Minnesota Ground Water Association

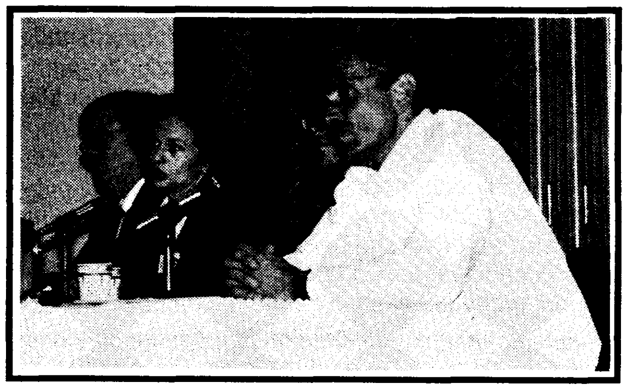
Volume 9, Number 4: December, 1990

President's Page

By Gordie Hess

One of the biggest tasks faced by the board of the MGWA is to keep a steady stream of ideas, topics, speakers, meeting places, and timely issues in the mill for presentation at our Association meetings. Our departing President, Bob Karls, visit with one of the panelists, Dr. Jay Lehr (Editor-Ground Water), at a special January 29th Meeting at Macalester College, at 1:30 p.m. (announcement elsewhere in the newsletter). Dr. Lehr is in the Twin Cities to attend the Minnesota Water Well Association Annual meeting and would like to speak to the Association. I urge you all to members. There are undoubtedly many new potential topics and speakers within our organization that can and should be discussed in future meetings.

(editor's note: Gordie Hess is the new President for 1991)



Speakers at the November 14, 1990 MGWA meeting on Risk Assessment included, from left to right, Gary Gilson, moderator, Barbara Scott Murdock, G. Robert Johnson, Dave Gray, Dr. Vernon Houk, Janet Hathaway, David Belluck, and Dr. Jay Lehr.

truly leaves some large shoes to fill. The speakers and meetings Bob has developed for Association meetings over the last year have been outstanding. The November meeting assembled a panel of nationally prominent individuals and those of you able to attend heard some lively and informative presentations and discussions. On behalf of the members of the MGWA, i.e. the board members, and myself, I would like to extend sincere and heartfelt thanks to Bob for an outstanding year of programs, board meetings, and professional development provided to the Association. A fine job well done!

For those of you who were not able to attend the November Meeting, you have a chance to hear and attend and hear Dr. Lehr's outspoken views on subjects from ground water to physical fitness.

Once again I am urging (begging?) the members to submit to the board any ideas or interests you have for future meeting topics. The board simply wants to know the current interests of our members. If you have any suggestions for speakers on specific topics or technical issues, your input would be welcome. Ideas may be submitted to any Association officer or to the Association at our regular mailing address. No topic is too outrageous or mundane for consideration. The Association has grown in numbers and diversity and that growth should provide some new areas of potential interest to our

Table of Contents

MGWA's New Officers

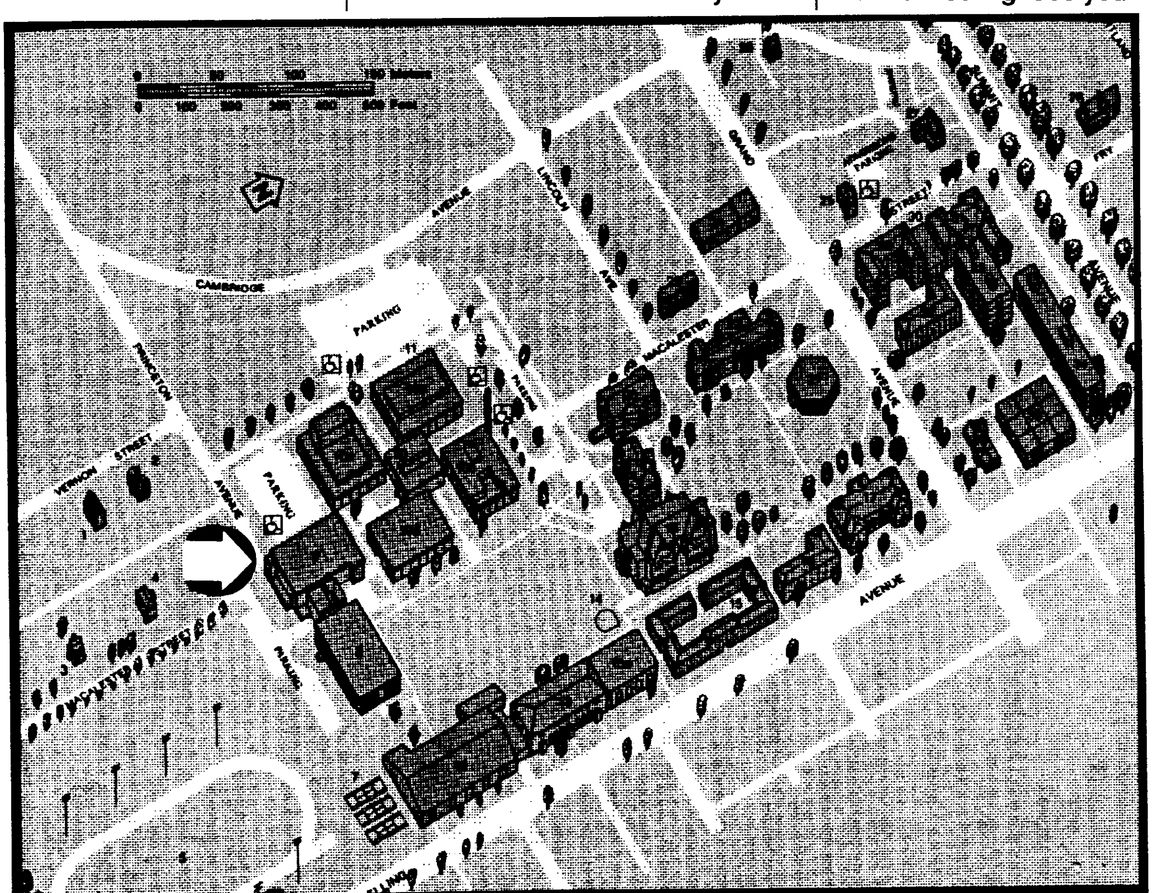
Pictured above are Shiela Grow (on right) and Susan Price (on left). Shiela Grow is MGWA's president elect. She is currently with the Minnesota Department of Agriculture in the Agronomy Services Division where she works with ground water issues in agriculture. Her graduate work was carried out at the University of Minnesota and her past work experience includes work at the Minnesota Pollution Control Agency. Susan Price, treasurer, is currently with HDR Engineering, Inc. in their Minneapolis office as a project hydrogeologist. Her former experience includes the Minnesota Pollution Control Agency's Pre-Remedial Superfund Program and the U.S. Air Force Installation Restoration Program. Susan is also a guest lecturer at Radford University.

January 29, 1991 Meeting

Dr. Jay Lehr will be back in town for the Minnesota Water Well Association annual meeting and will spend the afternoon of January 29, 1:30 - 4:00 with MGWA members. He has offered to give some introductory comments about some of his recent editorials, but the bulk of the conversation is to be determined by MGWA member interest.

We will meet in Room G03 of the Geology Department of Macalester College, ground level of Rice Hall. Rice Hall is building 9 on the map below at Princeton and Macalester Streets on the southwest corner of the Macalester campus. To drive to the parking lot next to Rice Hall, find Snelling and St. Clair, turn west, turn right on Macalester Street and left on Princeton to the parking lot entrance. The stairs down to the ground level of Rice Hall are at the Southwest corner of the building.

Refreshments will be provided at the meeting. See you there.



January 17, 1991 Meeting

Robert W. Farvolden, University of Waterloo, is the 1991 Birdsall Distinguished Lecturer. His main research interests are regiona;l hydrogeology and ground-water resources and contamination in developing countries. These interests were enhanced during a sabbatical year (1983) in Mexico City, which led to a project on the ground-water resources of the Valley of Mexico . The work is continuing, supported in part by the International Development Research Centre, Ottawa, and involving graduate students from Waterloo and Mexico. Similar projects are now underway in Nicaragua, Bolivia, and Argentina.

Dr. Farvolden will speak on *Ground Water in Human Societies* on January 17, 9 am, 121 Pillsbury Hall (Seminar Room), University of Minnesota. In some cases, ground-water conditions have been the basic cause of problems beyond the management capacity of societies and may, in some cases, have led to their ruin. Examples of current misuse and abuse demonstrate the need to apply modern hydrogeology to serious ground-water problems.

Hydrogeology and its Implications in the World's Largest City (Mexico City) will be Dr. Farvolden's topic on January 17, 7 pm in Pillsbury Hall 110, University of Minnesota. MGWA is cosponsor and refreshments will follow.

Mexico City, with a population of about 20 million, is located on the lacustrine clays of the Valley of Mexico. Valley aquifers provide about 56 m^3/s (about 85 percent of the total demand), which is almost certainly more than the natural recharge. Heavy pumping has caused land subsidence of up to 9 meters in the city center. The surficial clays were thought to be protection from surface sources of contamination, such as open sewers, but new field evidence suggests this is not necessarily so. Alternative sources of water supply would be so costly that ground water must be protected and exploited to the ultimate limit possible.

LCMR proposals

1993 LCMR Proposals
by John Velin

The LCMR is already busy planning their activities for their 1993 project recommendations which is anticipated to be in excess of $30 million. Let your voice be heard and your ideas be given consideration by providing us with an abstract of natural resources project ideas for LCMR funding. This process is a new technique of gathering information to improve the basis for decision making for project funding by LCMR members for the 1993 funding cycle.

For many years, to help with factfinding and background development, the LCMR asked the public for Issues Responses in the form of a letter. Response however, was limited. We're hopeful that more people will respond to the more concrete question asked in this solicitation, "Specifically, what would you like to see funded in the area of natural resources?"

Your answers will provide us with direct advice from a broad range of people - only if you send us your statements.

Please carefully follow the instructions below. We value and need your input. Remember, the deadline is February 15, 1991.

IMPORTANT NOTICE

This is your opportunity to provide LCMR with an

ABSTRACT

NATURAL RESOURCE PROJECT IDEAS

for the 1993 FUNDING CYCLE

STYLE: Direct and specific description - use any style you want

CONTENT: State clearly what projects you want to occur for the benefit of Minnesota natural resources. Avoid negative or critical comments.

LIMITS: Submit as many abstracts as you wish. Keep each idea separate and limited to 25 words or less.

EXAMPLE: Following is a random choice example of a clear and concise abstract:
Determine the direct and indirect effects of pesticide use on both upland and wetland wildlife and their habitats.

DEADLINE: February 15, 1991

SEND TO: John Velin, LCMR - 65 State Office Building - St. Paul MN 55155

Clip and send us your ideas on the form below. Photocopy the blank form and send us as many as you wish.
Please type or print clearly using black ink

Name______________________ Phone______________
Address____________________ City__________ Zip__________

ABSTRACT:______________________________________
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Carlson's Environmental Policy

Environmental protection is an investment, not a cost, for all of us. We must restore our natural resources where they are wounded, protect them where they are threatened, and preserve and enhance them where they are thriving - Arne H. Carlson.

Any environmental policy must be broad in scope and recognize the interdependence of all phases contained in such a policy. For example, wetlands restoration cannot be viewed as an isolated issue. It must integrate flood control, wildlife habitat, and ground water recharge issues.

The Carlson Administration will be aggressive and creative in shepherding Minnesota's resources. As Governor, I will actively pursue the following actions which will be only the first of many steps on the road to preserving our state's valuable natural resources.

1. Push for passage of the no net-loss wetlands bill within the first 60 days of office.

The bill will include the following provisions:

- Require the state to replace or restore an additional acre of wetlands for each acre that is developed or drained.
- Protect land tracts of one or more acres, as opposed to the regulations pertaining to tracts of at least 10 or more acres.
- Preserve a broader category of wetlands by including types 2-8, as opposed to the current regulations which only apply to types 3-5.
- Exempt cropland and allow for repair of existing drainage systems.
- Grant a property tax exemption on wetlands affected (the counties would be reimbursed by the state for lost revenue).
- Allow local government control of the program under strict guidelines, like the successful Shoreland Management Program.
- Provide clearer regulations so farmers are not penalized for innocent acts.

The facts supporting the bill are overwhelming:

- over 90% of the wetlands in the Prairie Pothole region (the southwestern half of the state) has been lost since 1950.
- 5,000 acres of wetlands continue to be destroyed each year.
- Wetlands provide natural storage of water drainage. Preserving wetlands for water storage would save the state $1.5 million per year in flood control programs.
- Agriculture is adversely affected by loss of our natural storage capacity.
- Wetlands act as an essential purifier of ground water. They act as a sponge of fertilizers and chemicals. The long-term implications of the wetlands loss are unknown.
- The loss of wetlands would greatly exacerbate our state and federal spending on non-point pollution control.
- Wetlands intercept sediment, preventing it from reaching streams.
- Wetlands provide essential habitat for waterfowl and other wildlife.

For years, conservation experts have warned state leaders about this urgent problem. Now, the majority of Minnesotans support wetland protection and we have a sound bill on the table.

I will mobilize all groups concerned with wetlands preservation to work together in sending a strong unified message to our legislators. These groups have the potential to make one of the strongest coalitions in the state.

2. Manage our water resources.

Minnesota is blessed with an abundance of perhaps the most important resource of all - clean, fresh water. From Lake Superior, to Big Stone Lake, to the Mississippi River, to the Red River of the North, lakes, ponds, streams,and rivers are a prominent feature in our state's landscape. Under the surface are huge aquifers on which many Minnesotans depend for drinking water, agricultural irrigation and industrial use.

The Problems:

The growing use and dependance on our lakes and rivers is threatening their cleanliness. Especially vulnerable is the Lakes Region which includes Alexandria, Bemidji, Brainered, Detroit Lakes, Fergus Falls, and Grand Rapids. These municipalities are being overburdened by these trends:

- New development has concentrated on the most accessible and highest quality lakes.
- The number of lakeshore homes has doubled in the last 20 years.
- Conversion from seasonal to permanent homes has resulted in higher use levels and increased waste disposal problems.
- High potential for ground water contamination in the St. Cloud, Twin Cities, Rochester corridor has emerged.

The Solutions:

As governor, I will tackle these problems in the following ways:

- Establish clear lines of authority with regard to management of water resources and protection. Currently, responsibility for water management rests with several autonomous bureaucracies including the Department of Agriculture, Health, and Natural Resources, the Pollution Control and State Planning Agencies, and a host of other entities.
- Designate a system of "research lakes and wetlands" to determine guidelines for water quality.
- Institute a Lakes Planning Assistance Program with local units of government. Its focus would emphasize water quality, recreational use, development assistance and preservation of critical and fragile habitats.
- Develop a statewide groundwater monitoring program.
- Institute an aggressive public education program on ground water protection.

(reprinted from an Arne Carlson election position paper)

New Members

Tom Ames, Griggs Contracting
Sally Lou Benjamin, MN PCA
Greg Buzicky, MN Department of Agriculture
Robert Caho, Exploration Technology, Inc.
Lauren Carlson
Joseph Peter Carruth, MN PCA
Richard Clark, MN PCA
Dr. Sandor Csallany, Env. Hydrology & Engineering
Chris DeMattos, MN Department of Health
Allison L. Dennen, Foth & Van Dyke
Mark E. Gamm, Dodge Co. Environ. Quality
John Helland, House of Representatives
Mark Hemstreet, EnPro Assessment Corp
Lisa Herschberger, Delta Environmental Cons., Inc
Barbara J. Huberty, Olmsted Co. Public Works Dept.
Patricia Jensen, Leg. Water Commission
Terry R. Johnson, Bruce Liesch Associates, Inc.
Karen Studders Lampert, Minnegasco, Inc.
Mary T. Mackey, Barr Engineering Co.
Mark Malmanger, MN Department of Health
Wayne Mattsfield, MN PCA
Joan Nephew, Institute for Env. Assessment
Jeff Powers, SEACOR Environmental Eng.
Jayne Reichhoff, University of Minnesota Duluth
Steve Robertson, Geraghty & Miller, Inc.
Tedd Ronning, MN PCA
Jennifer Schlotthauer, Macalester College
John K. Seaberg, MN PCA
Shannon Smith, U.S. Geological Survey
Chris Thompson, P.E., SEACOR Environmental Eng.
Gary Van Guilder, Bruce Liesch Associates, Inc.
Caroline Voelkers, MN PCA
Dana John Wagner, Bruce Liesch Associates, Inc.
Neal Wilson, MN Pollution Control Agency

EPA Grants Official Protection to Mille Lacs Aquifer

U.S. Environmental Protection Agency (EPA) Region 5 has announced the designation of the Mille Lacs Lake Confined Drift Aquifer in east-central Minnesota as a sole-source aquifer under the Safe Drinking Water Act.

The aquifer is within the Rum River and Mille Lacs Lake watersheds and is the sole, or principal, source of drinking water for approximately 6,500 residents of Mille Lacs and Aitkin Counties, MN. More than 95 percent of the drinking water in this area (about 450,000 gallons per day) is drawn from the aquifer.

"EPA has determined that, from both technical and economic perspectives, this is the most feasible source of drinking water in the area," said Dale S. Bryson, Regional director of the Water Division. "because contamination of this aquifer would present a significant hazard to public health, all federally financed projects in the area of the sole source aquifer and its recharge zone will now be subject to EPA review."

EPA based its determination on the following:

There is no other drinking-water source, or combination of sources, that provides 50 percent or more of the drinking water to this area. Nor is there any cost-effective potential source that could replace the drinking water communities now get from the aquifer; and

The moderate-to-high permeability of the aquifer makes it vulnerable to contamination. Potential sources of contamination include leaking underground storage tanks and spills of hazardous materials.

The economic and regulatory effects of this action are not expected to be significant, said Bryson.

(reprinted from an EPA news release, November 21, 1990)

What's Happening?

This is your newsletter, so keep us posted on what's happening in your corner of the world that might be of interest to other MGWA members. Thanks to the members who have contributed.

Along with your news, why not send some ideas for short articles?

Send your news and ideas to:
Jan Falteisek
Editor, MGWA Newsletter
DNR-Division of Waters
500 Lafayette Road
St. Paul, MN 55155-4032

MDH Developing Health-Based Ground Water Standards

The Minnesota Department of Health (MDH) anticipates proposing rules on Health Risk Limits for ground water contaminants by mid-Spring 1991. This is one of many provisions of Minnesota's 1989 Ground Water Protection Act. These limits will specify maximum concentrations of compounds in ground water that are safe to consume. The Act does not detail how these standards would be applied, except as required by provisions of Water Resource Protection Requirements.

The Ground Water Protection Act specifies that Health Risk Limits (HRLs) be formulated for substances found to degrade ground water in Minnesota. The contaminants slated for Health Risk Limits are being compiled from data from related state agencies, supplemented by suggestions from members of a work group advising the department of Health.

The Act directs that the Health Risk Limits be derived using U.S. Environmental Protection Agency (EPA) risk assessment methods. Contaminants are classified by EPA as carcinogens or noncarcinogens (Systemic Toxicants). Noncarcinogens have a threshold below which damaging physiologi-

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cal effects are not expected. Carcinogens are regarded as not having a threshold because even at very low doses damaging effects may occur. Only chemicals classified as known or probable human carcinogens will be considered carcinogenic in the HRLs.

The HRL calculation for carcinogens includes a lifetime risk level factor (no more than one excess cancer in 100,000 people), weight of the standard person (70kg), and a potency slope (mg/kg/day). For noncarcinogens, the HRL calculation includes a reference dose (lowest or no drinking water equivalent (2 liters/day), and a relative source contribution factor. Relative source contribution accounts for exposure to a contaminant from sources other than drinking water. It is assumed that 20% of exposure to a synthetic organic contaminant comes from drinking water, and 10% of inorganics is from drinking water.

The primary data source for the HRLs is the EPA's Integrated Risk Information Systems (IRIS), an electronic database for chemicals that have undergone scientific review by EPA. For contaminants not included on IRIS, pending review, or being updated, EPA recommends using the Health Effects Assessment Summary Tables (HEAST), a quarterly publication for chemicals commonly found at Superfund and Resource Conservation and Recovery Act sites. In special cases, EPA sources other than IRIS or HEAST may be used to generate HRLs.

Several issues have been raised in the work group that will not be addressed in the rule. Exposure other than through drinking water is of concern, for example. Showering, cooking, running humidifiers, and other activities can result in inhalation exposure. Because dermal and inhalation exposures are affected by site-specific conditions, EPA does not at this time recommend a model for dermal and inhalation exposures in risk assessment. Rather, these concerns can be more effectively addressed through risk management.

These are some of the methodological issues that have been discussed from affected business, industry, government, and environmental interests. The Health Risk Limits will establish health criteria for Minnesota. How the Health Risk Limits are applied in ground water protection and regulation programs is yet to be determined.

If you would like further information, contact Roberta Aitchison Olson at the Minnesota Department of Health, (612) 627-5051.

News of Members

Brad Barquest of Delta Environmental Consultants, Inc. presented the paper *A Hydrogeologic Assessment of the Austin Chalk Outcrop Belt, Central Texas* at the Fall 1990 GSA meeting.

Kelton D. Barr is now Senior Technical Advisor of Bioremediation Services at Geraghty & Miller, Inc.. He was also recently appointed Associate in the firm.

Dan Barret of Delta Environmental Consultants, Inc. presented the paper *A Hydrogeologic Assessment of the Ozan Formation, Central Texas* at the Fall 1990 GSA meeting.

Justin Blum has joined the Minnesota Department of Health, Environmental Health Group. Justin was formerly with Minnesota DNR, Division of Waters.

Ray W. Wuolo of Barr Engineering Company has been approved as a certified Ground Water Professional by the Association of Ground Water Scientists and Engineers.

Timothy Lockrem has joined IT Corp.

Jim Jacques, formerly with Dames & Moore, is now with Bay West, Inc.

Larry Johnson has moved to Dames & Moore

John Elks was hired at MN PCA

Tom Heenan is with Hennepin County Environmental Health.

Efie Wahlstrom now works at EnecoTech.

American Water Resources Association - Educational Program

AWRA has begun a project in cooperation with the U.S. Geological Survey, the U.S. Bureau of Land Management, the U.S. Bureau of Reclamation and a number of other educational institutions and organizations to develop a set of K-12 water resources educational materials for distribution nationwide. AWRA has begun to gather materials that already have been developed, and will assemble a team of educators and scientists to evaluate the wealth of existing material.

This team will provide recommendations for the best approach to stimulate the interest of students in water resources at all grade levels. Utilizing these recommendations, a series of educational materials will be developed. These materials will cover all facets of water resources and include class room activities, posters, and other training materials.

For more information, contact AWRA, 5410 Grosvenor Lane, Bethesda, MD 20814. (301) 493-8600.

(reprinted from Renewable Resources Journal, Summer 1990)

Ground Water Remediation

The Water Science and Technology Board of the National Research Council has published a report on a colloquium held in Washington, D.C., April 20-21. The report, *Ground Water and Soil Contamination Remediation, Toward Compatible Science, Policy and Public Perception*, was presented in 1989 in preparation for the colloquium. The dialog focused on how science influences policy and public perception where cleanup of ground water and soil conservation are concerned. The report costs $15 and is available from the National Academy Press, 2110 Constitution Ave., N.W., Washington, DC 20418.

Risk Assessment and Control Management of Radon in Drinking Water

by William A. Mills

Health Risk Assessment:Radon Levels in Water

Nazaroff *et al.* extensively reviewed and analyzed the distribution of radon concentrations in various types of potable water supplies in the United States and derived estimates of their contributions to levels of radon found in indoor air.

The distributions were found to be lognormal. Arithmetic mean estimates for various water sources investigated are shown in Table 1 as well as their geometric mean and associated standard deviation. Shown also are corresponding water and indoor radon concentrations, the latter assuming a conversion ratio from water to air of 1×10^{-4}.

Although almost 50% of the U.S. population is served by surface water sources, this population is subject to only about 1% of the population-weighted activity (concentration x population). Clearly, those persons served by private wells are at greater risk - almost 20 times those served by public ground water sources and 200 times those served by surface water sources.

Nazaroff *et al.* also examined the distribution of values for the ratio for converting radon concentrations in water to estimates of their contribution to radon in indoor air. Based on lognormal distribution of this ratio, they report a geometric mean of 0.65×10^{-4} with a standard deviation of 2.88. The calculated applicable arithmetic mean is 1.14×10^{-4}. A value of 1×10^{-4} is used herein.

As noted above, private wells are the sources of water that expose the fewest number of people but are most likely to result in the higher exposures to radon. Although the average indoor radon concentration contribution from private well water is about 0.6 pCi/L, concentrations in some private wells can be tens or even hundreds of thousands of pCi/L and therefore contribute substantially higher levels of radon to indoor air. An average radon concentration contribution of 0.65 pCi/L in those homes served by private wells is about one-half (actual comparison is five times, original text incorrect - editor) of the average indoor radon concentration found in U.S. housing.

Risk of Ingestion

There are two pathways through which radon in water exposes people - directly, from simply drinking water (ingestion); and indirectly, from the inhalation of radon daughters resulting from the decay of radon released during the household use of water. The type of radiation of concern is alpha particles. In the case of drinking water (ingestion), the alpha particles of concern are emitted from radon itself, but for inhalation the concern is with those alpha particles emitted from radon daughters, specifically polonium-214 and polonium-218. However, for both pathways it is the concentration of radon in the water at the point of release in the house, i.e., at the faucet, that is the important variable for assessing and controlling risk. The two diseases of principle concern are stomach cancer from ingestion of radon and lung cancer from inhalation of radon daughters. For ingestion, there is a smaller risk of other cancer due to some fractional transfer of radon from the gastrointestinal tract to circulating systemic blood.

There is no direct evidence that the ingestion of radon via drinking water produces any effects in humans or in experimental animals. Therefore, estimates of any health risk for the ingestion of radon must be based on indirect evidence, derived from studies that demonstrate an association between radiation exposure and stomach cancer.

The most credible study demonstrating this association is that of Japanese atomic bomb survivors. Table 2 shows the most recent results from these data for stomach and other cancers as reported by the United Nations Scientific Committee on Atomic Radiation (UNSCEAR). Shown also in Table 2, last column, are corresponding values reported by the International Commission on Radiological Protection (ICRP) in 1977 and currently used in radiation protection. Remarkably, the risk of stomach cancer is a factor of 10 higher and the remaining whole body a factor of 5 higher than in 1977. The higher estimates are used herein but it is noted that this use is likely to maximize risk estimates.

Cross *et al.* estimate the annual dose equivalent to be about 100 mrem for stomach and about 2 mrem to the remaining whole body, for a daily consumption of 0.5 L of untreated water, an exposure period of 60 years, and a radon concentration in water of 1000 pCi/L.

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Table 1. Estimates of Radon Concentrations in Indoor Air Resulting from Release of Radon in Various Types of Drinking Water Sources

Drinking Water Source	Fraction of U.S. Population Served	U.S. Population Served (Millions)	Indoor Air Radon Concentration[a] (pCi/L)			Associated Water[b] Concentration (pCi/L)
			Geometric Mean	Geo. Std. Dev.	Arithmetic Mean (pCi/L)	
Surface	0.495	119	0.0005	0.18	0.0035	35
Public Groundwater	0.322	77	0.009	0.14	0.035	350
Private Wells	0.183	44	0.06	0.23	0.65	6500
ALL	1.0	240			0.13	1300

Source: Nazaroff et al.[1]

[a]Values reported have been converted by using a factor of 1 Bq/m^3 = 0.027 pCi/L.

[b]Arithmetic mean values based on a concentration ratio of radon released to air from radon in water of 1×10^{-4}.

Dose estimates are based on an assumed quality factor of 20 for alpha particles relative to X-rays for converting absorbed dose in rad to dose equivalent in rem. These estimates of annual dose equivalent can be related to estimates of health risk, specifically lifetime risk of cancer death, by using UNSCEAR tissue/organ risk per unit dose coefficients shown in Table 2.

Using the above assumptions, lifetime risk estimates of cancer mortality are about 7×10^{-4} (or 7×10^{-7} per pCi/L of water) for stomach cancer and about 7×10^{-5} (or 7×10^{-8} per pCi/L of water) for all other cancers. Thus, for an average radon concentration of 6500 pCi/L in private wells, the associated lifetime risks from lifetime ingestion are about 5×10^{-3} (5 chances in 1000) for stomach cancer and about 5×10^{-4} (5 chances in 10,000) for all other "whole body" radiation induced cancers. Based on an average radon-in-water concentration of 1300 pCi/L, the corresponding risks for the average member of the U.S. population are about 9×10^{-4} for stomach cancer and about 9×10^{-5} for all other cancers.

For a perspective on these risks, the expected normal likelihood of dying of cancer in the U.S. is 1 chance in 5 (about 20%) for all cancers and 1 chance in about 170 (about 0.6%) for stomach cancer. Even for private wells and under lifetime exposure conditions, the lifetime risk of cancer death due to ingestion of radon via drinking water is significantly less than the expected "normal" risks of dying of these cancers.

Table 2. Estimates of Added Lifetime Risk of Death from Cancer

	UNSCEAR 1988 Estimates (L-LET; HDR)[a]			
Tissue/Organ	Multiplicative Model (% per 100 rem)	Additive Model (% per 100 rem)	Coefficients (per 10^4 rem)	Average Risk ICRP Values (per 10^4 rem)
Stomach	1.3	0.86	1	0.1
Whole Body (excl. stomach)	7.1	4.5	5	1

Source: UNSCEAR[4] and ICRP.[5]

[a]L-LET: Low linear-energy transfer radiation, such as gamma or X-rays. For radon alpha-particle irradiation, a relative biological effectiveness of 20 (X-rays = 1), and a linear, non-threshold dose-response model are assumed. HDR refers to high dose rates for the low LET radiation.

Inhalation

As noted earlier, household uses of water can result in an increase in indoor radon levels in air, especially when the concentration in water may be very much above average. The inhalation risk is the potential induction of lung cancer due to inhalation of the short-lived, alpha-emitting decay progeny of radon - specifically, polonium-214 and -218.

The association between exposure to airborne radon and the increased likelihood of lung cancer is well documented from epidemiological studies of underground miners and will not be further reviewed here. Instead, the recent comprehensive review and evaluation, known as BEIR IV Report, by the Committee of the Biological Effects of Ionizing Radiation, National Research Council, National Academy of Sciences, will be accepted as the basis of risk assessment of the consequences of indoor radon. The earlier review by Cross *et al.* is also noteworthy because it specifically addresses radon inhalation resulting from radon in water. It is noted that while the BEIR IV Committee accepted that findings from miners studies can be used for public exposures, it acknowledged that none of the, as yet, epidemiological studies of indoor radon exposure to the general public were of sufficient scientific certainty to provide a basis for estimating risk. Some support for the findings from studies of underground miners is found in animal experiments and in basic radiobiological considerations.

Table 3 shows the lifetime risk due to exposure to radon progeny reported by various authoritative "expert" groups, including estimates provided in Table 2-13 of the BEIR IV report. It is noteworthy that the risk coefficient derived from BEIR IV Committee's evaluation of the data is about a factor of 3 lower than the 1980 BEIR III report.

Summary of Risk Assessments

Table 4 summarizes lifetime risks of cancer death from radon in drinking water. The results suggest that only radon in drinking water from private wells contributes significantly to risk of cancer. These wells serve less than 20% of the total U.S. Population. For all sources of water, the average risks of induced lung cancer to an individual are about the same, on the order of one in one thousand.

Of the estimated possible 5000 cancers per year, almost all of which are associated with the population served by private wells, about 2000 would be lung cancers due to the release of radon in the home and the inhalation of its decay

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Table 3. Lifetime Risk of Lung Cancer Mortality Due to Lifetime Exposure to Radon Progeny

Study (year)	Cancer Deaths per 10^6 person WLM	Reference
BEIR IV (1980)	350	7
BEIR III (1980)	730	7
UNSCEAR (1977)	200–450	7
NCRP (1984)	130	
EPA (1987)	320–1280[a]	8
Evans, et al. (1981)	100	9

[a]EPA assumes a range of 1 to 4% for the relative risk percentage increase in annual lung cancer risk per working level month (WLM) and an underlying annual average of U.S. lifetime lung cancer risk (1980 vital statistics) equal to 4.584×10^{-4} per person. For a 70-year period at risk, this range corresponds to the range shown in terms of cancer deaths per 10^6 person WLM.

products. This number of annual lung cancer deaths attributable to radon in water represents about 0.7% of the annual lung cancer death rate in the United States; similarly, the total radon-attributable annual deaths represent about 1% of annual deaths in the United States from all cancers.

Caution is necessary, however, in ascribing to these estimates great confidence in their validity; the "true" number is likely to be much less, and the risk to an individual could be at or near zero. As noted earlier, there is no direct evidence of an association between radon in water and cancer induction. The estimates have been derived indirectly, using conservative assumptions from epidemiological studies in which exposure conditions are markedly dissimilar to conditions that would be experienced with drinking water. The estimates for stomach and "other" cancers are based on estimates derived primarily from Japanese atomic bomb survivors, where the exposure conditions were gamma rays at high dose rates and not alpha radiation at low dose rates. Estimates of stomach cancer were derived from Japanese populations, which have a much higher rate of stomach cancer than seen in the United States, and is likely to overestimate the risk to the U.S. population. Applying a generally conservative quality factor of 20 for converting risk estimates to alpha radiation for stomach cancer may also overestimate the risk.

Regarding the increased risk of lung cancer from radon released during the use of water in the home, an important consideration is the role of cigarette smoking in enhancing this increase in risk. There are clear differences in the risks from a given level of radon exposure to smokers and nonsmokers. According the BEIR IV report, smokers are at about ten times greater risk of lung cancer death than nonsmokers for a given level of radon exposure and males are at about 2 times greater risk than females.

Using BEIR IV estimates of risk and a "smoking" population of 50 million (60% males), it can be shown that over 70% or more of 2000 lung cancer deaths per year attributable to radon in water estimated above would be in smokers. Only a few hundred lung cancers per year might occur in non-smoking homes.

Thus, it is clear that the number of radon-attributable cancer deaths is significantly greater in the smoking population - a population already at a high risk of one in six of dying of a smoking-related disease. The most effective means to reduce the risk of radon-attributable lung cancer deaths, and the accompanying anxiety over radon exposures, is to eliminate cigarette smoking.

Control Management

Levels of radon in potable water can be reduced by a variety of means, all of which are rather simple in application. Storage of water will allow decay of the radon, aeration techniques can release radon prior to its use, and absorption of radon on solid materials, such as activated carbon, can be effective. Therefore, the major policy issue is whether or not federal regulations should be promulgated by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act (SDWA) to control levels of radon in "drinking water." Under the SDWA, EPA is authorized to establish standards to limit the concentration of harmful materials, including radioactive substances, in public drinking water supplies that serve 25 or more people or have 15 or mare service connections. The Act applies, therefore, to water sources for slightly more than 80% of the U.S. population, but not directly to the approximately 18% of the U.S. population served by private wells, which on the average have by far the greater concentration of radon in water "at the faucet." Under the Act and its accompanying Congressional instructions, EPA is required to have as its maximum contaminant level goal (MCLG) a concentration of zero for those contaminants that are non-threshold carcinogenic agents. Without unequivocal proof to the contrary, radioactive materials are assumed to be such carcinogenic agents for "prudent public health" reasons. However, there is clear evidence that equivocates this risk management assumption, such as an apparent threshold dose for bone sarcoma induction resulting from radium-226 deposition in bone. If controls cannot be instituted to obtain a MCLG, then EPA is instructed to establish standards as close to the goal as is feasible; these standards are referred to as "maximum contaminant levels" (MCLs).

The remainder of this paper discusses this action, especially in regard to the health benefits to be gained by such a policy.

From Table 1, it can be estimated that private wells represent about 90% of the population-weighted radon-in-water exposure, public ground water about 8%, and surface water only slightly more than 1%. Thus, promulgating standards under SDWA would apply to less than 10% of the population-weighted activity; it is unlikely that very many of the affected surface

continued on next page....

Table 4. Estimates of Lifetime Risk of Cancer Death from Radon in Various Types of Drinking Water Sources Serving U.S. Population

Water Source	Radon Concentration (pCi/L)	Lifetime Risk of Cancer Death: Inhalation – Lung	Ingestion – Stomach	Ingestion – Others	Total Risk	Annual Deaths
Surface	35	1×10^{-5}	2×10^{-5}	3×10^{-6}	3×10^{-5}	60
Public groundwater	350	1×10^{-4}	2×10^{-4}	3×10^{-5}	3×10^{-4}	400
Private wells	6500	3×10^{-3}	5×10^{-3}	5×10^{-4}	8×10^{-3}	5000
All sources	1300	5×10^{-4}	9×10^{-4}	1×10^{-4}	1×10^{-3}	5000

water or public ground water supplies would have concentrations more than an order of magnitude higher than the arithmetic mean values shown in Table 1. Arguments can be made that those public ground water supplies that have radon concentrations of several thousand pCi/L warrant consideration of radon-reducing techniques under SDWA if feasibility of control and costs are not prohibitive. However, there seems to be no strong argument to be made in justifying controls for surface water supplies. The radon levels in these waters appear to be of negligible health concern. The "cancer savings" realized in promulgating and enforcing drinking water standards under the SDWA would be less than 500 deaths per year or less than about 0.1% of the total cancer deaths that occur in the United States each year. Given the uncertainties in the risk assessment described and the lack of evidence that directly associates the induction of cancer with the presence of radon in drinking water, in this author's opinion, a regulatory control program is ill-advised. An awareness program for local governments in areas likely to have geological conditions that lead to higher radon-in-water concentrations (a few thousand pCi/L) seems a more appropriate policy.

Private ground water sources of drinking water, which are not subject to federal regulation under the SDWA, can have radon-in-water concentrations that are in excess of several hundred thousand pCi/L. Ingestion and household use of these waters appear to constitute a sufficient threat to health that some health protection is warranted. However, deciding on a level of protection in terms of radon-in-water concentration and who makes the decision on instituting protection matters are not simple decisions.

At present, the choice of taking remediation measures for private wells is a voluntary one made by the homeowner. This appears to be the most appropriate policy to follow, especially since the contamination at issue is a natural occurrence and action by an individual homeowner will have no impact on near neighbors who might depend on the same aquifer. In this context, radon in drinking water is not a national problem. If governmental control is warranted it should be instituted at the lowest state or local level effective in meeting responsibilities to protect public health.

Conclusions and Recommendations

1. The presence of radon in drinking water is estimated to have its greatest health impact on the 18% of the U.S. population served by private wells. Public ground water sources are of lesser concern, and surface water sources impose negligible health risk.

2. Although no direct evidence exists associating radon in water with health problems, the diseases that are associated with radon in drinking water are stomach cancer from ingestion and lung cancer from inhalation of radon (released during household use of water) decay products. Risks of other types of cancer appear negligible.

3. The total number of cancer deaths per year attributable to radon in water is estimated, by using a number of questionable assumptions, to be about 5000 as a maximum value, with essentially all cases occurring in the population served by private wells. Of this number, about 2000 would be lung cancers, with more than 70% occurring in smokers because of the apparent synergistic relationship between radon exposure and cigarette smoking. These estimates are considered to be maximum values and the true risks are probably much lower.

4. Promulgating federal regulations to control radon levels in water under the Safe Drinking Water Act seems unwarranted, since private wells would not likely be affected.

5. Government control programs should be limited to emphasizing an awareness of possible substantially higher than average levels of radon in water in certain geological areas.

(reprinted from Water Review Vol. 8, No. 3, 1990)

Braun Professorship at University of Minnesota

Braun Technologies Group was recognized by the University of Minnesota on Nov. 26 for its financial contribution to establish a chair within the Institute of Technology.

The purpose of the chair is to attract outstanding visiting professors to various University departments for special lectures, teaching and research. Visiting professors also will interact with the local technical community to exchange ideas and advance technology in Minnesota and the nation. The endowment represents an opportunity for the University to better accomplish its educational, research and land-grant mission.

(reprinted from a Braun news release)

Newsletter Advertising Policy

Advertising space is available in this newsletter to businesses and organizations. Display ads (4 issues = 1 year) are charged by fractional page:

Size	*inches*	*Annual Rate*
business card	*3.5x2.4*	*$50*
quarter page	*3.5x5*	*$90*
half page	*7x5*	*$170*
full page	*7x10*	*$320*

Copy should be a photostat of your camera-ready artwork.

The Editor has final determination on the acceptance of materials submitted. There are no commissions on ads. Advertising copy must be received by the publication deadlines: February 15, May 15, August 15, or November 15. The ad should be accompanied by a purchase order or a check. Checks should be payable to the Minnesota Ground Water Association. All materials should be sent to the Editor:

Jan Falteisek
Editor, MGWA Newsletter
DNR - Division of Waters
500 Lafayette Road

Chrysalis Scholarship

The AWG Foundation will award two Chrysalis Scholarships on March 1, 1991. The $500 awards will be given to geoscience Masters or PhD candidates to cover expenses associated with finishing their theses. The Chrysalis Scholarship is for candidates who have returned to school after an interruption in their education of one year or longer. The support can be used for typing or drafting expenses, child care, or anything necessary to allow a degree candidate to finish her thesis and enter a geoscience profession.

Applications should be made by January 31, 1991. The applicant should write a letter stating her background, career goals and objectives, how she will use the money, and explain the length and nature of the interruption to her education.

The applicant should also submit two letters of reference. The first, from her thesis advisor should include when the candidate will finish her degree, what requirements are as yet unfinished, and a statement of the candidate's prospect for future contributions to the geosciences.

For information or an application, please contact:

Chrysalis Scholarship
Association for Women Geoscientists Foundation
10200 West 44th Ave. #304
Wheat Ridge CO 80033

Catalog of Ground Water Programs

The Minnesota Pollution control Agency is preparing a catalog of ground water monitoring programs in Minnesota. The catalog, nearing completion, contains brief descriptions of 111 ground water monitoring programs administered by governmental units or academic institutions in Minnesota. Anyone who would like a copy please contact Susan Magdalene at (612) 296-8577 or toll free at 1-800-652-9747 (ask the operator for the MPCA).

Faculty Directory

The Water Resources Research Center at the University of Minnesota is in the process of finalizing a second edition for the directory of faculty expertise in water-related disciplines and issues. If you were not listed in our 1987 edition or know someone with water interests/expertise who is a new faculty member at a state college or university (public or private), please call 624-9282. The new directory will be available in late January, both in hard copy and in a computerized data base.

(reprinted from *Minne Gram* November 1990)

Water Quality Checklist Available from Trust

Copies of the Water Quality Self-Help Checklist are available free from The American Ground Water Trust, a co-sponsor of the pamphlet with the American Farm Bureau Federation.

The 15-page brochure will help homeowners analyze their own water supply and farming operations as a means to voluntarily reduce of prevent pollution from agricultural activities.

To obtain a free copy, send a stamped, self-addressed 9x12 envelope to: Water Quality Brochure, The American Ground Water Trust, 6375 Riverside Drive, Dublin, Ohio 43017.

(reprinted from *POINTS, Newsletter of the American Ground Water Trust*, Summer 1990)

1991 Board of Directors

1991 Dues

Dues for 1991 are payable now. We regret the increase to $15 for professional members and to $10 for students, but found we were spending more on postage and printing for newsletters and announcements than we receive in dues and advertising. Thank you.

Minnesota Environmental Law Handbook Published

The *Minnesota Environmental Law Handbook* is a new business guide that provides a clear explanation of Minnesota environmental laws, regulations, required permits and reports and potential penalties. It provides an analysis of business' obligations in chapters on: State and Local Agencies with Responsibility for Environmental Programs; Minnesota Environmental Policy Act and Minnesota Environmental Rights Act; Air Pollution Control; Water Pollution Control; Wetlands and Other Protected Areas; Superfund; The Minnesota Environmental Response and Liability Act ("MERLA"); Hazardous Waste Management; Infectious Waste Control; Solid Waste Management; Storage Tank Regulation; Agricultural Chemicals; Asbestos and PCB Regulation; Environmental Common Law and Toxic Torts; and Environmental Considerations in Real Estate and Business Transactions.

In addition, the handbook includes phone numbers and addresses of important environmental contacts.

The 266 - page, softcover *Minnesota Environmental Law Handbook* is available for $69.00 (plus $3.00 for shipping and handling in the U.S. and $5.00 elsewhere) from Government Institutes, Inc., 966 Hungerford Drive, #24, Rockville, MD 20850 ; (301) 251-9250.

(reprinted from Government Institutes Inc., News Release, September 4, 1990)

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 1991. Annual dues are $15 for professional members and $10 for students.

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

Mail now and you will be included in the MGWA Membership Directory for 1991, which will be distributed in March.

- -

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Activated Carbon Treatment

by Lou J. Sorren

Over the last 30 years, the industries of water and wastewater treatment have undergone significant change and growth. While the growth of these industries has accelerated, most technologies employed in water and wastewater treatment have undergone little or no change since first introduced for large-scale use in public water supplies in the l8th and l9th centuries. On the other hand, development of adsorption technology has paralleled the growth of these industries.

Adsorption

Absorption and adsorption are often confused. Both processes involve the interaction of atoms and molecules between phases of a system. These interactions may involve gases with liquids or solids or liquids with solids or other liquids. When the interactions result in the distribution of one phase within the bulk of the other it is termed absorption. Adsorption, on the other hand, limits the interaction such that it occurs solely at the interface between the phases. As such, adsorption can occur only when one phase is a solid because it is a surface phenomenon.

Activated carbon adsorption is a complex process involving at least three steps:

1. Bulk transport of the solute from the solution to the surface of the activated carbon.
2. Intraparticular diffusion into the pores.
3. Adsorption onto the internal surface of the pores.

The last step is the fastest. It is widely accepted that intraparticular diffusion is the rate-limiting step. Also the rate of adsorption decreases as sites become filled. In addition, the selection of adsorbent can influence intraparticular diffusion. The pore structure of the activated carbon will affect the rate of adsorption.

While a number of workers have studied and derived mathematical models for the adsorptive process, the Freundlich equation is widely used for aqueous systems (1):

$X/M = KCr^{1/n}$ (Equation 1)

where:

X = weight of solute adsorbed

M = weight of adsorbent

Cr = residual solute concentration in the liquid phase at equilibrium

K and 1/n are constants specific to the system.

When the logarithm is taken the equation becomes:

$\log X/M = \log K + 1/n \log Cr$ (Equation 2)

For adsorption of organics from water by activated carbon, the term 1/n is less than 1. X/M is the adsorptive capacity at a given solute concentration. As the term 1/n increases, the capacity of the carbon for adsorbate is improved at high concentrations, but becomes significantly reduced at lower concentrations.

Most descriptions of adsorption processes have been from studies of single-solute systems using distilled water. Researchers have become increasingly aware of the effects of the environment of a system on the adsorption of a particular species from the system. Zagorski demonstrated enhanced adsorption capacity of phenolics when inorganic salts are present (2). Weber's work showed improved removal of humics with calcium and magnesium in the system indicating that hardness can play an important part in the usefulness of activated carbon (3). Work by Lee and Snoeyink suggests that anions, specifically phosphate, also enhance adsorption of humic substances (4). A number of workers have addressed the effects of low concentrations of organics on the removal of specific compounds. To the designer of an adsorption system this means that there is no substitute for data derived from testing performed on the medium to be treated.

Manufacture And Pore Structure Of Activated Carbon

The pore structure of activated carbon determines the application in which it will best perform. In turn, the raw material will produce a characteristic pore structure which may be modified during manufacturing. It is most desirable that the activated carbon selected for use in a Point-of-Use or Point-of-Entry (POU/POE) filter remove the widest possible variety of potential adsorbates. This is true unless the filter is to be marketed in a specific location with known contaminants of limited molecular size.

While there are a variety of materials used for making activated carbon, the basic processes used are common. First, the carbon source is converted to a fixed carbon mass with a small pore volume by the process of carbonization. The carbonized material is then activated; that is to say, the pore structure is developed. Steam reacts with the carbon surface at high temperature (~1600 F) which generates a micropore structure in the carbon source. A slight excess of oxygen will promote the oxidation of the carbon surface. The excess oxygen/oxidation reaction is responsible for the macropore structure of activated carbon.

The micropores of activated carbon are loosely defined as pores with a diameter less than 100 Angstroms. Macropores have diameters greater than 10,000 Angstroms. This leaves the range between 100 and 10,000 Angstroms defined as mesopores or transition pores. The pore structure is described by the pore size distribution which is depicted by either the volume or surface area plotted against pore diameter.

The raw material determines to a large degree the pore structure of an activated carbon. Three common source materials for activated carbon are compared: lignite, coal, and coconut shell. Lignite is a coal which possesses a high content of volatiles which are lost during carbonization. The remaining fixed carbon has a low fraction of graphitic (crystalline) carbon and a high amorphous carbon fraction. The amorphous carbon is easily reacted with steam as well as oxygen. The activated carbon made from lignite possesses a low volume of micropores compared to macropores.

Coconut shell, on the other hand, contains a low volatiles content and a high fraction of graphitic carbon in the fixed carbon mass. It is slow to react with steam. Because the surface resists oxidation, it can be permitted a long reaction time with steam resulting in the creation of a highly-developed micropore network.

When coal is used as the base material, it is possible to obtain a wide range of pore sizes. Coals vary in volatiles content, fixed carbon, and other parameters responsible for mechanical and physical properties in the activated carbon. The selection of a coal for use in the manufacture of activated carbon is complicated by the balance of economics of production and desired properties. Coal is generally pulverized, compacted, and crushed to size before carbonization and activation. The resulting activated carbon is then a hard granule which can withstand mechanical treatment without significant degradation.

The choice of raw material can give activated carbon unique pore structures which result in suitability for use in particular applications. For example, the fine pore structure of coconut shell carbon lends itself to adsorption of gases while the predominance of large pores found in lignite and peat-based carbons finds particular utility in decolorization applications or wastewater treatment where species of larger molecular weight are generally the rule.

The "activity" of carbon is generally expressed by the adsorptive capacity for materials which relate to the surface area or pore volume of pores of a given minimum size. The Iodine Number, for example, is the number of milligrams of iodine adsorbed at a residual concentration of 0.02N from an initial concentration of 0.01N. It is a measure of the micropore volume and sometimes taken directly as an estimate of total surface area in square meters per gram. Phenol adsorption is also used to measure the volume of micropores.

The volume of large pores is often measured by the ability of the carbon to remove color from a solution of molasses. The Molasses Number, Relative Efficiency, and Decolorizing Index are examples. These tests involve a comparison of performance against a standard carbon and molasses solution. A Molasses Number less than 200 is considered to indicate little or no macropore structure. A Molasses Number of 400 (Relative Efficiency ~ 100) is indicative of a good decolorizing carbon. Decolorizing ability or macropore volume is also expressed by adsorption of tannin.

The mesopore volume is often measured by adsorption of Methylene blue.

Fixed Bed Adsorbers

POU/POE filters are small-scale fixed bed adsorbers intended to "polish" water for individual residential or commercial users. Operation of these adsorbers follows the same principles as large columns. Fixed bed adsorption makes efficient use of the adsorption capacity of Granular Activated Carbon (GAC) allowing maximum saturation of the carbon. As the solution is passed through a bed of GAC, the initial layer of carbon is exposed to a high concentration of adsorbate. Subsequent layers see lower concentrations creating a wave front of solute. Adsorption takes place until the initial layer is saturated. The front passes through the bed as each subsequent layer reaches maximum loading. This wave front, commonly referred to as the mass transfer zone, must be narrow enough to be contained within the height of the bed. The depth of the mass transfer zone is dependent upon the adsorbate (i.e., particle size, porosity, and pore size distribution) and hydraulic factors such as flow rate, column diameter, and bed depth. When the mass transfer zone begins to exit the column, the solute concentration begins to increase in the effluent. Breakthrough is achieved when the concentration reaches a predetermined level. At this point, the bed is no longer of use for control of the particular species of interest.

In large adsorber systems efficient operation of the beds often results from having two beds in series so that the first (lead) bed can be operated to exhaustion. That is, the mass transfer zone is permitted to pass completely through the bed (i.e., until the influent and effluent concentrations are equal). In POU/POE adsorbers, beds are operated often only until the contaminant of interest reaches the breakthrough level at which time the bed is replaced with a fresh charge of GAC. Prediction of the breakthrough curve is the primary objective in the design of a fixed bed adsorber. An isotherm is used to determine the theoretical capacity of the activated carbon for the contaminant. Column testing is then performed to determine the optimum contact time needed to reach the treatment objective.

Proper execution of a column study involves passing the water to be treated through a series of columns containing known weights of GAC. Samples of effluent from each column are analyzed and a series of breakthrough curves are plotted. The volumes treated by each column to breakthrough and cumulative carbon weights are used to compute the carbon usage rate for each column. The usage rates are then plotted against empty bed contact times. From the curve obtained, the optimum contact time can be determined. Column diameters typically range from 1 to 6 inches and flow rates from 2 to 10 gallons per minute per square foot. Once the carbon usage rate and contact time are known, the vessel can be designed to meet the treatment objective. Several workers have presented alternate design schemes (5,6).

With POU/POE filters, the designer or distributor is often faced with determining the expected service life of the adsorber for a specific case. Column testing is the method of choice. An estimate could be made from a carbon usage rate obtained from isotherm testing provided some complex factors about the effects of dispersion on the mass transfer zone are computed.

Adsorption In Point-Of-Use Filters

POU/POE filters are intended to serve as a final step in the delivery of potable water to the consumer. One might ask why an activated carbon filter is needed at the point of use with the existing regulations on the quality of water from municipal water treatment facilities. The primary application for a POU adsorber is the removal of taste and odor from treated water.

Chlorine is added to water to kill disease-causing organisms and itself imparts taste and odor. Free chlorine removal is achieved by a chemical reaction depending upon the surface area and carbon content available, as well as pH. Since activated carbon has a large surface and high carbon content, the life expectancy for activated carbon is long for chlorine removal. Carbon capacity has been measured in some systems at 1 g/g. Cases have been reported where activated carbon has lasted over 10 years in very clean waters. One drawback is that over time, the carbon is consumed and sloughs off as a brown slime. The failure of a GAC filter used for dechlorination may be detected by increasing pressure drop or by a brown tint to the product water.

Other organics may be found in treated waters that impart taste and odor. They are diverse in nature and adsorbability. Chlorinated phenols have been studied extensively while little data are available on compounds such as butylmercaptan, methylisoborneal, and geosmin. The variety of chemical species that may be found indicates that a carbon selected must posses a wide range of capabilities.

It is important to note that multicomponent systems have been studied by a number of workers with an eye toward measuring reductions in capacity for constituents compared to their single-solute adsorption, comparison of experimental data to existing multicomponent models, or development of new models (7,8,9). The distributor must be aware that reduced capacity of a POU/POE filter may be caused by the presence of organics not of primary interest for the treatment objective.

Summary

Use of activated carbon filters for the treatment of potable water at the point of use is a growing practice stimulating a thriving business. There are a number of important factors to be considered in the design, selection, and application of these filters. It is strongly recommended that the designer or distributor perform broad-range field tests on prospective filters in order that they may be properly applied to achieve maximum performance and user satisfaction.

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(reprinted from Water Review Vol 8, No. 2, 1990)

Calendar

January 17, 1991. MGWA sponsored Birdsall Lecturer Dr. Bob Farvolden. 9am and 7 pm. Pillsbury Hall, University of Minnesota. See announcement in this newsletter.

January 28 - 29, 1991. *Minnesota Water Well Association 1991 Convention*. To be held in Minnetonka, Minnesota. Contact Susan J. Church, NWWA, 26 East Exchange St., St. Paul, MN 55101, (612) 290-2823.

January 29, 1991. Dr. Jay Lehr to visit with MGWA members at Macalester College, 1:30 pm. See announcement in this newsletter.

February 5 - 7, 1991. *Critical Issues in Underground Storage Tank Management*. To be held at the Hyatt Regency Albuquerque in Albuquerque, New Mexico by NWWA.

February 6 - 7, 1991. *Environmental Property Assessments in Conjunction with Real Estate Transactions*. To be held in Albuquerque, New Mexico by NWWA.

February 6 - 8, 1991. *Iowa Well Water Association Convention.* To be held in Des Moines, Iowa. Contact Dennis Scheider, IWWA Executive Director (515) 266-2189.

February 18 - 20, 1991. *Corrective Action for Containing and Controlling Ground Water Contamination*. To be held in Salt Lake City, Utah by NWWA.

February 18 - 22, 1991. *Introduction to Ground Water Modeling.* To be held at the Holcomb Research Institute, Indianapolis, Indiana by IGWMC.

February 19-21, 1991. *Theory and Practice of Ground Water Monitoring and Sampling*. To be held in Salt Lake City, Utah by NWWA.

February 24 - 28, 1991. *Symposium on Surface and Ground Water Quality: Pollution Prevention, Remediation, and Great Lakes*. To be held in Cleveland, Ohio by AWRA.

February 25 - March 1, 1991. *Flow and Associated Transport Basins: Driving Forces, Coupling and Geologic Controls.* To be held in Napa Valley, California. Contact Stuart Rojstaczer, Department of Geology, Old Chemistry Building, Duke University, Durham, NC 27706.

March 12 - 14, 1991. *Applications of Environmental Isotopes to Practical Ground Water Studies.* To be held in Philadelphia, Pennsylvania by NWWA.

March 13 - 14, 1991. *Applied Drilling Engineering for Rotary and Auger Methods & Environmental Property Assessments in Conjunction with Real Estate Transactions.* Both to be held in Philadelphia, Pennsylvania by NWWA.

March 18 - 21, 1991. *Fifth Federal Interagency Sedimentation Conference, Practical Sediment Management: Issues and Answers.* To be held at the Riviera Hotel, Las Vegas, Nevada by the USGS Office of Water Data Coordination. Contact Robert T. Joyce, (615) 623-6360.

March 19 - 21, 1991. *In Situ and On-Site Bioreclamation, An International Symposium.* To be held in San Diego, CA. Contact Battelle Inc., Phillip Wells, (800) 783-6338.

March 20 - 21, 1991. *Nonpoint Source Pollution Conference, The unfinished agenda for the protection of our water quality.* To be held in Tacoma, Washington. Contact State of Washington Water Research Center, Washington State University, Pullman, WA 99164-5531 (509) 335-5531.

March 26 - 28, 1991. *Introduction to Ground Water Geochemistry.* To be held in Dublin, Ohio by NWWA.

April 8 - 10, 1991. *Upper Midwest Water Well Expo.* To be held in La Cross, Wisconsin by NWWA.

April 16 - 18, 1991. *Theory and Application of Vadose Zone Monitoring, Sampling, and Remediation.* To be held in Reston, Virginia by NWWA.

April 18 - 19, 1991. *GSA North-Central Section.* To be held in Toledo, Ohio. Contact Lon Ruedisili, Department of Geology, University of Toledo, Toledo, OH 43606.

April 29 - May 2, 1991. *Eighth Thematic Conference on Remote Sensing for Exploration Geology.* To be held in Denver Colorado. Contact Robert H. Rogers, ERIM Thematic Conferences, P.O. Box 8618, Ann Arbor, MI 48107-8618 (313) 994-1200.

May 7 -9, 1991. *Principles of Ground Water Hydrology & Critical Issues in Underground Storage Tank Management.* Both to be held in Minneapolis, Minnesota by NWWA.

May 10, 1991. *Environmental Property Assessments.* To be held at the Hyatt Regency Minneapolis in Minneapolis, Minnesota by NWWA.

May 12 - 18, 1991. *Fourth International Symposium on Land Subsidence.* To be held in Houston, Texas. Contact: A. Ivan Johnson, 7474 Upham Court, Arvada Colorado 80003.

May 13 - 16, 1991. *Outdoor Action Conference/Expo.* To be held in Las Vegas, Nevada by NWWA.

May 16 - 17, 1991. *18th Annual Conference on Wetlands Restoration and Creation.* To be held in Tampa, Florida. Contact Fredrick J. Webb, (813) 752-2104.

May 20 - 24, 1991. *International Conference on Modeling and Mitigation Consequences of Accidental Release of Hazardous Materials.* To be held in New Orleans, Louisiana. Contact R. E. Emmert, (212) 705-7660, ext. 61.

May 28 - June 1, 1991. *Spring Meeting, American Geophysical Union.* To be held in Baltimore, Maryland. Contact AGU, 2000 Florida Ave., N.W. Washington, DC 20009. (202) 462-6900.

June 2 - 6, 1991. *Symposium on Water Supply and Water Reclamation.* To be held in San Diego, California by AWRA.

June 3 - 5, 1991. *Fundamentals of Ground Water and Well Technology & Theory and Practice of Ground Water Monitoring and Sampling.* Both to be held in Monroeville, Pennsylvania by NWWA.

June 21, 1991. *Environmental Property Assessments.* To be held in Clearwater Beach, Florida by NWWA.

July 16-18, 1991. *Principles of Ground Water Hydrology.* To be held in Nashville, Tennessee by NWWA.

July 16 - 18, 1991. *Corrective Action for Containing and Controlling Ground Water Contamination.* To be held in Nashville, Tennessee by NWWA.

July 16 - 18, 1991. *Introduction to Ground Water Geochemistry.* To be held in Nashville, Tennessee by NWWA.

August 20 - 22, 1991. *Treatment Technology for Contaminated Ground Water.* To be held in Chicago, Illinois by NWWA.

September 8 - 13, 1991. *Water management of River Systems* and *Resource Development of the Lower Mississippi River, 27th Annual Conference and Symposium.* To be held in New Orleans, Louisiana by AWRA.

September 9 - 13, 1991. *Introduction to Ground Water Modeling.* To be held at the Holcomb Research Institute, Indianapolis, Indiana by IGWMC.

September 16-18, 1991. *Principles of Ground Water Hydrology.* To be held in Dublin, Ohio by NWWA.

September 27, 1991. *Environmental Property Assessments.* To be held in Seattle, Washington by NWWA.

October 8 - 10, 1991. *Introduction to Ground Water Geochemistry & Corrective Action for Containing and Controlling Ground Water Contamination.* Both to be held at Hartford Marriot Farmington in Farmington, Connecticut by NWWA.

October 16-19, 1991. *American Institute of Professional Geologists Annual Meeting.* To be held in Gatlinberg, Tennessee. Contact Lawrence I. Benson, ERC/EDGE. P.O. Box 22879, Knoxville, TN 37933-0879. (615) 966-9761.

October 21-23, 1991. *National Water Well Expo.* To be held in Washington, D.C. by NWWA.

October 21-24, 1991. *Geological Society of America Annual Meeting.* To be held in San Diego, California. Contact GSA, Meetings Department, P.O. Box 9140, Boulder, CO 80301 (303) 477-2020.

November 6-7, 1991. *Applied Drilling Engineering for Rotary and Auger Methods.* To be held at the Tampa Marriott Westshore in Tampa, Florida by NWWA.

November 18-20, 1991. *Theory and Practice of Ground Water Monitoring and Sampling & Theory and Application of Vadose Zone Monitoring, Sampling, and Remediation.* Both to be held at the Sheraton Dallas Hotel in Dallas, Texas by NWWA.

November 19-22, 1991. *Petroleum Hydrocarbons Conference and Expo.* To be held in Houston, Texas by NWWA.

December 3-5, 1991. *Treatment Technology for Contaminated Ground Water.* To be held at the Stouffer Concourse Hotel, in Denver, Colorado by NWWA.

December 6, 1991. *Legal Implications of Environmental Property Assessments.* To be held at the Stouffer Concourse Hotel in Denver, Colorado by NWWA.

For Information about meetings and seminars to be held by the AWRA, contact Michael C. Fink, Meetings Manager AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192 (301) 493-8600, Fax (301) 483-5844.

For information about meetings and seminars to be held by the NWWA, contact NWWA at 6375

Don't Miss!

January 17th

Birdsall Lecturer:
Dr. Robert Farvolden

9 am Pillsbury Hall 121:
Ground Water in Human Societies

7 pm Pillsbury Hall 110:
Hydrogeology and its Implications in the World's Largest City (Mexico City)

Minnesota Ground Water Association
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