

MINNESOTA GROUND WATER ASSOCIATION

Newsletter Volume 7 Number 1, February 1988

President's Page

By Linda Lehman

Student Assistant Fund

In past issues, I have discussed the concept of a Student Assistant Fund. I am proud to say that we have finally initiated the fund and have received several grant requests from worthy students. What remains is, unfortunately, the unpleasant aspect of requesting funds. Soon, you, the membership of MGWA, will receive a letter which asks that you voluntarily contribute to this fund. Please contribute so that the students can take advantage of this opportunity.

Spring MGWA Meeting

The next opportunity for student participation will be the upcoming spring meeting. Tentatively, we have a topic and a place. The proposed topic will be "Radium in Ground Water". The place will be Winona. Specifics on times and dates have not yet been nailed down. We will notify you as soon as we know the details. The topic is thought to generate interest due to the problems recently encountered in Minnesota City Water Supplies (see Radium article in this issue).

Nevada Gets the Shaft

Nevada has won the right to host the Nation's first nuclear waste repository. Congress, on December 23, 1987, gave Nevada a Christmas present by cancelling all other first and second round repository work to focus on the Nevada Yucca Mountain Site. Further, to add insult to injury, the \$100 million/year incentive for accepting the site was reduced to a paltry \$10 million/year. Thus, finally

putting to rest the notion that site selection is a technical undertaking!

Nevada is not taking this lying down, however, and has plans to show the site may be unsuitable under the current laws. In support of Nevada's position, an internal report written by a top level U.S. Department of Energy (DOE) scientist casts doubt on the viability of Yucca Mountain. I have excerpted several paragraphs from the newsletter OVERSITE, Vol. No. 55, January 22, 1988, that describes specific highlights of that report.

A DOE scientist in Nevada believes the department's assumptions about the groundwater system beneath Yucca Mountain are critically flawed, and he has proposed his own model which suggests "serious consideration should be given to abandoning the Yucca Mountain site and declaring it as unsuitable for the purposes of permanent disposal of the high-level nuclear waste." Jerry Szymanski wrote a paper in November 1987 outlining his concerns that tectonic and volcanic activity at Yucca Mountain may cause the level of the water table to fluctuate hundreds of meters over long periods of time, perhaps "resulting in the flooding of the repository and in expulsion of groundwater at the ground surface." Szymanski's paper suggests DOE should perform experiments to determine which model is correct "prior to the commitment of substantial resources, such as those associated with the Site Characterization Process and the in-situ testing in the Exploratory Shaft."

Szymanski argued in his paper that tectonic processes at Yucca Mountain may cause the level of the water table to fluctuate tens of meters over the short term and hundreds of meters over longer periods. Short-term fluctuations, he wrote, "could constitute a 'pumping' mechanism for gaseous transport through

the vadose zone." Long-term fluctuations, Szymanski continued, "would directly impact the radionuclide migration path and the radionuclide migration time." In extreme cases, he said, "these displacements can result in the flooding of the repository and in expulsion of groundwater at the ground surface."

The scientist recommended that DOE conduct a series of tests to confirm which model of the groundwater system is correct before full-scale site characterization commences. "In all sincerity," wrote Szymanski, "the U.S. Government would be well advised to perform the recommended investigations prior to the commitment of substantial resources, such as those associated with the Site Characterization Process and the in-situ testing in the Exploratory Shaft."

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Szymanski based his paper on what he considers is the inadequate hydrology model DOE used to prepare the environmental assessment and site characterization plan for Yucca Mountain. "Examination of the extensive data base pertaining to the Death Valley groundwater system . . . reveals that this flow field is considerably different than the flow system currently envisaged by the [Nevada Nuclear Waste Storage Investigations] Project," Szymanski argued. "The conceptual model of this flow system, as used in performing site suitability assessments for purposes of establishing an approach to the forthcoming site characterization activities, is far too simple and much too far removed from reality. Simply stated this conceptual model ignores completely the volcano-tectonic setting of the Yucca Mountain site." The scientist said DOE's model limits "the influence of tectonic disruptions" to local disruptions and fracturing and minor changes in the water table.

"A completely different picture emerges if one considers the volcano-tectonic setting of the Yucca Mountain site and of the groundwater system operating at this site," maintained Szymanski. "The setting of Yucca Mountain contains . . . basalts . . . indicative of . . . mantle origin. The isotopic and geochemical characteristics of these rocks are best accounted for by assuming that the convective mass and heat transfer occurs in the upper mantle. From a point of view of regional hydrology, this mantle upwelling appears to be responsible for two very important, tectonophysical factors."

"The first factor is high and, most importantly, spatially heterogeneous heat flow . . . In such a flow field, an arbitrary plane adopted as the base of the flow field must be considered as the 'flow' boundary . . . Mathematical models used in numerical simulations of the flow process in this field must account for this circumstance, otherwise calculations and interpretations may be grossly misleading and, with reference to the Death Valley flow system, are quite irrelevant," the scientist wrote.

"The second factor is the strain energy, which because of the mantle upwelling, is being supplied into the flow field on a continuous basis . . . As the strain energy field changes with time, the thermal and hydraulic parameters also change. Consequently, the entire flow system acts as a three way . . . coupled thermodynamic

continuum," Szymanski continued. "Assumption of the two phase, heat-fluid coupled, flow field . . . is in full accord with all known characteristics of the Death Valley groundwater system. This is in sharp contrast to the DOE conceptual model of this system used to: a) perform assessments of suitability of Yucca Mountain for site characteristics; and, b) develop strategies for demonstrating compliance of this site with all applicable Federal regulations."

"Not accounting for the true nature of the flow field will, undoubtedly, entail serious errors in judgement amounting to a complete misunderstanding and, therefore, misrepresentation of the flow field," Szymanski declared.

"Conceptualization of hydrologic processes operating in the vadose zone . . . yields a completely different picture than the one currently envisaged by the NNWSI Project," he added. In light of experiments at Yucca Mountain, "an expectation that the movement of water through the vadose zone of Yucca Mountain involves the mechanism of interstitial porous flow does not appear to have a proper foundation."

Szymanski averred the "presence of: a) short lived instabilities of the water table; b) expressions of large scale instabilities of the water table during the last 105 years; c) perched waters with chemical compositions indicative of below the water table origin; and, d) meaningful difference in the chemistry of interstitial pore water relative to the fracture water, would confirm that the proposed conceptual model of the flow field is correct."

"In this situation," he concluded, "serious consideration should be given to abandoning the Yucca Mountain site and declaring it as unsuitable for the purposes of permanent disposal of the high-level nuclear wastes. In all sincerity, the U.S. Government would be well advised to perform the recommended investigations prior to the commitment of substantial resources, such as those associated with the Site Characterization Process and the in-situ testing in the Exploratory Shaft."

The State of Nevada is urging the DOE to consider the Szymanski approach and determine if the site is fatally flawed prior to investing billions of dollars in a site characterization program. If the site is flawed, then Minnesota will undoubtedly, once again, be back in line.

Minnesota Water: 1988

CONFERENCE OVERVIEW

MGWA recommends attending Minnesota Water: 1988 February 15-16, 1988 at the St. Paul Hotel, St. Paul, MN.

Minnesota Water: 1988 will present a broad review of water resources issues and problems facing Minnesota. Oral and poster sessions will present up-to-date information on:

- current status of Minnesota's surface and groundwater resources
- on-going research in academic institutions and government agencies to define water resources problems, understand causes, and develop solutions
- local and state efforts to develop comprehensive water plans and water management strategies
- recent and pending state and federal legislation affecting the management of Minnesota's water resources

A plenary session will feature a broad treatment of these subjects by national and state water experts. Concurrent half-day technical sessions will focus on specific water issues, including acid rain, lake restoration and lake level management, water and human health issues, groundwater contamination, nonpoint source pollution, wetlands water management, and local water planning. A poster session will feature findings of recent and ongoing water research projects funded by the LCMR, WRRR, and other agencies. Four workshops will demonstrate computer programs designed to help water researchers and managers.

Conference registration includes all sessions, a book of abstracts, two lunches, and an evening social hour.

Minnesota Water: 1988
WRRR 866 BioSciences Center
University of Minnesota
St. Paul, MN 55108

CALENDAR

February 8 - 10, 1988 *Fluid flow in fractured media*. International conference in Atlanta sponsored by USGS, the Georgia Water Research Institute, and Georgia State University.

February 15 - 16, 1988 *Minnesota Water: 1988*. To be held in St. Paul, Minnesota. See Announcement and Call for Papers in this issue.

February 16 - 18, 1988 *Ground Water Geochemistry Conference*. To be held in Denver, Colorado by NWWA.

March 3 - 4, 1988 *Wisconsin's Environment: The State of Our State*. To be held in Eau Claire, Wisconsin. Sponsored by AWWA, Wisconsin DNR, University of Wisconsin Eau Claire and University of Wisconsin Water Resources Research Center. Contact: Jim O'Loughlin, Wisconsin State Lab of Hygiene, 465 Henry Mall Madison, WI 53706

March 7 - 8, 1988 *Environment 88*. To be held in Milwaukee, Wisconsin. Contact: Federation of Environmental Technologists, PO Box 185, Milwaukee, WI 53201

March 8 - 10, 1988 *Corrective Action for Containing and Controlling Ground Water Contamination*. To be held in Atlanta, Georgia by NWWA.

March 16 - 18, 1988 *Basics of Ground Water Modeling*, a short course to be held in Indianapolis by IGWMC

March 20 - 23, 1988 *AAPG Annual Convention*. Contact AAPG Convention Department, P.O. Box 979 Tulsa OK, 74101-0979.

March 21 - 23, 1988 *Agricultural Impacts on Ground Water*. To be held in Des Moines, Iowa by NWWA.

March 21 - 25, 1988 *Applied Groundwater Modeling*, a short course to be held in Indianapolis by IGWMC

April 18 - 22, 1988 *Flow and Transport in Unsaturated Zones*, a short course to be held in Indianapolis by IGWMC

April 29 - June 3 *6th World Congress on Water Resources*. Ottawa, Canada. Contact: The Secretariat, University of Ot-

tawa, 631 King Edward Ave. Ottawa, Ontario K1N 6N5 Canada

May 16 - 20, 1988 *Deep-Well Injection of Liquid Wastes in Saline Formations: Hydrologic and Geochemical Processes*. To be held in Baltimore, MD, Contact: Charles W. Kreitler, The University of Texas at Austin, University Station, Box X, Austin Texas, 78713 (817) 565-2091.

May 23 - 26, 1988 *Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods*. To be held in Las Vegas, Nevada by NWWA.

June 12 - 14, 1988 *Third National Conference on Drinking Water*. St. John's Newfoundland, Canada. Contact: Chairman, Third National Conference on Drinking Water, P.O. Box 205, St. John's Newfoundland, Canada A1C 5J2.

June 13 - 16, 1988 *Ground Water Modeling Without Advanced Mathematics (Course I)*. To be held in Baltimore, Maryland by NWWA's AGWSE.

June 13 - 18, 1988 *International Conference on Constructed Wetlands for Wastewater Treatment*. To be held in Chattanooga, Tennessee by TVA and EPA. Contact: Donald A. Hammer, Senior Wetlands Ecologist, TVA, Division of Land and Economic Resources, Forestry Bldg., Norris, TN 37828

June 13 - 16, 1988 *Ground Water Modeling Without Advanced Mathematics (Course Mini II)*. To be held in Baltimore, Maryland by NWWA's AGWSE.

June 20 - 24, 1988 *Parameter Estimation in Groundwater Simulation*. A short course to be held in Indianapolis, Indiana, by IGWMC.

June 21 - 24, 1988 *Canadian/American Conference on Hydrogeology: Fluid Flow, Heat Transfer and Mass Transport in Fractured Rocks*. To be held in Banff, Alberta, Canada, cosponsored by NWWA's AGWSE.

July 25 - 29, 1988, *Modeling of Fluid Flow and Contaminant Transport in Fractured or Granular Porous Media*, a short course to be held in Indianapolis by IGWMC

August 22 - 26, 1988, *Stochastic and Geostatistical Analysis for Groundwater Modeling*, a short course to be held in Indianapolis by IGWMC

August 28 - 31, 1988 *Symposium on Water-Use Data for Water Resources Management*. To be held in Tucson, Arizona by AWWA.

October 11 - 13, 1988 *Introduction to Contaminant Transport Modeling*, a short course to be held in Tampa, Florida by NWWA

For information about meetings and seminars to be held by the NWWA, contact NWWA at 6375 Riverside Drive, Dublin, Ohio 43017 (614) 761-1711, Telex 241302.

For information about Short Courses to be held by IGWMC, contact Margaret Butorac, International Ground Water Modeling Center, Holcomb Research Institute, Butler University, Indianapolis, IN 46208 (317) 283-9458.

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POLICY ISSUES

In order to keep our membership informed, this newsletter periodically describes issues, strategies, and needs of concern to ground water professionals at work in Minnesota. The following short news items are reprinted from Future Scans, a publication of the Minnesota State Planning Agency. Future Scans welcomes submissions; contact the SPA at 300 Centennial Office Building, 658 Cedar Street, St. Paul, MN 55155.

Program Proposes Sale of Pollution Permits.

A new program based on marketable permits to pollute air and water was developed recently in New York City, according to Chemical Week. The permits to pollute would be auctioned off periodically. The system is based on economic incentives and could result in more efficient environmental regulation than the current system, which is poorly funded and inefficient at determining the extent of contamination or providing enforcement.

The federal government could recoup a large portion of the \$50 billion spent annually on air and water pollution by selling rights to pollute to the highest bidder. The program could result in cheaper environmental regulation. However, it could also result in increased damage to health and the environment if polluters are willing to pay for the right to pollute and society is willing to accept cash as a trade-off to a cleaner environment.

North Dakota, with its relatively low air pollution levels, may be a state which would strongly consider such trade-offs. Yet many questions remain, including how these choices will affect surrounding states and what standards should be used beyond which this program could not go.

- For more information, contact Dick Gross, North Dakota Governor's Office, 701-224-2200.

New Insurance to Protect Farmers who Pollute Water Supplies.

In the near future, farmers may be facing lawsuits from cities, states or other groups on the grounds that chemicals used to control insects and weeds have polluted drinking water supplies. Farm Bureau Mutual Insurance is offering a new type of coverage, pollution insurance, to protect farmers from being wiped out by such suits, according to the Minot Daily News.

Farmers' general liability policies cover "sudden or accidental" pollution on their property, such as a chemical tank rupture or the dumping of chemicals into a nearby stream. Now, the courts have decided "sudden and accidental" no longer make a difference in pollution liability cases, meaning farmers using chemical for a period of years may be liable in a pollution case. Therefore, traditional insurance policies may not protect a farmer sued for pollution.

This potential liability is being handled differently by different states. Iowa has passed legislation allowing that the farmer is not liable for active cleanup or damage if he or she followed the label instructions and had appropriate certification for using the chemicals. New York is considering a similar law. Such laws, however, do not mean farmers cannot be found liable, only that they can use their compliance with the law as a defense against charges. Connecticut does consider the farmer to be liable for chemical pollution of ground water, and five cases are currently pending.

Minnesota is considering legislation similar to that which provides funds to cover cost of the underground storage of hazardous materials: Under a certain amount of cost for damage, farmers would be responsible; in an intermediate range, money from the fund would be used; and excessive amounts would be covered by insurance.

Whether this is an appropriate area for insurance examination or tort reform, the potential for significant loss to Minnesota farmers is great.

- For more information contact Dick Gross, North Dakota Governor's Office, 701-224-2200 and Deborah Pile, 297-2375.

Safety Questions about Bottled Water

Bottled water is enticing growing numbers of American consumers. Industry sales throughout the U.S. reached \$1 billion in 1985 and growth through 1990 is expected to run at 15 percent annually, according to articles in *The Groundwater Newsletter*. Minnesota now has five companies producing bulk bottled water and a number of companies that market specialty waters.

The desire for safe water has been a factor in the growth of sales, but concerns about the safety of bottled water are growing. Bulk water (gallon jugs or water cooler bottles) must meet the standards for contaminant levels specified in the Safe Drinking Water Act. However, these standards do not apply to specialty waters (mineral waters, sparkling waters, etc.)

A Consumer Reports test found arsenic and fluoride levels that exceeded drinking water standards in three mineral waters. It also found high sodium levels in some sparkling waters tested and minute quantities of organic compounds (e.g. industrial solvents) in some bulk water samples. Well water and spring water may contain natural or man-made contaminants; in some cases, bottled water may be more contaminated than the public water supply.

For more information contact Marilyn Lundberg (296-0676)

New Address for MGWA

Our Box number has been changed. The new address is:

Minnesota Ground Water Association
P. O. Box 65362
St. Paul, MN 55165

Minnesota Ground Water Protection Strategy, 1988

by Gretchen Sable, Minnesota Pollution Control Agency, Division of Ground Water and Solid Waste

In May of 1987 an intrepid band of state and federal ground water specialists began a journey aimed at developing a comprehensive, coordinated ground water protection strategy for Minnesota. The goals of this effort are to:

- establish Minnesota's ground water protection policy
- coordinate state agency functions in the area of ground water protection
- ensure that gaps in ground water protection are documented and appropriate measures taken to fill the gaps.

The workgroup responsible for developing the strategy is being led by the Minnesota Pollution Control Agency and coordinated through the Water Resources Committee of the Environmental Quality Board. The following agencies have been a part of the development process:

- Department of Health,
- Department of Natural Resources,
- Department of Agriculture,
- State Planning Agency,
- Minnesota Geological Survey,
- Board of Water and Soil Resources,
- Department of Transportation,
- Waste Management Board,
- Attorney General's Office,
- US Geological Survey,
- Metropolitan Council
- US Soil Conservation Service.

Recommendations are being prepared with an eye toward the 1989 legislative session.

Local governments are also involved in the process, helping define the local role in ground water management and protection. An initial draft strategy document has been prepared, and is undergoing individual agency review. Public meetings to present the strategy and receive general comments are planned for early April. Individual agency approval and adoption by the participating agencies is

targeted for summer of 1988. Governor Perpich will also be asked to sign the strategy, thus casting it as the state's blueprint for ground water management.

The Strategy has been structured around five major initiatives:

1. To protect ground water quality now and for the future; ensure safe drinking water supplies and effectively regulate sources of ground water pollution.
2. To ensure adequate water supplies and regulate water appropriation and use to protect highest priority users.
3. To enhance the current body of knowledge on Minnesota's ground water resource, delineating problem areas and providing information needed to effectively manage the resource.
4. To better coordinate State ground water responsibilities and programs; and to coordinate with federal and local levels of government.
5. To provide the public with the necessary information and education for making environmentally sound decisions in areas which may impact ground water.

The first initiative will include recommendations on ground water quality standards (and the relationship of numerical standards to the state's nondegradation policy) and classification of ground water based on factors of vulnerability. Meeting the increased analytical testing requirements imposed in the 1986 reauthorization of the Safe Drinking Water Act will be discussed, as will the feasibility of developing a state wellhead protection program without financial assistance from the federal government. The last issue covered under this initiative is the regulation of ground water pollution sources, in which the strategy will consider baseline protection measures felt necessary to ensure adequate and consistent protection of ground water from contamination.

The second initiative deals with issues relating to water use and appropriation. In some areas of the state, increased withdrawals are having a detrimental effect on surface water quality by lessening baseflow into rivers at critical times. The

strategy looks into these issues, and deals with questions such as "is 'safe yield' as currently defined really safe?" and "is it appropriate as a long term ground water management goal?"

Initiative four considers issues relating to coordination of the ground water related responsibilities and programs of various levels of government. Ground water in Minnesota is regulated by a varied array of agencies. The regulation of pollution sources is done by the Pollution Control Agency. The Department of Health is responsible for ensuring that safe drinking water is available for all Minnesotans, both from public and private supplies. The Department of Natural Resources regulates appropriations. Counties can create local water plans which can include ground water protection measures. Coordination of these functions continues to be a concern to government and citizens alike. While the strategy does not recommend a major reorganization of state government, it does call for a stronger coordinative role for the Water Resources Committee of the Environmental Quality Board.

Initiative three concerns the basic information needs of the state, and is still in the process of development. Initiative five is also in the developmental state. More information will be available concerning these initiatives once the public review draft is prepared in March.

If you would like more information on any aspect of the Minnesota Ground Water Protection Strategy, contact Gretchen Sabel of the Minnesota Pollution Control Agency, Division of Ground Water and Solid Waste, at (612) 296-7358.

OFFICERS NEEDED

The MGWA is soliciting nominations for president-elect, treasurer-elect and secretary-elect. It is important that each member participate in the search for good leaders. If you know someone with an interest in water issues and with sound ideas about what the goals of MGWA should be (perhaps yourself), then give us a call.

Radium in Drinking Water

by L. Lehman & Assoc.

The water supply of the City of Savage has been found to contain a higher level of the element radium than is allowed by National Drinking Water Standards. The City of Savage is now taking the steps necessary to comply with the Standard.

Radium in water supply wells is a problem that is not unique to Minnesota. The U.S. Environmental Protection Agency (EPA) (1984) states that of 59,872 community drinking water supplies in the United States, from 2,500 to 5,000 may exceed the radium standard. In order to make the safest and most cost effective decision on lowering the radium concentrations, several questions must be addressed:

- What is radium?
- Where does it come from?
- How does it get in the water?
- How can we get rid of it?
- What are the health risks?

WHAT IS RADIUM AND WHERE DOES IT COME FROM?

Radium is a naturally occurring element that is formed from the radioactive decay of uranium. There are two (2) isotopes of concern; radium 226 and radium 228. Radium 226 has the longest half-life which is 1,620 years. A half-life is the time it takes for an isotope to decay to one-half the initial amount. Uranium occurs widely throughout the geologic environment although usually in minute quantities. The age and type of rock generally influence the amount of radium and uranium. The highest concentrations are usually associated with very old granitic rocks and sandstones formed from granitic rocks.

Occurrences of higher than normal concentrations have been reported in Wisconsin, Illinois and Iowa in the Great Lakes/Midwest region. Other states with reported high concentrations are North Carolina and Maine; areas which are also underlain by old granitic-type rocks. Since radium is a product of the decay of uranium, older rocks will generally contain higher concentrations of radium. A map published in 1961 by the United

States Geological Survey (USGS) shows the location of areas containing high radium (Figure 1). The large area of high uranium in the Great Lakes region should now be expanded further into Minnesota.

HOW DOES RADIUM GET IN OUR WATER?

The City of Savage gets its water from three (3) wells drilled deep into the bedrock. The geologic column in Figure 2 depicts the geologic formations that underlie Savage. Two of the City's wells are drilled into the Jordan formation, and the third is drilled into the Mt. Simon-Hinckley formation.

Both the Jordan and the Mt. Simon-Hinckley formations are predominantly sandstones that are quite old in terms of geologic time. They are of Cambrian Period, i.e., older than 485 million years. It is most likely radium is somewhat concentrated within these units, and is therefore leaching into the water drawn from the wells.

HOW CAN RADIUM BE REMOVED FROM THE WATER?

There are several options the City is considering. These options are as follows:

- Replace water supplies with new wells.
- Correct supply within existing wells.
- Treatment.
- Some combination of the above.

Water Supply Replacement

New wells could be drilled into more shallow formations which do not contain as much radium. Care must be taken in locating shallower wells since the pollution potential from surface contaminants is greater than for deep wells, especially from nitrates.

Correct problem at existing wells

This option involves pulling out the existing pump and utilizing special well logging techniques to locate high radium

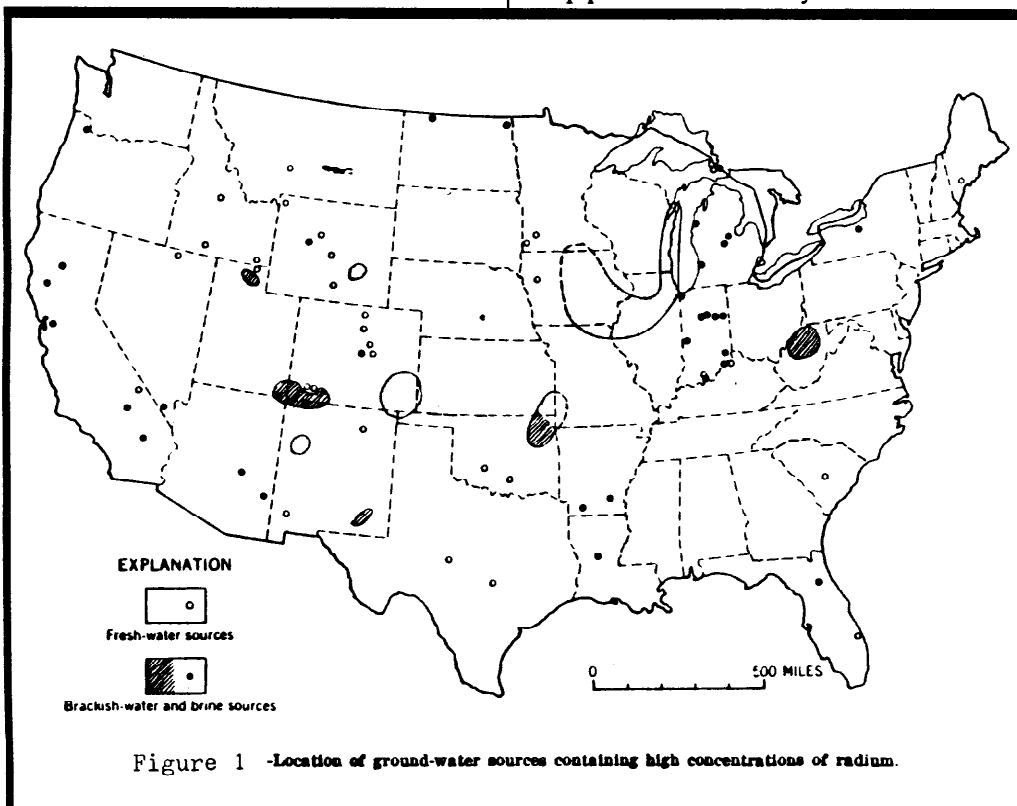


Figure 1 -Location of ground-water sources containing high concentrations of radium.

zones within the well. The precise levels where radium occurs are determined by a series of highly sophisticated testing devices which are further verified by down-hole videotaping. Once the high radium zones are located, it may be possible to block them off and only draw water from less radioactive units within the well. This method has been successfully utilized in Wisconsin.

Water Treatment

Processes that are effective in removing radium from drinking water include lime softening, cation exchange, reverse osmosis and selective adsorption.

Lime softening is best suited for large capacity plants. This process requires more complicated equipment and demands more operating supervision.

Cation exchange to replace calcium and magnesium ions with sodium ions to soften water is a widely practiced technology. If radium is present in the water, it will be removed with the hardness since radium is similar in chemistry to calcium and magnesium. The problem with this process is it adds to the sodium content of the water. This could be a potential problem for people with restricted diets and hypertension. Potassium chloride could be used as a substitute for the sodium chloride, but costs approximately five (5) times as much.

Reverse osmosis is a relatively new technology, and is commonly used in areas where water has a high total dissolved solids content (or high salinity). This process utilizes a membrane which allows the passage of the water, but not the dissolved salts. Pressure is required to force the water through the membrane. Compared to other treatment techniques, reverse osmosis is relatively expensive to operate due to high energy requirements for pressure pumps.

Removal processes via adsorption, although in the development stages, should be given consideration due to their potential to remove radium. One of the adsorption processes utilizes the capabilities of manganese dioxide to adsorb metal ions. The drawback to treatment is the need to dispose of the various residues. If the plant removes the radium from the drinking water, radium will accumulate to relatively high levels at the plant. Sewer disposal of these residues may be possible if concentrations are kept below levels

specified by the U.S. Nuclear Regulatory Commission for hospital wastes. The allowable levels for sewer disposal within the State are not currently defined for naturally occurring radiation.

WHAT ARE THE HEALTH RISKS?

The Safe Drinking Water Act specifies five (5) picocuries per liter of radium is the allowable limit for drinking water supplies. The average amount in the three (3) Savage wells is 9.3 (pCi/liter). A picocurie is one trillionth or 1/1,000,000,000,000 or a curie.

What we know of the carcinogenic effects of radium comes primarily from two group studies: 1) several thousand German patients who received injections of radium as therapy for tuberculosis, and 2) about 2,000 American watch-dial painters who ingested as much as 2,000 microcuries (1/1,000,000 curies). These luminous watch-dial painters ingested the

radium by "tipping" the paint brush in their mouths in order to keep a fine point on the brush.

Because of its similarity to calcium, nearly 90% of the naturally occurring radium contained in the body resides in the bones. Consequently the primary risk from radium ingestion is cancer of the bone, or of the tissues within the sinus cavities of the bone. Cancer caused by radium ingestion does not occur in every person who has been exposed, nor does it appear until many years after ingestion.

Cancer risk is quantified by first determining the dose to the bone from continuous ingestion of radium. If a person drinks two liters of water a day containing 5 pCi/liter over a 70 year period, the result would be a lifetime dose of 6,440 millirems (mR) to the skeleton. By comparison, we would receive a lifetime dose of about 5,600 millirems from cosmic rays and other external naturally occurring background radioactive materials.

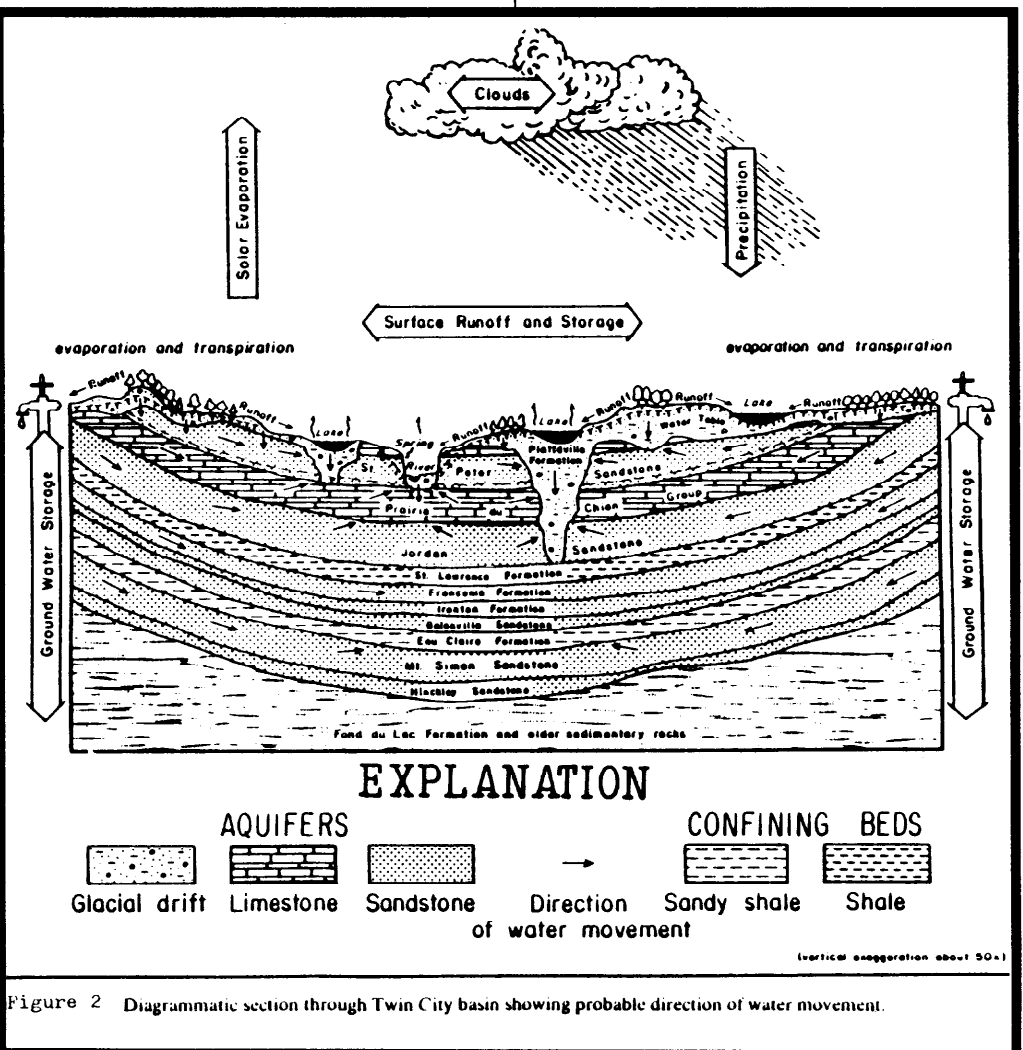


Figure 2 Diagrammatic section through Twin City basin showing probable direction of water movement.

The lowest known intake of radium to cause a tumor is about 9 microcuries. The body is thought to retain only 20% of the radium ingested. From this basis, we can calculate how long it would take to accumulate 9 microcuries in our bodies from drinking Savage municipal water. Another assumption is we consume two liters of water daily.

The calculation is as follows:
 2 liters/day X 9.3 pCi/liter = 18.6 pCi/day
 18.6 pCi/day X 20% ingestion = 3.72 pCi/day
 9 microcuries = 9,000,000 pCi divided by 3.72 pCi/day = 2,419,355 days divided by 365 days/year = 6,628 years

It is doubtful any of us will live this long.

No immediate health effects are known to result from low levels of radium ingestion. The risks of genetic effects in subsequent generations are also thought to be much lower than general cancer risks. The EPA has calculated a population consuming water at the Safe Drinking Water Act limits would have a death rate per lifetime of 44 deaths per million. Translated to a community of 10,000 people at the concentrations we are drinking, this is approximately equivalent to 1 death every 80 years.

WHAT CAN WE DO UNTIL THE CITY CORRECTS THE PROBLEM?

A residential water softener which removes calcium and magnesium will also remove radium. To bring the concentrations to within the Safe Drinking Water Standard, you will need to dilute the unsoftened tap water by half. If you have a water softener, you can mix the softened water (usually the hot water tap) half and half with the cold tap water. However, this process raises the level of sodium in the water. Persons on sodium restricted diets should be aware of this. If you personally feel the need to take additional measures, buy distilled water for consumption, or mix distilled water half and half with cold tap water

FOR MORE INFORMATION:

Attend the Spring Meeting, announced elsewhere in this newsletter.

New Publications

USGS Releases a New Topo Map Index and Catalog for Minnesota.

USGS Press Release 1/11/1988

A new index and companion catalog of the 2,296 topographic and related maps of Minnesota available from the U.S. Geological Survey have been published by the USGS.

The *Minnesota Index to Topographic and Other Map Coverage* and the *Minnesota Catalog of Topographic and Other Published Maps* were designed to assist users in selecting and purchasing maps of the state. The index and catalog are in booklet form and replace the old single-sheet format.

The Minnesota index and catalog also list United States maps, county maps, national park maps, National Atlas maps, world maps, orthophotoquads, orthophotomaps and special maps that include all or parts of Minnesota.

Single copies of the Minnesota Index and catalog are available free from the U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225 - (303) 236-7477. Copies can also be obtained from authorized USGS map dealers.

The USGS expects to sell and distribute more than 9.6 million copies of its more than 82,000 published topographic and thematic maps in 1988.

Contaminants from Buried Oil-and-Gas Drilling Fluids

North Dakota Geological Survey Press Release 12/4/87

Sidney B. Anderson, Acting North Dakota State Geologist, announces the release of Report of Investigation 86 by the North Dakota Geological Survey. This report, titled *Migration of Contaminants from Buried Oil-and-Gas Drilling Fluids within the Glacial Sediments of North-Central North Dakota*, was written by William A. Beal, Edward C. Murphy, and Alan E. Kehew. It is an expanded version of Mr. Beal's Master's thesis at the University of North Dakota.

The authors studied two reclaimed oil and gas well sites, one in Renville County and the other in Bottineau County. At the Renville County site, the drilling fluids were disposed of in a shallow pit excavated in Pleistocene glaciofluvial deposits (gravel), and at the other site they were disposed of in trenches in the Pleistocene glacial till. The results of chemical analyses of porewater, groundwater, saturated-paste extracts, and earth resistivity surveys indicate that leachate is being generated from the buried drilling fluids. The contaminants have migrated away from the sites.

The authors recommend that drilling fluids not be disposed of in glaciofluvial sediments. The environmental impact from disposal of drilling muds in glacial till depends on the geological setting and a subsurface investigation should be conducted at any potential disposal sites in till. The authors believe that, in many cases, disposal of drilling fluid wastes at properly chosen central locations is more effective than disposing of them at each drilling site.

Report of Investigation 86 is a 43-page report. It can be obtained for \$2.00 from the North Dakota Geological Survey, University Station, Grand Forks, North Dakota 58202-8156.

Water Use Corner

Minnesota withdrew 131.27 MGD of ground water for irrigation purposes in 1985, ranking us as the 22nd highest ground water irrigator in the nation -- and #1 in the Upper Midwest. The county-distribution graphic shown is a result of the cooperative Water-Use Program between the MN Department of Natural Resources (DNR) and the U.S. Geological Survey. An excellent source of information on Minnesota Irrigation has just been published by the DNR. It is called *Water Use in Minnesota Agriculture*, by P. G. Young and S. C. Woods, 1987.

Member News

Editor's Note: This section is dependent upon information from you. If there are changes in your office - let us know!

Promotions at Twin City Testing Corp. (TCT), Environmental Department.

David Luick, PE, formerly Project Manager, has been named Assistant to Department Manager. Luick has been with TCT since 1982 in several different capacities including Waterloo, Iowa Branch Manager.

Other promotions:

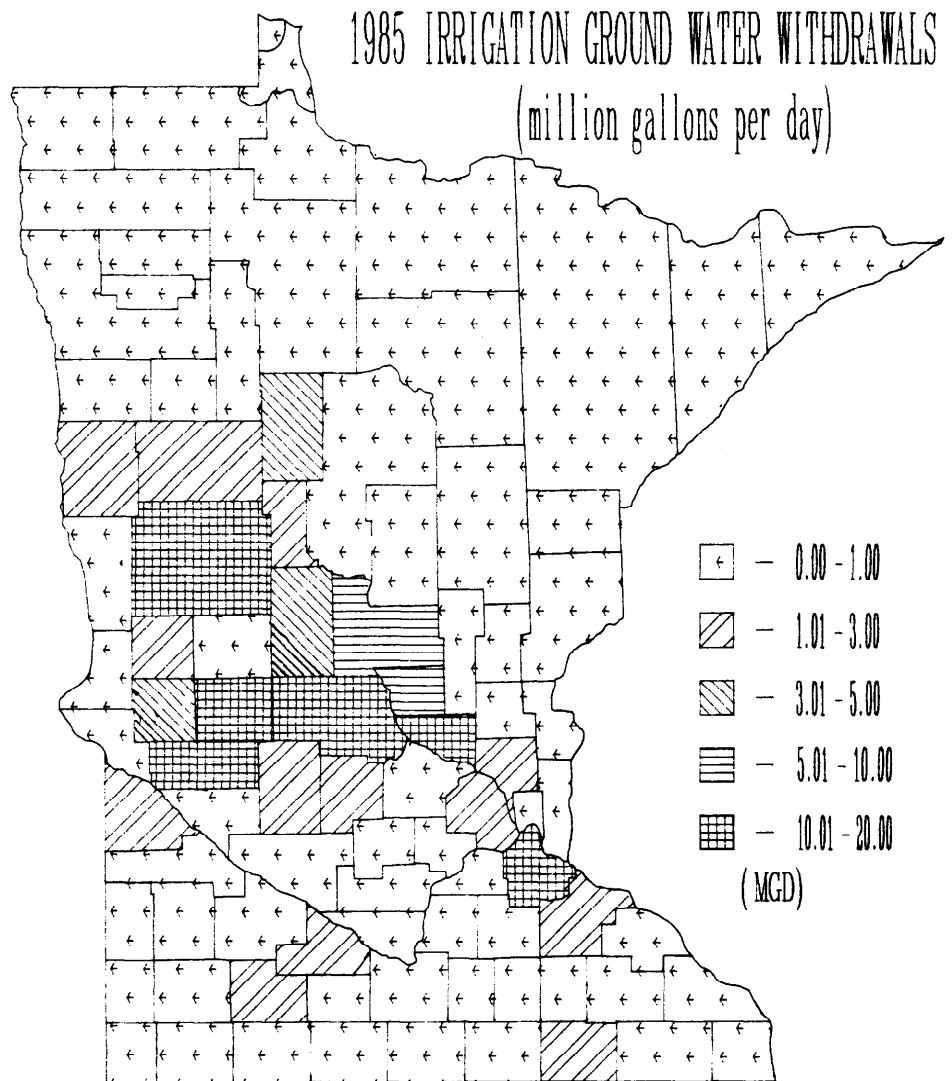
Gil Gabanski, Supervisor of Technical Systems/Hydrogeologic Sciences; Jane Willard, Supervisor of Environmental Assessment Consulting; Tom Gapinske, Supervisor of Groundwater and Subsurface Consulting; Mark Mason, Supervisor of Groundwater and Subsurface Field Services; Keith Govro, Supervisor of Water Quality and Biological Sciences Consulting; Laura Meyers-Wittman, Hydrogeologist; Bob Wojciak, Project Manager; Lynne Grigor, Assistant Project Manager; Robin Whitaker, Assistant Project Manager.

Bob Beltrame has joined Nova Environmental Services.

Rick Johnston has joined Braun Companies.

Mike Hansel has joined Koch Refining, Inc.

If you don't want rumors started, inform us of your whereabouts!



Winter Mini-Meeting to be Sponsored by DNR and MGWA

A demonstration of the WELLS data base will be given on February 17th at 10:00 am on the 3rd floor of the Department of Natural Resources building.

WELLS contains well log summary information on 100,000 wells statewide and uses much of the information described in Bruce Olsen's poster presentation (on February 16th at the MINNESOTA WATER: 88 conference).

Consultants especially are invited to see first hand the capabilities of the data base at DNR on Wednesday morning. Admission is free and coffee will be served.

The DNR building is at 500 Lafayette Road, the Division of Waters is on third floor.

Minnesota Society of Optical Microscopists

Monday Night Dinner Meetings:

March 14th, 1988: "Microscopical Tricks of the Trade" Poster Talks by Members.

April 11th, 1988: "Recent advances in Microscopy" Walter McCrone, McCrone Institute.

Symposium:

April 25th, 1988: "Symposium: Quantitative Microscopy"

Contact Mark Cavaleri at (612) 696-6448

Geological Society of Minnesota

Monday Evening Meetings:

February 22nd, 1988: "Twin Cities Glacial Geology" Gary Meyer, Minnesota Geological Survey

April 4th, 1988: "Water" E. Calvin Alexander, U of M, Geology

Contact Robert Handshin at (612) 774-1431

University of Minnesota Geology Department

Winter Seminar Series

February 11, 1988: "Seismic Anisotropy and Mantle Dynamics" Professor Shun Karato, Ocean Research Institute, University of Tokyo

February 12, 1988: "Plastic Deformation of Mantle Material: Professor Karato

March 10, 1988: "Geology and Tectonics of the Archean Superior Province, Canadian Shield" Kenneth Card, Geological Survey of Canada

March 11, 1988: "Early Proterozoic Geology of the North Shore of Huron; Huronian Fold Belt and the Sudbury Structure". Kenneth Card

Advertisers Please Note:

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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. Annual dues are \$10 for professional members and \$5 for students.

Just complete the form below and mail to: Minnesota Ground Water Association, P.O. Box 65362, St. Paul, MN 55165

Name _____

Affiliation _____

Mailing Address _____

City, State, Zip _____

Telephone Number (____) _____



**Minnesota Ground Water Association
P. O. Box 65362
St. Paul, MN 55165**