

Minnesota Ground Water Association

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Volume 19, Number 4: December, 2000

President's Column

— Jim Lundy, MGWA President

Although I was very pleased with the fall conference (see related story), I admit I was a bit disturbed by the range of potential threats to ground water quality and the apparent obstacles the ground water scientific community faces in protecting and sustaining the ground water resource. I don't think anyone really comprehends the whole picture yet, and solutions will only slowly become apparent as the science informs our thinking. But it's clear that the need for Minnesota's ground water scientists to communicate their concerns to non-experts will become more critical if we are really interested in protecting and sustaining the resource. There is an important and emerging role for MGWA to play in this area.

But there I go, trying to open a new can of worms, when I should be wrapping up. This column completes my term as MGWA President, and so I would like to thank those who worked hard to make great things happen this past year. First I thank **you**, the MGWA members. You place high value on ground water and its protection through education, and you translate that value into action by renewing your membership and attending our events.

Next I thank the MGWA Board of Directors, though it sounds funny to write it that way. The "board" is really a bunch of characters who drink coffee once a month while dreaming up cool projects concerning ground water. Besides me, the board members are Jim Piegat (Past President), Jim Stark (President Elect), Lee Trotta (Treasurer), and Jan Falteisek (Secretary). We soon say farewell to Jim Piegat and Lee Trotta, whose office terms expire. I will remain next year

as past president, and Jim Stark takes over as president.

Besides elected board members, I thank several others for their indispensable help. The newsletter team publishes this first rate newsletter four times each year (thanks to Steve Robertson, Jan Falteisek, and especially Tom Clark, editor in chief). Many thanks to Jim Aiken, who arranges the advertising that helps to pay for the newsletter, and I thank our advertisers, too. We wouldn't get anything done at all without our contractor WRI, in the persons of Sean Hunt and Jennie Leete.

Major accomplishments this year included two conferences, the field trip, and the establishment of the MGWA Foundation. The conferences explored Minnesota water law and emerging ground water quality issues, while the field trip explored the lower Minnesota River Valley. Thanks for your strong attendance at these events. The MGWA Foundation is a non-profit organization designed to carry out the educational function until now carried by MGWA. I thank Jennie Leete for the vision and energy to get this done; thanks also go to Paula Berger, MGWA Foundation President, and to Pat Bloomgren for her service on the Foundation board. Your donations totaling \$700 promoted ground water education of students by funding several geology department field trips and a portion of the Children's Water Festival.

I hope that next year's accomplishments will be even greater. Next year let's focus MGWA's role as educator and communicator of scientific concerns to decision-makers. The recent fall conference was a first step, and I now think there is a future for MGWA in this direction. It's going to take

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The Minnesota Arsenic Study (MARS): Mechanism and Occurrence of Arsenic in Western Minnesota Drinking Water

— Michael E. Berndt¹, Richard G. Soule², and Melinda L. Erickson³

Abstract

Many groundwaters from glacial aquifers in Minnesota have arsenic concentrations significantly above current and proposed EPA drinking water standards. Evaluating the source and occurrence of this arsenic is obviously a high priority for communities and households both in and outside of Minnesota, where drinking water is supplied from glacial aquifers. To better understand the distribution and origin of this arsenic, approximately 900 wells in a known arsenic "hot-spot" region in west-central Minnesota were sampled and analyzed for arsenic and other parameters during the Minnesota Arsenic Study (MARS). Study wells producing waters with the highest arsenic

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such.

President's Column, cont.

some thought and vision—who has
ideas?

Next year let's increase MGWA mem-
bership (currently close to 600) by
encouraging our colleagues to join.
Renew your membership and donate
to the Foundation using the MGWA
online ordering at www.mgwa.org.
Let's increase student involvement in
MGWA, too. Student members net-
work with members to improve
employment prospects; they also rep-
resent MGWA's future. We are seeing
increased donations to the MGWA
Foundation, and would like to encour-
age that trend.

During the day many of us make a liv-
ing studying, managing and protect-
ing ground water, but please consider
that the resource may be worth some
of your free time as well. The essence
of MGWA is ground water education
through meetings and the newsletter.
Much of the work to make these
things happen falls on the board (and
on the President), but it's best to
spread it around. So volunteer your
time and enthusiasm! Even for
ground water professionals it's easy
to forget the routine miracle of clean
water at the tap, on demand, and the
irony that Minnesota's watery abun-
dance can be taken for granted,
wasted, and abused. An important
part of the MGWA's future work is to
communicate that fragile and miracu-
lous watery abundance to Minne-
sota's decision-makers, citizens, and
children. You can help make it
happen.

From MGWA Foundation:

The Minnesota Ground Water Asso-
ciation Foundation was formed in
2000 and is off and running. The
goal of the MGWAF is to raise funds
that can be used to assist in promot-
ing ground-water related public bene-
fit activities. The first Board meeting
("Board 0") was held in April, with
Paula Berger as President, Jim
Lundy as Secretary, and Pat
Bloomgren as Treasurer. Jeanette
Leete is serving as Executive
Director.

MARS Study, cont.

concentrations tended to be com-
pleted down-gradient from surficial
regional aquifer recharge features in
deep sand units (approximately
100-200 ft in depth), although many
wells completed in the same strata
produced waters containing little or
no arsenic. This distribution and a
close association of arsenic with
sulfidic groundwaters, together with
preliminary evidence for pyrite disso-
lution and precipitation processes
occurring within affected aquifers,
suggests that high arsenic in the
study area may be a by-product of a
pyrite roll-front system advancing
through the inter-till aquifer network.
Further study is needed, however, to
evaluate whether this interpretation is
accurate and, if so, to determine the
current shape and distributions of
these roll-fronts.

Introduction

The EPA recently proposed a lower-
ing of the federal drinking water stan-
dard (the Maximum Contaminant
Level or "MCL") for arsenic from 50
µg/l to 5 µg/l. This proposed change
is of particular significance to Minne-
sotans because a number of private
wells have naturally-occurring arsenic
concentrations above the current
MCL, and many more, including
almost 20% of municipal water sup-
plies, have levels above the proposed
MCL. Figure 1 shows the distribution
of arsenic in Minnesota groundwater
(Minnesota Pollution Control Agency,
1998 and Minnesota Department of
Health data).

Unquestionably, the most significant
occurrences of high arsenic in Minne-
sota groundwaters are those pro-
duced from inter-till sandy aquifers in
Des Moines lobe glacial sediments
(Kanivetsky, 2000). This high arsenic
led the Minnesota Department of
Health to conduct a major study,
referred to as the Minnesota Arsenic
Study (MARS; Messing *et al.*, 2000).
This study was designed to gain a
better understanding of the geologic
and hydrologic processes responsible
for the occurrence of the arsenic in
glacial aquifers and to assess human

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MARS Study, cont.

exposure to drinking water containing greater than 50 µg/l arsenic. Water samples were collected from approximately 900 wells in a selected nine-county area and analyzed for arsenic and approximately 30 other key elements and compounds.

Results indicate that arsenic may be elevated as a by-product of an extensive pyrite roll-front system that is actively penetrating into glacial sediments in the study area. This article briefly describes the distribution of arsenic, and provides preliminary evidence that leads to a conceptual model for a possible roll-front system in Minnesota glacial sediments. The human exposure/risk portion of MARS is not addressed here, but is available in Messing (2000).

Arsenic distribution:

Arsenic distribution in the MARS study area revealed a close correlation between high arsenic and the subcropping of stagnation moraines of the Lower Goose River Group glacial unit within the Des Moines lobe glacial complex (Figure 2). In addition, it was found that most high-arsenic samples came from relatively deep, artesian wells rather than from relatively shallow wells. Approximately 7.5% of the samples had arsenic concentrations exceeding 50 µg/l, the current federal drinking water standard set by the US Environmental Protection Agency (EPA), while 65% of samples had arsenic greater than 5 µg/l, the recently proposed and lowered EPA drinking water standard.

While our findings were broadly similar to those of

Kanivetsky (2000), who believed that the high arsenic occurs where pH and redox conditions at depth in

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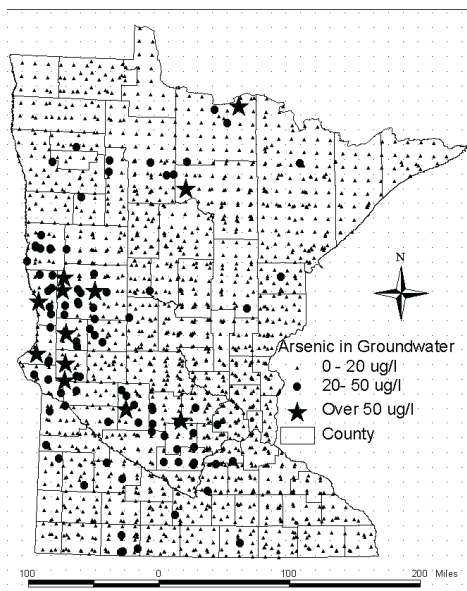


Figure 1: Distribution of arsenic in Minnesota groundwater from MPCA (1998), Ground Water Monitoring and Assessment Program, and MDH data.

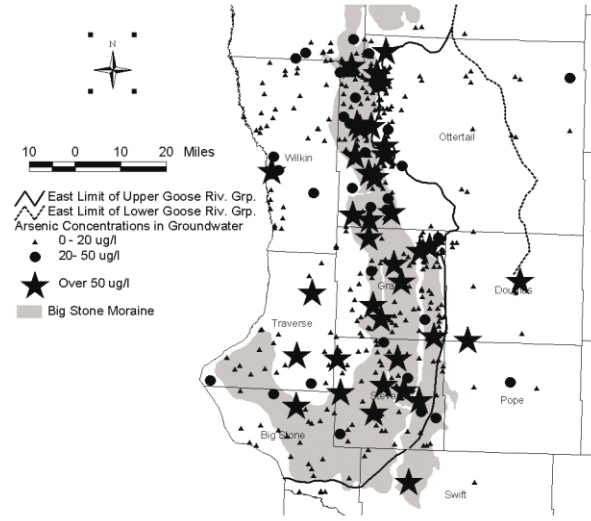


Figure 2: Distribution of arsenic in the nine-county area studied in the MARS Study (Messing, 2000). Arsenic correlates well with the occurrence of the Goose River Group of the Des Moines lobe, which, owing to its variable topography and bimodal permeability (tills vs. sand), serves as a recharge area to sandy intertill aquifers beneath. The distribution of high and low arsenic waters in MARS samples is highly complex. However, 7.5% of the MARS wells had arsenic exceeding the current MCL for drinking water (50 µg/l), and 65% had arsenic exceeding the proposed MCL (5 µg/l).

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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.

MARS Study, cont.

some glacial aquifers were ideally poised to promote desorption of the element from iron oxides and oxyhydroxides, some of the detailed systematics of the arsenic distributions remained puzzling and difficult to explain by this type of model. In particular, extremely large ranges were found in the concentrations of arsenic from groundwaters with nearly the same chemistry and collected from the same stratigraphic unit. If a simple adsorption/desorption model were responsible for all of the high arsenic, we would expect good correlation between high arsenic and the primary adsorption parameters, pH and Eh, but no clear correlation was found. In effect, the occurrence of both high and low arsenic in the same system suggests that another mechanism, capable of enriching arsenic in some portions of sandy aquifers while depleting others, is affecting arsenic distribution in the MARS study region.

Pyrite dissolution and precipitation in Minnesota aquifers?

Pyrite, a mineral often enriched in arsenic, is common in many Des Moines lobe tills because the Pierre Shale, a geologic unit containing pyrite, was an important source rock for some of the glacial deposits (Schultz et al., 1980). Pyrite in tills is potentially of great significance because this mineral often contains arsenic, and it, like many other sulfide minerals, is rapidly oxidized and easily dissolved when exposed to aerated water. Thus, one mechanism to account for high arsenic in groundwater is by the aggressive dissolution and preferential release of arsenic from pyrite in the glacial tills. In fact, dissolved sulfate is commonly present at high concentrations in groundwaters throughout the region, and the sulfur in dissolved sulfate was found to have very negative sulfur isotope ratios, consistent with derivation by oxidation of a pyritic source rock (Berndt and Soule, 1999).

However, high arsenic in Minnesota groundwaters appears to involve a much more complicated process than simple dissolution of arsenic-rich pyrite. In particular, if this were the

only process accounting for high arsenic, there should be a strong correlation between the concentrations of arsenic and dissolved sulfate. No such correlation exists; some waters have high sulfate and low arsenic while others have low sulfate and high arsenic. Furthermore, if pyrite dissolution were the only source of arsenic in groundwaters, then the highest arsenic concentrations should be found in the areas where pyrite is exposed to oxygen. This is the opposite of what is observed; most high arsenic concentrations are found in deeper portions of the aquifers where little or no dissolved oxy-

In response to the observations discussed above, a pyrite "roll-front" model (Fig. 3) was developed to account for the relative distributions of arsenic and dissolved sulfate. The roll-front forms at a chemical redox boundary in response to chemical changes taking place within the aquifer. By this model, sulfate derived from oxidation of pyrite in surface recharge areas is reduced to sulfide at the chemical boundary. This sulfide combines with dissolved iron at depth to precipitate pyrite at the roll-front. As this chemical boundary moves downward through the system with passage of time, the roll-front moves with it.

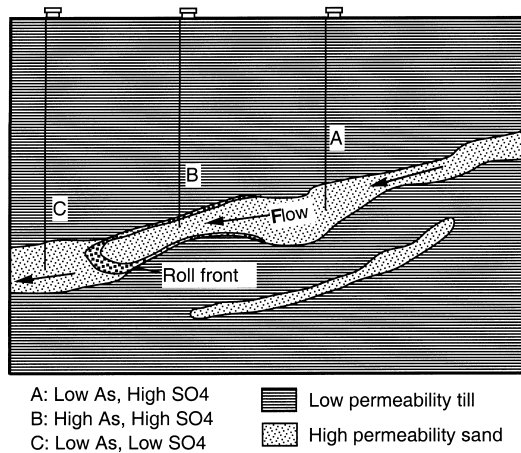


Figure 3: Conceptual "roll front" model to account for high arsenic in intertill aquifers. Well A is located in a region where sulfate (SO₄⁼) and iron concentrations are high, but where conditions are not sufficiently reducing to permit desorption of arsenic from the surfaces of iron-oxides. Well B is in the high arsenic region immediately behind the roll-front and is more likely to have high arsenic concentrations owing to dissolution of pyrite from past roll-front deposits. Well C has low arsenic because any arsenic that was in the water at the location of Well B is trapped in pyrite when the water passes through the roll-front. Arsenic accumulates at the roll-front as it migrates down the hydraulic gradient with time.

gen is present to oxidize the sulfide minerals. Arsenic concentrations in the shallower portions of the aquifer systems are generally low, even when sulfate concentrations are high. Therefore, the high arsenic in groundwaters is currently being released into the groundwater relatively deep within the aquifer.

If such a system is active in western Minnesota aquifers, it will have a profound influence on the distribution of arsenic in associated groundwaters. Not only does arsenic have a strong affinity to precipitate within the pyrite framework but the conditions needed to maximize arsenic release from the surface of iron oxides and hydroxides occurs right at the geochemical conditions where this mineral begins to precipitate. Thus, in a system dominated by flow of sulfate-rich waters into a reduced portion of the aquifer, arsenic is first released from iron oxides and then transported to the roll-front, where it may be trapped within the framework of precipitating pyrite. Through time, as more oxidizing conditions penetrate progressively deeper into the system, the roll-front also migrates deeper and the arsenic will continue to be collected and accumulated at this boundary.

A key point is that when this roll-front moves, the arsenic-enriched pyrite that was deposited at the previous position of the roll-front becomes unstable and can redissolve, potentially releasing large amounts of arsenic into the surrounding groundwater. This roll-front mechanism may

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MARS Study, cont.

explain why some waters in Minnesota aquifers have been found with more than 150 µg of dissolved arsenic. Indeed, pyrite has been identified as the major culprit for trapping and then releasing arsenic into waters in a number of other environments (Thornton, 1996; Bhattacharya *et al.*, 1997).

Several pieces of evidence support a roll-front model for high arsenic in western Minnesota groundwaters. These include: (1) the presence of a strong sulfide odor in many water samples collected from the region, indicative of conditions appropriate for conversion of sulfate to sulfide at depth within at least some portions of the aquifer system; (2) actual observation of scant pyrite within rotosonic drill core from a sandy interval that appeared to correlate stratigraphically with a high arsenic aquifer (Berndt and Soule, 1999); (3) a general regional pattern for redox-sensitive elements (U, As, and SO₄) suggesting that the oxidizing conditions in the recharge areas upgradient of the arsenic-rich zones give way to much more reducing conditions downgradient within the system (see appendix G in Messing, 2000).

Roll-front models have been used to account for the occurrences and distributions of uranium ore deposits in the western US (Reynolds and Goldhaber, 1978; Miller *et al.*, 1984). In those settings, the primary target element, U, is released in the oxidized portions of an aquifer system and redeposited at positions in the aquifer where conditions become reducing. Arsenic enriched pyrite is commonly associated with these deposits. It is possible, therefore, that these deposits may provide an excellent analogue for high arsenic zones in western Minnesota glacial aquifers.

At this time, arsenic distributions in Minnesota groundwaters have yet to be unequivocally linked to pyrite in the host aquifer groundmass, and sufficient data has still not been collected which can prove the existence of an active pyrite roll-front system in glacial sediments. However, research is currently in the planning stages to study one or more of the western Minnesota high-arsenic

areas in more detail. This research will be specifically focused on determining the subsurface distributions of pyrite and arsenic (dissolved, absorbed, or sulfide related) as well as identifying potential chemical reductants (e.g., buried organic matter). It is hoped that this work will help better determine whether a roll-front mechanism is responsible for high arsenic in Minnesota groundwaters, and if so, refine our understanding of how it operates. More experience with these systems will help geologists and hydrologists to make better predictions of where high arsenic wells are likely to be located, and will also provide a clearer means to determine how human activities may alter the present distribution of arsenic in groundwaters either to the betterment or detriment of existing or planned water supply systems.

Acknowledgements:

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New From the MGS

Referenced in the article above, this new publication is available from the Minnesota Geological Survey, University of Minnesota: "Arsenic in Minnesota Ground Water: Hydrogeochemical Modeling of the Quaternary Buried Artesian Aquifer and Cretaceous Aquifer Systems", by Roman Kanivetsky, Report of Investigations #55, 2000.

Call the survey publication office at (612)627-4782. Also available for download from www.geo.umn.edu/mgs



Capillary Fringe

Public Perceptions behind the Airport Dewatering Controversy

— Mark Toso, Hydrologist, MN Pollution Control Agency

In the September 2000 MGWA newsletter, Stu Grubb detailed the controversy surrounding construction dewatering at the Minneapolis-St. Paul (MSP) airport. This issue focused the public spotlight on the groundwater profession, and in particular groundwater modeling. Public attention can be positive to our little corner of the world, but in this case it was not. As the Minnesota Pollution Control Agency (MPCA) hydrogeologist assigned to the MSP airport I was involved in this unfortunate situation. Stu Grubb did an excellent job of highlighting the chronology and details missed by the media. I would like to discuss the reasons this issue grew to colossal proportions and to point out some lessons learned.

I too had the pleasure of attending the Department of Natural Resources meeting on June 22, 2000 to discuss the appropriation permit for the 17-35 runway tunnel dewatering project. Attending the meeting were about 30 people consisting of consultants, regulators, Metropolitan Airports Commission (MAC) officials, reporters and legislators from the area. As expected with a group this contentious crammed into a poorly ventilated room, a heated discussion ensued. The discussion focused on a June 14, 2000 Kelton Barr Consulting (KBC) draft report on MSP airport tunnel dewatering projects completed for the Minnehaha Creek Watershed District (MCWD). About a week prior to the DNR meeting, the Star Tribune caught wind of the KBC report, which resulted in the widespread media coverage we all know too well about. The KBC report was well written and informative to anyone in the groundwater profession. However, the general public had no hope of ever understanding this highly technical groundwater report. Terms such as steady state flow, boundary conditions, semi-confined flow, hydraulic conductivity are a complete loss to the masses. The only thing the public

saw in that report was groundwater drawdown due to the 17-35 dewatering project at Lake Nokomis was going to be 4 feet and they related that to a drop in Lake Nokomis of the same amount. (Incidentally, KBC also reported a drawdown of 9 feet at Lake Nokomis if all the anticipated dewatering was done at the same time, thus the source for that number in media reports).

As professionals it is our duty to help the public understand technical issues and try to avoid misconceptions. Once the public saw the results in the KBC report they were convinced that Lake Nokomis was going to be irreparably harmed. When the groundwater professionals tried to explain the numbers, it seemed like we were arguing over the facts. The perception of our profession, and groundwater modeling in general, became like that of meteorologists... we can't predict anything. Once they couldn't get a straight answer to their questions the public lost faith in ground water science. All they saw was the number... 4 feet. At this point it was fruitless to try to convince the public that Lake Nokomis was not going to dry up from this project.

Ignored during this media-hyped controversy was the fact that the consultants for both the MAC and MCWD were in general agreement on the potential dewatering effects. But, due to the technical nature of the discussion before them, all the public saw was a classic battle of the "experts". The discussion over the uncertainties with the geology, the hydraulic conductivities, and in particular, the differences in the models only served to confuse the public. Modeling is a very useful tool, but as anyone who has worked with models knows, there are some severe limitations. It is the technical knowledge required to understand these limitations that make it virtually impossible for the general public to comprehend.

The real issue with the KBC draft report was use of the steady state model MLAEM to perform a rough estimate of the off-airport dewatering effects. The parameters used for the model were based on a Liesch Associates report done to provide an

estimate for contractors bidding on the project. Thus, the input parameters were overly liberal to provide a maximum pumping rate for bidding purposes. The MLAEM model was also overly predictive not only because KBC used the Leisch data but because they used a steady state model. Liesch used the transient model MODFLOW in their analysis.

The MCWD requested KBC to evaluate the proposed dewatering to determine if there would be any impacts off site, and if they needed MAC to do any further work. This could have been accomplished well outside the spotlight, as is normally the case. However this became a moot point when the media reported the results from the draft report. While the consultants generally agreed on the potential effects and the need for further modeling, this was not adequately communicated to the public. Instead, the discussions in public between the consultants were about the differences between the models, unknowns with the transmissivity values, geology, and the sediments at bottom of the lake. In my opinion, this was very unfavorable to groundwater professionals, and damaging to the use of groundwater models as well. The bottom line was that pumping would have little, if any, effect on the lake. The consultants also knew this, but failed to make the public understand. KBC even discussed a revised MLAEM model that reduced the predicted drawdown in the watertable at Lake Nokomis to around one foot. At this point the public (and the media) was already skeptical and could not comprehend what had changed. In addition, lost in the discussion was a similar MAC dewatering project at Duck Lake, which is about 2500 feet closer to Lake Nokomis. The pumping volumes were comparable to the 17-35 project and no adverse effects were ever noted in any area lake.

It seems that sometimes as professionals, we get lost in all the analysis. Perhaps we need to be less precise with the results and just answer the question. Giving a professional opinion is a good thing! Most of the time that's all the public is

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Capillary Fringe, cont.

really looking for. Yes or no, please. Keep the big fancy words to yourself, thank you. In this case trying to explain the results of an inaccurate model was not the right thing to do. It caused even more confusion, which obviously didn't reflect favorably on our profession. All the public wanted to know was "is Lake Nokomis going to be affected?". Given what we knew then, it was not a long shot to say no. Granted MAC needed to do more work to satisfy outstanding concerns, but in no way was Lake Nokomis going to dry up. Just because we couldn't say for sure whether the impact was going to be 2 inches or 6 inches after 13 months is no excuse not to directly address and clarify the misunderstandings.

Furthermore MAC produced a detailed monitoring plan that would shut down the pumps if any effects were observed in area lakes. However, with time running out on contractual issues MAC decided to spend an additional 4.5 million dollars to install a grout curtain around all major dewatering projects to get the MCWD permit they needed. This was clearly a political decision resulting from the misconception with Lake Nokomis. Unfortunately this unnecessary cost will be borne by all future airport users. But the story doesn't end there. The public discussions continued on the effectiveness of a grout curtain and whether that would be enough to protect Lake Nokomis from the perceived threat. Thus we couldn't even agree that potential impacts with sheet piling/grouting from the dewatering projects that had no adverse impacts in the first place was, well, none.



— Hogs at a CAFO, photo by Sean Hunt

Fall Field Trip: Lower Minnesota River Valley

The Minnesota Ground Water Association (MGWA) along with the American Institute of Professional Geologists (AIPG) sponsored this year's fall field trip on September 22 and 23, 2000, featuring the geology and hydrology of the Lower



— Sue Magdalene explains her research to the group, photo by Kelton Barr



— Jon Ellingson at Minneopa Falls, photo by Kelton Barr



— Dave Wall and Jim Stark describe results of CAFOs, photo by Kelton Barr

Minnesota River Valley. The field trip organizers were Jim Stark, US Geological Survey and Lee Trotta, US Filter Corporation. Stops included Savage Fen (including a rare calcareous fen peatland) and the Minnesota River at Jordan to see the stream gage and hear presentations on the hydrology of the watershed and water flow and quality monitoring programs. Continuing upstream, we had lunch at Minneopa Falls State Park including a presentation on the geological history of the area by Jon Ellingson, MN DNR Lands and Minerals. A stop at the Minnesota River near Judson revealed an exposure of the St. Lawrence Formation and another water chemistry monitoring site. In New Ulm we were introduced to the MN River Corporate Sponsorship Site by Scott Sparlin. While in New Ulm we stopped in for a scheduled tour of the historic Schell's brewery. Dinner was authentic German food at the historic Turner Halle. Scott Sparlin provided entertainment with songs on siltation and fishing.

Day two began with a clay mining site not far from New Ulm. We went to the John Rollings Farm where researchers from the University of Minnesota are measuring the quantity and quality of the discharge waters from agricultural tile drainage. Dave Wall, MN Pollution Control Agency, presented information on confined animal feeding operations (CAFOs or feedlots) at a feeding operation in Blue Earth County. Next we found our way back into the wide Minnesota River Valley to tour the protected portions of Kasota Prairie. Lunch was enjoyed in the shadow of the Jolly Green Giant outside of Le Sueur. Last, we were presented with information about the Quaternary section in Henderson.



— Field trip group at Minnesota River at Jordan, photo by Sean Hunt

Learning and Sharing at the Fall Conference

On November 3rd, MGWA President Jim Lundy welcomed well over one hundred attendees to a day of learning about emerging ground-water quality issues in Minnesota. Later in the day, attendees in small groups were given the opportunity to develop a priority list of issues for legislative consideration. The result of the small-group process is summarized following this article.

Representative Dennis Ozment, chair of the Minnesota House Environment and Natural Resources Policy Committee, led off the day's program. Rep. Ozment reminded those attending that "legislators are your neighbors" and they come to their responsibilities with only their own knowledge and background. And they need input and help from experts and specialists to accomplish their work. He noted a particular need to educate legislators on ground water so they have the necessary background to evaluate legislative proposals. The establishment of the Ground Water Subcommittee to the House Environment Committee is one way they are building their knowledge base. Rep. Ozment noted the need for managing limited water resources in face of increasing population and industry.

Jim Stark, U.S. Geological Survey, and President-Elect of the MGWA, reviewed national water-quality results from the National Water Quality Assessment (NAWQA) series of studies. This long-term effort is designed for periodic examination of water, stream sediment, and aquatic biota in selected major watersheds across the U.S. Jim provided a national view of results of these studies. Jim described an approach to evaluate risk to contamination that includes factors of nitrogen loading and aquifer vulnerability, based on soil hydrologic group and the woodland to cropland land use ratio. He said 2 mg/L nitrate is considered a trigger for nitrogen and aquifer management actions. The NAWQA study results of pesticide sampling showed concentrations seldom exceeded health limits but that more information was needed to evaluate risk. Jim noted comparatively fewer detections of MTBE in the Midwest compared to elsewhere in the county, likely due to the greater use here of alcohol as an oxygenate.

Jennifer Maloney, Minnesota Pollution Control Agency, described land use trends and the impact on ground-water quality. Emerging land use trends Jennifer noted included increased urbanization, brownfield cleanups, increased irrigation of farmland, land application (instead of incineration) of manure and biosolids, and the changing

management of farm wastes. Some of these changes are noted in increased concentrations of chloride and nitrate. Jennifer noted that while the total amount of manure being land applied is not increasing, the proportion of hog manure is increasing. The manure may be a source of residual antibiotics. The results of a GWMAP study of feedlots showed that concrete basins leak less than unlined and earthen basins, or an open lot.

Jeff Cahill, U.S. Geological Survey, Denver, was a special guest speaker to report on the results of a national reconnaissance of pharmaceuticals in surface and ground water. Jeff led off his talk by noting that the U.S. is well medicated. Newer technology with greater sensitivity has found pharmaceuticals in sewage treatment effluent and in sewage sludge. Although concentrations are low, many questions remain about environmental effects and effects on the human population such as promoting antibiotic resistance. Advanced methods for extracting pharmaceuticals from samples using solid-phase extraction and identification using HPLC were described. Of 127 surface-water samples the most common detections were caffeine, acetaminophen, and nicotine. Detections were in the 1-100 ng/L range. Of 34 ground-water samples, caffeine was detected most often, although antibiotics were also detected. Concentrations found were about 10 ng/L. The research continues and additional information can be found on the web at toxics.usgs.gov/regional/emc.html.

Jim Walsh, Minnesota Department of Health, reported on a study of 75 ground-water samples to determine presence of bacteria and viruses. A national study had shown high levels of detection. The MDH study results showed 6% bacteria and 1% virus detections. If total coliform is excluded, only 1% of samples had bacteria detected. No infectious viruses were detected. The Minnesota results were very different compared to the national results. Jim noted that the national sample set



— Standing room only at the Fall Meeting, photo by Sean Hunt

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Fall Meeting Report, cont.

included wells with known problems. He also said the Minnesota results are similar to other Minnesota sampling efforts for bacteria.

Rich Soule, Minnesota Department of Health, reported on a study to evaluate the distribution of arsenic in Minnesota ground water. Rich noted that arsenic is active at very low levels, "not all natural things are good for you", and that arsenic is common in the rocks and minerals in Minnesota. Based on samples to date, elevated arsenic in Minnesota ground water is found in the same areas in western Minnesota as Des Moines lobe glacial deposits. The source is Pierre Shale (which contains pyrite) that was incorporated into the Des Moines lobe. Using some clear and informative graphics, Rich showed how over time arsenic is released from the glacial sediments, accumulates, and then is mobilized along the ground-water flow path.

Kathy Lee, U.S. Geological Survey, described current work on the effects of endocrine disrupters on Minnesota fish. Many commonly used chemicals may be hormonally active. Kathy described the results of examining carp collected from below waste-water treatment plants. Some carp were diseased, deformed, or show other evidence of hormone action. She noted that the agent(s) responsible for the effects on carp have not yet been identified but the action is like an estrogen. She also noted it is not yet known if the agents affecting fish produce a human health effect.

Cathy Villas-Horns and John Hines, Minnesota Department of Agriculture, described their work on pesticide degradation. First, Cathy described results of samples taken at agriculture chemical clean-up sites. She said that the total amounts of most pesticides sold in Minnesota are stable, but that the quantity of glyphosate (Round Up) is on the increase. Results of samples at one site showed that degradates of the parent pesticides acetochlor, alachlor, and metolochlor exceed the parent concentrations. In contrast to the point-source study reported by Cathy, John discussed non-point effects of

pesticide degradation and the policy implications. The results of pesticide sampling in 78 wells by the MPCA and USGS are possibly indicative of non-point sources. Both parent and degradates were found. Policy implications include changes in pesticide registration procedures, limiting state registration of questionable compounds, and the use of conditional registration.

A short business meeting was held at the beginning of the afternoon session. Jim Lundy summarized the Association's 2000 activities and looked to next year. In 2000, the Association maintained stable finances and accomplished two conferences and a field trip. Association news was brought to members in the quarterly newsletter and the web site. The MGWA donated \$700 to educational programs such as student field trips and the Children's Water Festival. A major change in 2000 was the creation of the MGWA Foundation to take on and expand the educational programs that are part of the MGWA charter.

Mike Trojan, Minnesota Pollution Control Agency, described the use of nitrate as qualitative environmental indicator. He noted that nitrate has the attributes of an indicator: it is inexpensive to sample, widely distributed and studied, and indicates source or aquifer conditions. Several examples were shown how nitrate could be an indicator of other chemicals or conditions. Mike advocated better use of the nitrate data collected by state and other agencies, better coordination, and additional research to evaluate relationships between nitrate and chemicals of concern.

Joe Zachmann, Minnesota Department of Agriculture, provided a status report on the implementation of the state nitrogen fertilizer management plan. He described the process underway to prevent non-point impacts of fertilizer use. Fertilizer Best Management Practices, BMP's, are currently being promoted, with special BMP's for irrigated corn and potatoes. If studies show these are ineffective, Joe described the regulatory options available.

Sheila Grow, Minnesota Department of Health, showed how using existing

data resources, such as from the County Well Index database, and the GIS program ArcView, many questions can be quickly visualized and answered. As an example Sheila showed the Washington County Nitrate Probability Map for the Prairie du Chien-Jordan aquifer.

Editor's Note: Following is a summary of the small group discussions that were held as a part of the Fall Conference to develop a list of issues for consideration by the 2001 Legislature. This should be considered a draft and we will accept comments in writing or by email until January 15, 2001. A final copy will be posted to the MGWA website.

Outcomes from the MGWA's fall conference 2000

Minnesota's Emerging Ground Water Quality Issues What Science is Telling Us About the Need for New Ground Water Law in Minnesota

In response to questions to the Minnesota Ground Water Association (MGWA) about ground water policy and legislative needs from Rep. Dennis Ozment (chair, House Environment and Natural Resources Policy committee; who also created the House Subcommittee on Ground Water), the MGWA conducted its fall conference using a workshop format to consult with its members about current ground water issues. The workshop purpose was to answer the question "What is the science telling us about the need for new ground water law". This report summarizes the outcomes from the workshop.

MGWA conference attendees identified the following major issues of concern related to Minnesota's ground water. Note that members strongly recommended using existing programs to address these concerns rather than starting new ones and recommended that the primary focus of new legislation be on education and incentives rather than regulation. The issues are not in priority order.

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Conference outcomes, cont.

1. Emerging Ground Water Contaminants of Concern

Problem:

A great deal of concern has arisen in the recent scientific literature and in scientific conferences regarding the water contaminants that have not previously been considered a significant environmental concern.

For instance, a large suite of pharmaceutical compounds has appeared in surface water (such as heart medicine, cholesterol medicine, viagra, and acetaminophen), often immediately downstream of municipal wastewater treatment plants. Wastewater treatment plants may be ineffective in removing these compounds, with the result that they may be present in many rivers and lakes (they are present near Pig's Eye in St. Paul). There may be limited aquatic toxicological information on these individual compounds, and little or no information on the human and ecological risk posed by mixtures of compounds that may be present together in the environment.

Another emerging issue is the potential presence of pesticide degradation products in the environment. Pesticides of known chemical structure and toxicity may transform in the environment to new compounds for which we have limited toxicological data. They can be difficult to identify and measure in ground water because of the potential for multiple degradation products for many parent compounds and because effective analytical methods may not be available or the analytical methods are difficult or expensive.

There is an increasing concern that some chemicals that are present in the environment are "endocrine disrupting compounds" that may cause changes in hormonal activities of aquatic and other organisms. These compounds appear to be affecting the reproductive systems of some fish in Minnesota. It is unknown whether similar changes could occur in humans who ingest water with these contaminants, and it is unknown whether such compounds occur in ground water. Potential endocrine disrupting compounds include

pharmaceuticals, pesticide degradates and plasticizers.

Other potential contaminants of concern include radioactive compounds (e.g., radon) and viruses in ground water. Viruses in ground water appear to be of concern in certain parts of the nation, and are being addressed in a "Ground Water Rule" being promulgated by the U.S. EPA. For this reason, the Minnesota Department of Health (MDH) studied viruses in ground water in Minnesota. The results suggest that viruses are not a great concern in Minnesota.

Funding and Actions:

Since there will always be changing issues and concerns for ground water protection, funding should focus on an overall sustainable approach for ground water protection, which might include the following parts:

- Long term trend monitoring for emerging contaminants

- Development of analytical methods for emerging contaminants

- Toxicological assessment of emerging compounds, especially synergistic effects, to determine which compounds or groups pose actual threats to humans or the environment

- Training for scientists on emerging ground water issues

2. Nitrates in Minnesota's Ground Water

Problem:

Ground water in some shallow aquifers in Minnesota is contaminated by nitrates above a human health drinking water standard. This contamination is a significant concern in some parts of Minnesota.

Funding and Actions:

The 1989 Ground Water Protection Act created a structure through the MDA to address agricultural sources of nitrogen in ground water, but the program was never funded. Programs which address poorly constructed wells, inadequate individual septic systems and other potential sources of nitrate in ground water also should be funded. Farmer to farmer and other education and demonstration activities for

promoting agricultural best management practices (BMP's) for nitrate fertilizer should be supported. Crop yield insurance and other incentive programs also should be formally evaluated.

Also suggested was a requirement to record nitrate concentrations on property deeds to protect human health.

3. Sustainability of Minnesota's Ground Water Supply

Problem:

Ground water quantity issues are emerging as issues of concern in Minnesota's ground water community. In many parts of Minnesota, ground water resources are very limited and in other areas new development threatens existing resources or may lower the water table sufficiently to limit the use of existing wells. It is desirable to develop a policy or approach at the state level to promote conservation of Minnesota's ground water to ensure adequate ground water resources in perpetuity. A suggested approach might be a "certificate of need" prior to construction of new high capacity wells and a "certificate of ground water availability" prior to construction of new ground-water dependent facilities.

In practice it can be difficult to separate ground water quality and quantity issues, since the quality may affect the quantity that is usable for a given purpose. Therefore, state ground water programs should consider both quantity and quality.

It is important to increase the perceived value of ground water to the public. Water-rich Minnesota has not adequately recognized or emphasized the true value of ground water. Conserving the resource, emphasizing prevention of ground water contamination and increased emphasis on land use planning for ground water quality and quantity need to be promoted at the state and local level.

Funding and Actions:

Provide adequate funding to programs that provide regional assessments and protection of ground water resources including:

Ground water recharge

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Conference Outcomes, cont.

Increase the number of observation wells in the network for adequate monitoring of water availability. Instrument observation wells and precipitation gages for long-term recharge studies in critical areas.

Chemistry of precipitation—standardize statewide to estimate impact on ground water quality.

Recharge zone protection coupled with green space/wetland land use preservation.

Recharge (spatial, temporal), surface water ground water interaction.

Ground water sensitivity—especially karst regions.

Monitor “gray water” entering aquifers.

Establish water budget for major aquifers, define sustainable yield for heavily used aquifers (Age dating, Long term tracer tests, Aquitard studies, Definition of impacts on natural discharge represented by aquatics, wetlands, cliff communities).

Development

Include an assessment of a wetland’s value to ground water quality and quantity in wetland protection incentive programs.

Consider policies and mechanisms to encourage science-based land use decisions in wellhead protection areas and, if necessary, to review decisions which may have a significant regional impact.

Assess the impacts of urban development, drainage, and use of chemicals (e.g., road salt, fertilizers, roadway/parking lot runoff) on ground water that we might not see for 10-100 years.

Discourage water intensive development in low water supply areas by requiring water availability assessments and ground water withdrawal impact studies as a pre-funding condition of projects involving any form of direct or indirect state funding.

Agriculture

Provide funding to demonstrate and promote agricultural best management practices with the priority for funding going to those hydrogeologic regions and for those practices which pose the largest risk to ground water.

Evaluate the potential benefits and environmental risks from agricultural drainage reductions.

Evaluate differences in regulations relative to wastewater treatment for large feedlot operators and municipalities.

Conservation

Increase the perceived value of water (fee for water use). Proceeds to be directly returned to the programs that monitoring the impacts of the water use: the observation well monitoring network and ground water resource and availability studies.

Assess and if necessary regulate dewatering operations statewide

Revisit ground water as a possible source heat source/heat sink for heating and cooling—a possible use for non-potable aquifers

Interbasin transfer

4. Long Term, Stable, and Dedicated Funding for Minnesota Ground Water Programs

Problem:

The peril of government science is that the political process sometimes abbreviates, curtails or eliminates programs that produce useful results. Conference attendees expressed some frustration about poorly funded programs, and underlined the absolute need to consider adequate funding for existing rules and regulations.

Funding and Actions:

The legislature should consider providing and protecting long term funding for ground water activities.

Effectiveness monitoring for BMPs, KREP, RIM, and other programs.

Increase funding to state mapping agencies (MGS and DNR) to provide the hydrogeologic framework for developing conceptual ground water models.

5. Education for Conservation and Protection of the Resource - for the General Public and Contaminant Source Groups

Problem:

Ground water is often considered to be mysterious; people identify with surface water, but ground water is out of sight and out of mind. It is important to communicate to public the value of ground water and the importance and cost of ground water science and conservation. It is particularly important to conduct educational efforts for those groups who may unintentionally be contributing to ground water quantity or quality problems.

Funding and Actions:

Examples include activities to promote use of agricultural best management practices for farmers, preferably farmer to farmer, and public education and notification of programs in recharge areas and in areas such a karst areas where there is a high risk or vulnerability of ground water/surface water interaction. Other examples include public service messages for children and adults, videos for the general public, legislators; etc. on how to access ground water programs and data and the value they provide, and expansion and cross-linking of Non-governmental Organization and State Agency Web pages on ground water.

6. Coordination Between Agencies

Problem:

There are many different agencies and programs involved in ground water. It is difficult to coordinate activities, ensure that data generated by one program is available to all groups and to eliminate potential duplication of efforts between all these groups. Significant progress has been made but it is important to continue to coordinate these efforts to provide the maximum value given limited resources.

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MGWA Officer Helps Educate Visiting Drillers

Lee Trotta, MGWA Treasurer and applications engineer for the Water Products Unit of US Filter Company in New Brighton, recently met with representatives (Robert Schutt and Oscar Torres) of Daho Pozo, a drilling firm in Guatemala. The visitors got a tour of the factory and Trotta trained them in sand analysis. He also presented them with screen samples and well design guidance documents.

He then arranged their visits with local drilling experts at E.H. Renner & Sons and Bergeson Caswell in order to see several drilling methods.

Conference Outcomes, cont.

Funding and Actions:

The following is suggested:

The legislature designate a lead agency for all programs

A ground water data coordinator be funded in each agency to minimize duplication of effort between agencies and programs

Funding be provided to coordinate and track land use/soil use data management through GIS and other data bases in environ-

Fall Field Trip Guidebooks Available

Guidebooks are still available for \$18.00 including shipping, handling, a field trip logo patch and MN state sales tax.

Order yours on the MGWA secure commerce site (follow the link from www.mgwa.org) or send your check to MGWA at 4779 126th Street North, White Bear Lake MN 55110-5910.

A few field trip guidebooks from past years are also available. To check availability send an e-mail inquiry to office@mgwa.org.

Students Learn by Doing at Water Festival

Some 1500 metropolitan area fifth graders attended the third annual Metro Children's Water Festival September 27th at the State Fairgrounds. As in previous years, the MGWA was proud to be a cosponsor of this event. Following this year's Festival, students of several schools sent cards and letters thanking the MGWA for helping to sponsor the program. Here are a few:

To: MN Groundwater Association, Mr. Jim Piegat.

It was a really fun field trip!! Thanks, we learned alot at the water festival.

From: Mrs. Jorvig's Class, Woodbury Elementary

Dear Minnesota Groundwater Association,

Thank you for sponsoring the Minnesota Waterfest. I had a lot of fun there. I learned that the water that I am drinking right now has been around in the world for over 4 billion years. I also learned that the frogs that are found in some ponds are deformed. Thank you again very much.

From, Jenna Schwinghammer, Castle Elementary School, Oakdale

Dear Minnesota Groundwater Association,

Thank you for donating money for us to go to the Waterfest. Our class went and we had a

BLAST! One of my favorite parts was the ponds with the little bugs and animals. I also like the Science Museum show.

Thank you again for paying for us to go!

Sincerely, Kate Hagerty, Castle Elementary

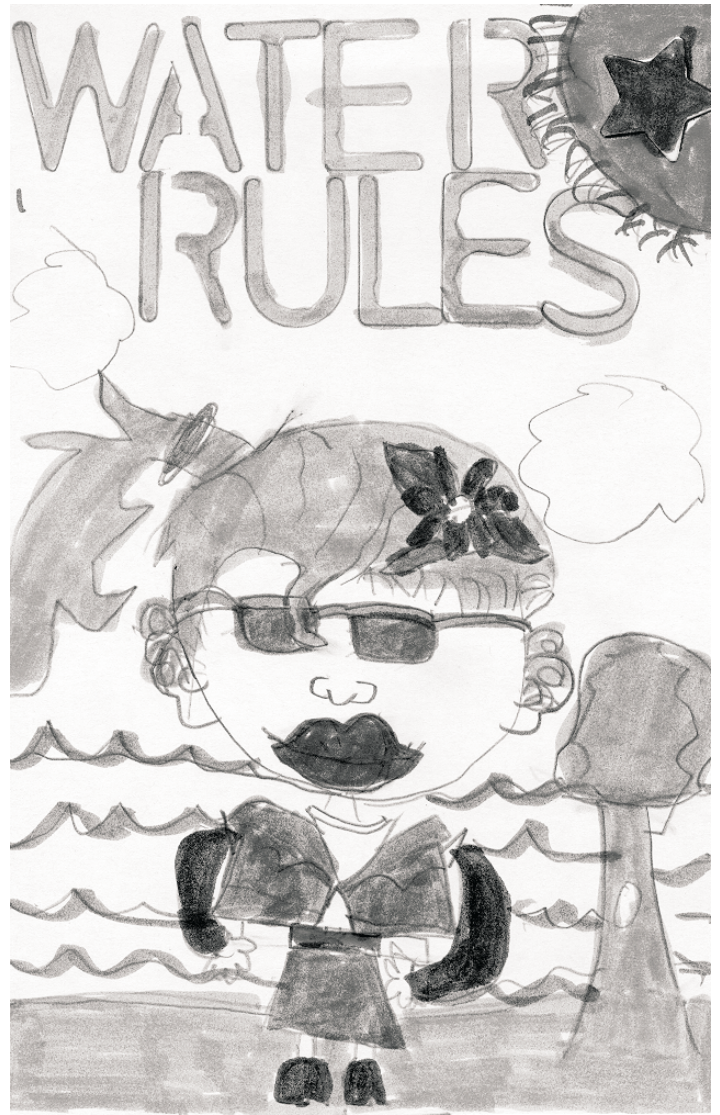
Dear Jim Piegat:

Thank you for sponsoring the Water Festival. It was really, really, fun. I liked it a lot. And I learned a lot too. I

learned about watersheds, pollution, evaporation, and the critters. It was fun. Thank you so much.

From, Megan Erickson, St. Michael School, West St. Paul.

This is the cover of Megan's card. It seems like she's got the right idea!



Western MN Regional Hydrogeologic Assessment Report Available

The Minnesota Department of Natural Resources (DNR) recently published Part B of the Upper Minnesota River Valley Regional Hydrogeologic Assessment. The assessment includes Lac Qui Parle, Swift, and Yellow Medicine counties, and parts of Big Stone, Kandiyohi, Lincoln, Lyon, Redwood, and Renville counties.

Part B includes two plates describing the surficial hydrogeology and pollution sensitivity of the study area. As shown on the surficial hydrogeology map, the water table surface approximates a subdued replica of the land surface topography; the Minnesota River is the major surface and ground water drain in this study area. Some of the most productive water-table aquifers are located near the city of Appleton and along the Pomme de Terre River. However, most of the municipal and domestic water supplies come from buried aquifers. Locations of some of the larger buried aquifers are indicated on the map, which shows several aquifers buried at different depths in the vicinity of the city of Appleton. In places, several buried aquifers are stacked vertically and may be interconnected. Carbon 14 analysis of 10 water samples indicates water in aquifers located at depths greater than 100 feet below the surface may be as much as 9,000 years old. However, within 50 feet of the land surface, tritium analysis of 84 water samples shows that aquifers are more likely to have water only weeks to a few decades old. The pollution sensitivity map shows that water found in near-surface sands and gravels is very sensitive and may be contaminated, or could become contaminated unless preventive measures are taken. Elsewhere, the near-surface sediments are finer grained and not as well sorted, and have a significant clay fraction ranging from 10 to 40 percent. These sediments greatly restrict vertical downward movement of water. In these areas the greatest concern is

that contaminants in runoff could move laterally to discharge into nearby surface water. The method for describing pollution potential uses estimates of travel time for contaminants traveling with water to move vertically from the surface to shallow ground water. A more detailed explanation of map preparation is provided in the text and supported with graphics.

Digital files of the databases and maps, plus portable document files (PDF) of both plates will be available on the DNR web site at the web address below. The Minnesota Geological Survey published Part A, two plates describing the surficial geology and glacial stratigraphy of the region, in 1999. Digital database, map, and PDF files of Part A are available on the MGS web site at their web address below.

This report completes the fourth assessment in the series and two more reports are underway. Part A of the Otter Tail Regional Hydrogeologic Assessments was published by the MGS in 1999. An assessment in the area of Traverse, Grant, and Big Stone counties recently started.

These reports are the result of an ongoing cooperative program between the DNR and the Minnesota Geological Survey. The overall effort also includes preparation of the popular County Atlas Series of reports. The reports produced by the program support planning, research, education, and environmental protection efforts.

More information about other reports can be found on the web at http://www.dnr.state.mn.us/waters/programs/gw_section/cgarha/status.html and <http://www.geo.umn.edu/mgs/>.

Regional Hydrogeologic Assessment RHA-4, Part B, Upper Minnesota River Valley, Minnesota. Two color plates. Scale 1:200,000. \$8.00 (sales tax and shipping charges extra).

The report may be ordered from the Minnesota Geological Survey, Publications, 2642 University Avenue W., St. Paul, MN 55114-1057, phone 612-627-4782.

Metro Model E-zine

Lower Aquifers Report - A New Look at Old Aquifers

Welcome to the Metro Model E-zine! This installment is being sent to inform you of a new report now available from our website that provides a fresh look at the Twin Cities metropolitan area's two oldest aquifers. The report shows how a holistic look at these two aquifer systems has helped to unlock some of their secrets. The aquifers have been combined into a two-layer groundwater flow simulation:

- 1) the Franconia-Ironton-Galesville Aquifer (Layer 4), and
- 2) the Mt. Simon-Hinckley Aquifer (Layer 5).

Although our area of interest is the metropolitan area, we've incorporated hydrogeologic features so that the model covers an area that extends from almost as far as Duluth down to the Iowa border. The purpose of the report is twofold. First, it provides the documentation required by users of the model itself. This documentation is not intended to be read straight through by most people, but rather is a reference to be kept at hand for those using the model. Secondly, the report presents the results of our modeling effort regarding the nature of groundwater flow, recharge, and discharge over the large regional area encompassed by the model. In the "Model Results" section, we present comparisons of modeling results to measured heads, stream

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Officer Ballot and Membership Survey

The ballot and the second annual membership survey are enclosed in this newsletter.

The MGWA Board of Directors uses your responses to the survey to help plan the events you need to stay current in the rapidly changing field of ground water science. Please fill in the survey and return it (and the ballot, of course) to the MGWA office right away!

Metro Model, cont.

discharge estimates, and radiometric age dating of groundwater samples. Additionally, we present an evaluation of the water budget of the lower aquifer system, including recharge, leakage, and discharge. This report, entitled "Lower Aquifers Model, Layers 4 and 5", may be accessed from our website: <http://www.pca.state.mn.us/water/groundwater/metromodel.html>

To download this report, click on "Project Reports" under the "Available for Download" heading, then select the file layer45.pdf under "Layers 4 and 5 Summary". Future developments: Full documentation of the supporting databases for the Metro Model is expected to be available as a report in January 2001.

To learn more about the Metro Model, check out the short summary on the web page. A more complete description of the project can be found in the project Overview Report, which may be accessed at the website presented above by clicking on "Project Reports" and selecting the file overview.pdf under "Project Overview". Project staff really want to know what is working and what isn't. If you 1) have feedback to offer the Metro Model team, 2) would like more information, 3) think that the Metro model project team can provide you with resources you need for your project, or 4) wish to have your name added to our E-zine mailing list, please contact one of the following individuals:

John Seaberg (651) 296.0550
john.seaberg@pca.state.mn.us
Andrew Streit (218) 723.4929
andrew.streit@pca.state.mn.us
Doug Hansen (651) 296.9192
douglas.hansen@pca.state.mn.us

This E-zine is sent via e-mail to people who may have interest in the Twin Cities Metropolitan Groundwater Model project.

This edition of the Metro Model E-Zine was published with permission of the Metro Model team of the Minnesota Pollution Control Agency.

MGWA Committees Working Hard this Year

Editor's note: The newsletter is beginning a regular feature of publishing meeting summaries of MGWA committees. Committee membership is a great way to serve the organization without the time commitment required for Board membership. If interested, contact a Board member.

Membership – The Membership Committee was formed in January 2000 to take on the tasks of corporate membership, membership recruitment, and membership tracking. Committee members this year have been Jim Lundy, Lee Trotta, Jan Falteisek, Sean Hunt, and Paula Berger. The committee has identified ways to better track members and former members. The Committee is considering awards to recognize members and others for their contributions to MGWA and the ground-water community. A student recruitment poster was developed to encourage student involvement and academic contacts for students contacted. A proposal for corporate membership is under consideration.

Education — The Ground Water Education committee has met three times to discuss a project that helps provide education to grade school students on ground water issues. Ground water experts (like MGWA members) can visit grade school classes to teach basic ground water concepts, but preparation time can be significant. The committee is collating the many ground water teaching resources into a ready-made "wash and go" curriculum. The finished product will contain age appropriate 60-90 minute presentations, demonstrations on ground water, and a list of available resources (slides, equipment, people, etc.). Look for the finished product on the "members only" section of the MGWA web page (www.mgwa.org). Committee members are Kevin Powers (Leggette Brashears and Graham), Cathy Villas-Horns (Minnesota Department of Agriculture), Dan Wiberg (Epoch Consulting), Jim Lundy (Minnesota Pollution Control Agency) and Erin Eid (Minnesota Pollution Control Agency).

Foundation — The MGWA Foundation Board of Directors met on Tuesday October 10, 2000 at the Day by Day

Cafe in St. Paul. The first item discussed was Pat Bloomgren's departure from the board and possible candidates to fill the position. This position will be the first of "Board 1". "Board 0" will likely retire about next spring, when planning for the first fund raising event is nearly/fully complete.

The second agenda item was the student paper competition, to be piggybacked onto the MGWA Spring Conference (usually at the end of April). We decided the most workable format would be to ask for paper (not poster) submittals, to be judged at leisure before the conference. Winners (first, second, third) would be announced at the conference, given a plaque or some other recognition, and the first place manuscript would be published in the June 2001 issue of the MGWA newsletter (all three winners could be published on the web page). The MGWA Foundation board needs to determine the framework for judging (could this be patterned after GSA or some other organization? Jennie is looking into) and circulate this information to professors.

The spring conference might be held somewhere like the Macalester College Geology department. There is a large lecture hall for the sessions, and a very nice exhibition hall (dinosaurs and other fossils) where snacks could be dispensed. This area could also serve as the location for the first MGWA Foundation fund raiser, possibly a beer tasting event and silent auction.

Jennie had heard Lee Trotta mention that MDH is not doing the well conference any longer. If true, perhaps MGWA (F) could pick up this conference? After the meeting Ed Schneider of MDH confirmed that they are no longer doing the conference. They have seen a big drop in the number of water well contractors attending; this is the audience they need to reach. He said they still had strong attendance from environmental consultants and monitoring well contractors, but MDH can no longer justify the time spent organizing. They used to charge \$50 (hadn't changed in 10

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MGWA Calendar

The most complete version of the MGWA Calendar is available on our web page at www.mgwa.org.

Contact information for the major event holders is listed at the end of the column. If you become aware of a relevant event which may not be widely publicized, please send the information to the attention of the editor. Thank you.

December 4-8, 2000 Princeton Ground Water Remediation Course. Orlando, FL. Contact: Princeton Groundwater.

December 11-12, 2000 Monitoring and Evaluating Wetlands for Ground Water and Lake Impacts. Contact: NGWA.

January 8-9, 2001 Low-Cost Remediation Strategies for Soil and Ground Water, Milwaukee, Wisconsin. Contact: Steve Scott, Environmental Resources, steve@mo-raine.com, 262-691-7413, www.mo-raine.com

January 10-12, 2001 Natural Attenuation for Remediation of Contaminated Sites, Milwaukee, Wisconsin, Contact: Steve Scott, Environmental Resources, steve@mo-raine.com, 262-691-7413, www.mo-raine.com

March 19-21, 2001 Principles of Ground Water: Flow, Transport, and Remediation. Columbus, OH. Contact: NGWA.

April 1-4, 2001 8th Multidisciplinary Conference on Sinkholes and Karst and the Engineering and Environmental Impacts of Karst, "2001 - A Karst Odyssey," Louisville, KY. Contact: (865) 483-7483, 8thcon@pela-tenn.com.

April 23-24, 2001 35th Annual Meeting, North Central Section of the Geological Society of America. Bloomington-Normal, IL. Contact: www.geosociety.org/sectdiv/Northc/01ncmtg.htm

April 30-May 2, 2001 AWRA Annual Spring Specialty Conference, "Water Quality, Monitoring, and Modeling," San Antonio, TX. Contact: (540)687-8390.

June 11-13, 2001 Analysis and Design of Aquifer Tests Including Slug Tests. Columbus, OH. Contact: NGWA.

This Newsletter brought to you by:

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MGWA Newsletter Deadlines for 2001

Issue	Copy to Editor	Copy to Publisher
March (Vol.20, No. 1)	02/09/01	02/16/01
June (Vol.20, No. 2)	05/11/01	05/18/01
September (Vol.20, No. 3)	08/10/01	08/17/01
December (Vol.20, No. 4)	11/09/01	11/16/01

October 9-11, 2001 2nd International Conference on Pharmaceuticals and Endocrine Disrupting Chemicals in Water, Minneapolis, MN. Abstracts due March 31, 2001. Contact: NGWA

October 14-17, 2001 Hydrologic Science: Challenges for the 21st Century. Minneapolis, MN. Contact the American Institute of Hydrology at 651-484-8169 or AlHydro@aol.com.

Contacts for the most frequent conference sponsors:

National Ground Water Association (NGWA)

601 Dempsey Road
Westerville, OH 43081
800-551-7379
<http://www.ngwa.org>

Princeton Groundwater

PO Box 273776
Tampa, FL 33688-3776
813-964-0800
813-964-0900 (fax)
Info@princeton-groundwater.com
<http://www.princeton-groundwater.com>

Nielsen Environmental Field School, Inc.

David M. Nielsen
4686 State Route 605 S.
Galena, OH 43021
614-965-5026
614-965-5027 (fax)
nielsenfieldschool@juno.com

New from USGS

NAWQA Reports

"Pesticides in Stream Sediment and Aquatic Biota", USGS Fact Sheet FS-092-00.

Fong, Alison L., "Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin - Ground-Water Quality in Three Different Land-Use Areas, 1996-98," USGS Water-Resources Investigations Report 00-4131.

Ruhl, James F., Fong, Alison L., Hanson, Paul E., and Andrews, William J., "Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin - Ground Water Quality in an Agricultural Area of Sherburne County, Minnesota, 1998," USGS Water-Resources Investigations Report 00-4107.

Contact Jim Stark, U.S. Geological Survey, Water Resources Division, Moundsview, MN (763) 783-3230, stark@usgs.gov.

New USGS Public Web Page on Drinking Water Programs

The Office of Water Quality has established a new public web page on USGS Drinking Water Programs (<http://water.usgs.gov/owq/dwi/index.html>). This page replaces the

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MGWA Committees, cont.

years) for an all day conference including lunch, at the Thunderbird (rates are increasing there).

I proposed a half day conference, plenary session, no meal. Perhaps at Earle Brown for the first run; bigger facility in other years if attendance warrants. Agenda would heavily feature well management unit staff presentations, but there would room for other technical topics of hydrogeologic interest as well. He is going to float this idea to other staff and management, and get back to me about it next week.

Paula is drafting a letter to send to geology/hydrogeology departments asking them to submit proposals for funding for spring field trips.

The next MGWA Foundation board meeting is scheduled for Friday December 8, 2000 at the Day by Day Café.

Respectfully submitted, Jim Lundy,
MGWAF Secretary

MGWA Board Meeting Minutes

September 7, 2000

Location and Time: Black Bear Crossing, 831 Como Ave., St. Paul, MN, 7:30 a.m.

Attending: Jim Lundy, President; Lee Trotta, Treasurer; Jan Falteisek, Secretary; Jeanette Leete, WRI; Tom Clark, Newsletter Editor.

Approval of Minutes – Jim Lundy called the meeting to order at 7:40 a.m. Minutes for the regular Board meeting held August 3, 2000 were approved.

Treasurer's Report – Financial reports were distributed previous to the meeting. Lee Trotta had no further items to add. Financial issues were discussed in relation to field trip preparations.

Newsletter – Proofs of the September newsletter have been provided by Jennie. The newsletter group meets next Tuesday.

Membership Committee – The student recruitment poster is nearly

completed. The cover letter for the poster was discussed and will also be discussed at the MGWA Foundation meeting on September 8th.

Web Page – Sean noted that he had added calendar items to the web page. He also noted that on-line registrations for the field trip had gone smoothly.

Advertising – The report on advertising options by Jim Aiken was discussed. A proposal of advertising choices needs to be prepared and submitted by Jim Aiken and Lee Trotta. Any changes to the advertising rates should be included in the December newsletter. The proposal for corporate membership will be addressed separate from advertising.

Membership Survey – In preparation for the membership survey, Sean Hunt is to look at last year's survey. The survey and ballot will go into the newsletter.

Membership Awards – Membership awards are under consideration and will be further discussed.

MGWA Foundation – It was noted that the Foundation received their IRS charitable designation.

Ground Water Education Committee – It was noted that the meeting scheduled for September 6th was postponed to October 10th. An article on the committee should be prepared for the December newsletter.

Fall Field Trip – Lee noted that the road log and Guidebook were being prepared. It was noted that for trip speakers expenses would be covered for speakers at multiple stops and multiple days.

Fall Conference – Jim L. provided a summary of speakers for the fall conference. He noted the need for a speaker on the topic of endocrine disruptors. Several subtopics for the nitrate issue were discussed, including stability and geochemistry, regulatory issues related to agriculture, and public health.

2001 Officer Nominations – Openings will be noted in the September newsletter.

Wisconsin Ground Water Association – Jim L. reported that he had called Bruce Hensel of the WGWA and suggested cross-linking web

pages. The WGWA will get back to Jim L. on his proposal. The same contacts and linking could be pursued with the Iowa Ground Water Association and the Illinois Ground Water Association.

Next meeting – The next Board meeting will be Thursday October 5, 2000, 7:30 a.m., at Black Bear Crossing.

Meeting adjourned at 9:00 a.m.

October 5, 2000

Location and Time: Black Bear Crossing, 831 Como Ave., St. Paul, MN, 7:30 a.m.

Attending: Jim Lundy, President; Jim Stark, President-Elect; Lee Trotta, Treasurer; Jan Falteisek, Secretary; Jeanette Leete, Sean Hunt, WRI; Tom Clark, Newsletter Editor.

Approval of Minutes – Jim Lundy called the meeting to order at 7:40 a.m. Minutes for the regular Board meeting held September 7, 2000 were approved with corrections.

Treasurer's Report – Financial reports were distributed. The amount of \$500 was transferred from the money market to the checking account to pay for field trip expenses.

Newsletter – The September newsletter was mailed. The newsletter team met last Tuesday. Plans are underway for the December newsletter. The newsletter will publish new members in 2000 and possibly quarterly. Tom said the newsletter team is still in need of a private sector representative. The team will try e-mail to private-sector members inviting a volunteer for the newsletter team. Sean will provide a selected list of members with e-mail addresses.

Membership Committee – The Membership Committee has not met since the last Board meeting. It was noted the student recruitment poster and cover letter are nearly done. Discussion continues on awards. In preparation for the membership survey, Sean will e-mail the last survey to Board members for updating.

Corporate Membership – Lee Trotta noted that the businesses Jim

— *continued on next page*

MGWA Board Meeting Minutes, cont.

Aiken had contacted requested the options previously prepared be simplified. Lee and Jim A. suggested the regular ad rates be increased to make the corporate option more desirable. Additional suggestions are noted in Jim A.'s e-mail of October 4. Approval of 2001 ad rates and corporate membership structure deferred to the November meeting. Comments are due to Lee Trotta by October 13.

Fall Field Trip – It was noted the field trip made a small amount of money after accounting for all bills.

Fall Conference – It was noted that the brochure went to the printer on October 5. The process for the small group activity was discussed. Each group should provide three to five top issues. Jim L. said he had contacted the media and notified them of the conference. Video/audio taping of the program was discussed.

Web Page – Sean said that page updates are needed.

Ground Water Education Committee – The scheduled meeting was postponed.

2001 Officer Nominations – There is currently one nomination for each position.

School Earth Day – Jim L. reported that the MGWA had been invited to participate April 19, 2001 at Olson Middle School in north Minneapolis. The MGWA would have a booth to this event open to the public.

Next meeting – The next Board meeting will be Thursday November 9, 2000, 7:30 a.m., at Black Bear Crossing.

Meeting adjourned at 9:00 a.m.

**Support Your
Association
— Invite a
Student
to Join**

New Minnesota Environment magazine Available

The Minnesota Pollution Control Agency (MPCA) has announced that the first issue of its new magazine *Minnesota Environment* is now available and will be published quarterly. The current issue includes several articles that touch on ground water impacts including the effects of sprawling development in the Brainerd Lakes region, and ramifications of road salt storage piles. Regular features include Compliance Matters and a Training Calendar. The on-line version is available on the MPCA website at:
www.pca.state.mn.us/publications/mnenvironmental/index.html.

Print copies are also available from the Agency's Public Information Office at 520 Lafayette Road, St. Paul 55155.



MGWA Welcomes New Members for 2000

During 2000 thus far, the following members have joined MGWA for the first time or renewed their membership after an absence of a few years. Welcome!

William Arnold, Don Baron, George E. Beatty, John Betcher, David N. Bourland, Don Brauer, Gregory J. Brennan, Paul Carter, Sarah A. Cherney, Paul Davis, David Dekrey, Jon Ellingson, Mark Ferrey, Rob Heimbach, Gerard Herro, Paul Hester, Jerry Hildebrandt, Laura Hite, Jim Hodgson, Bryce Hoppie, Pat Huggarth, Daniel E. Hunter, Garry Johanson, Pat J. Jurcek, William J. Keis, Robert Kostinec, Joseph Kroening, Kevin Kuehner, Michael Liljegren, Brian Livingston, Katherine Logan, Annette M. Marier, Jason R. Meek, Mike Mehmert, Carol Mostrom, John L. Nieber, Denise Oakes, Iain Olness, Edward P. Olson, Jeremy Pavlish, Camie Pederson, Doug Peterson, Jon

Pollock, Roger Reeves, Mike Rose, James F. Ruhl, Matt Schemmel, Troy D. Schultz, Norm Senjem, Terry Sieck, Erik A. Silvola, David Slomkowski, Scott R. Stanley, Bill Thompson, Erik Tomlinson, Mike Trojan, Cathy Udem, Donald E. Van Keulen, Robert J. Willard, Hans Wronka, and Virginia Yingling.

New from USGS, cont.

obsolete internal web page on the same topic. The new page provides descriptions and links to 216 USGS projects and reports from all Districts (and some other disciplines) that involve some aspect of drinking-water quality. The projects are listed conveniently by State, and are cross-referenced by topic. A separate page lists drinking-water projects and reports with a nationwide scope. Links are also provided to numerous external drinking-water web sites. This web site should be a useful tool for both USGS people and potential cooperators who are interested in developing drinking-water programs. Glenn Patterson (gpatter), the webmaster, will periodically update the page by checking the projects and reports posted on web pages of the District offices. He welcomes suggestions for additions or corrections. Janice Ward Acting Chief, Office of Water Quality US Geological Survey Reston, VA 703-648-6871 jward@usgs.gov

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2001 Minnesota Ground Water Association Newsletter Advertising Policy

Display ads:

Size	Inches H x V	Quarterly Newsletter Annual Rate; 4 issues	2001 Membership Directory Annual Rate; 1 issue
Business Card	3.5 x 2.3	\$66	\$50
Quarter Page	3.5 x 4.8	\$121	\$99
Half Page	7.5 x 4.8	\$225	\$190
Full Page	7.5 x 9.75	\$425	\$360
Inside Cover	7.5 x 9.75	not available	\$395

Classified ads: Classified ads in the newsletter are charged at the rate of \$3 per 45 characters (including spaces and punctuation) per newsletter issue.

E-mail notices: A one-time e-mailing to the membership costs \$10 for an individual (e.g., seeking a job), and \$50 for an organization (e.g., announcing a new product, job opening etc.). A 200 word limit is imposed. The advantage of e-mail is the speed of dissemination.

The Advertising Manager has final determination on the acceptance of materials submitted. There are no commissions on ads. Advertising copy must be received by the publication deadlines: 16 February, 18 May, 17 August, or 16 November. Advertisers are encouraged to submit material as a digital file in TIFF or PCX format at 300 to 600 dpi. If a digital file is not available, your copy should be a photostat of your art work at the exact insertion size. Photostats give the highest quality print reproduction. If a photostat is not available, high-quality copies of the ad on plain paper must be submitted for each issue published (e.g., four copies for the quarterly newsletter).

Please make checks payable to "Minnesota Ground Water Association" or "MGWA." Direct your orders and questions concerning advertising rates and policy to the Advertising Manager: Jim Aiken, Advertising Manager, c/o MGWA, 4779 126th Street, White Bear Lake MN 55110-5910; *Phone* (612) 375-1909; 612-361-4944 ; jaiken@northjacksonco.com.

Join the Minnesota Ground Water Association!

If you are reading this newsletter second-hand, we'd like to take this opportunity to invite you to become a member of **MGWA** for **2001**. Annual dues are \$25 for professional members and \$15 for students. Members are entitled to purchase a paper copy of the annual membership directory for \$7; an electronic version will be available on the website for paid members. Tax deductible contributions to the MGWA Foundation scholarship fund will be gratefully accepted.

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

Just complete the form below and mail to: MGWA, c/o WRI, 4779 126th St. N, White Bear Lake, MN 55110-5910.

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Which Address should we use for Mailings and for Directory Listing? _____
Which Telephone Number should we use for Directory Listing? _____

Your Career in Hydrogeology

Get connected with MGWA



Pursuing a career in Hydrogeology? Sure, you need good grades. But you also need to know the market and the jobs that are available. You need to know the latest on ground water science and policy. Most of all you need connections. MGWA is a sure route to those connections.

Join the Minnesota Ground Water Association as a student member for \$15 per year.

- Reduced registration fee for our policy and technical conferences
- Reduced registration fee for the fall field trip
- Opportunities to meet and network with prospective employers at MGWA events
- Four issues of the MGWA newsletter
- Directory of professional contacts
- Access to the members only page of the MGWA web site

Minnesota Ground Water Association

www.mgwa.org

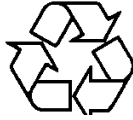
Join MGWA - sign up on our web site
Present a Paper - at the student research competition

Ask your advisor about the student research competition sponsored by the MGWA Foundation or email: office@mgwa.org

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