Roseville, Minnesota
Attending: Dale Setterholm, President; Laurel Reeves, Past President; Jeff Stoner, President Elect; Craig Kurtz, Treasurer; Jon Pollock, Secretary; Norm Mofjeld, Newsletter Editor; Jennie Leete, WRI; Sean Hunt, WRI.
Treasurer: $30,684.90 in total checking/savings. $16,185.00 in dues. $1,080.00 in advertising. Net Income thus far in 2006 is $15,956.24. Treasurer will conduct internal audit of 2005.
Membership: Renewals are being received - 504 members thus far.
Web Page: Minor updates. No new employment opportunities. Receiving a lot of "spam". Will inquire with service provider about decreasing amount of "spam".
Foundation: Met in December. Requesting another Foundation Board member to increase the number to seven. Motion to approve Amanda Goebel as a Foundation Board member passed by MGWA Board. Foundation is planning on reviewing the Foundation bylaws this year. Foundation looking at preparing a policy, operation and financial manual. Foundation considering meeting on a quarterly basis. $54,558.99 currently in Foundation with over 50 percent in endowment.
Education: Committee will meet if MGWA encounters a specific topic/project.
Newsletter: Articles due today for March issue. Discussion on potential revisions to newsletter.
Old Business:
Spring 2006 Conference: Lining up speakers. Currently 8 topics and 11 speakers. May add another topic concerning how legislators get their scientific information.
WRI Contract: Contract was accepted as modified during the last Board meeting.
MGS/USGS: Jon Pollock will be MGWA representative for State Mapping Program.
Advisory Committee: President presented three ideas to get legislators to look at MGWA newsletter. President will work on preparing examples of each from next issue of newsletter.
Minnesota Environmental Partnership (MEP): President emailed MEP board member concerning MGWA becoming a member of MEP, but received no response. Past President will follow up with MEP.
Revisions to MGWA Operations Manual: Newsletter editor working on revisions to the manual involving the newsletter.
New Business:
Discussion of fall field trip. National AIPG fall field trip in 2006; therefore, no fall MGWA field trip in 2006.

The full text of recent official minutes is available at: www.mgwa.org

CALENDAR

April 12, 2006
MGWA Spring Conference
Topic: Better Ground Water by Design:
A Review of Practices and Systems That Impact Ground Water
Continuing Education and Conference Center
University of Minnesota, St Paul Campus
www.mgwa.org/meetings/meetings2006.html

April 20-21, 2006
North-Central Section, Geological Society of America Meeting
University of Akron, Akron, Ohio
Information: www.geosociety.org

May 21-24, 2006
MODFLOW and More 2006
Managing Ground Water Systems
Colorado School of Mines, Golden Colorado
Information: International Ground Water Modeling Center
www.mines.edu/igwmc/

May 22 - June 30, 2006
International Stone Carving Symposium
Saint Paul College Lawn
Kellogg Blvd. At Summit Avenue
St. Paul, Minnesota
www.publicartstpaul.org/mnrocks/mnrocks_symposium.html

September 23-28, 2006
American Institute of Professional Geologists, National Convention
43rd Annual Meeting
St. Paul Hotel, St Paul, MN
www.aipgmn.org/2006_national.htm and
www.aipg2006.org

September 24-28, 2006
14th National Nonpoint Source Monitoring Workshop
Minneapolis, MN
gregory.johnson@pca.state.mn.us

Don't forget: Professional Geologist license renewals are due June 30, 2006