# MINNESOTA GROUND WATER ASSOCIATION

NEWSLETTER v. 1, n. 3 April 1983

Thanks to those who sent in articles about the work you are doing. The response was larger than expected so this newsletter is a bit larger. Unless we hear of many objections, we plan to devote one newsletter per year to printing current research. I should have expanded upon the idea of research to include current projects that one would not call "research". For instance, Glenn Evavold of RREM, Inc. in Duluth wrote in and briefly discussed work they are currently performing on ground water contamination at existing landfills in northern Minnesota. RREM is also "definitely" interested in a groundwater modeling workshop. Would you people like to see a listing of companies represented by members and a synopsis of the type of work they specialize in? Let us know.

The next meeting (details inside) fits in with the type of research many reported on in this newsletter -- ground water modeling. Dr. Mary Anderson will discuss an interesting and overlooked aspect of models; the presentation will not be very technical in nature so those who are leery of modeling do not stay away; in fact, you might enjoy this talk. A special thanks to Dr. Olaf Pfannkuch, University of Minnesota, Department of Geology and Geophysics professor, for his assistance in organizing this presentation. Hope to see you all there on May 19th.

Thanks to the ninety-plus who attended the seminar on groundwater law and a special thanks to everyone who drove in from outside the metro area. I think the entire Geology Department from the University of Minnesota - Morris was here. Anyway, the attendance and the response indicated that the meeting was worth the effort. For those who did not make it, a brief discussion of the four topics follows. By the way, in the future how would one of you like to report on the previous meeting in the following newsletter? Any takers?

Dr. David Prince, William Mitchell College of Law, presented a history of groundwater law and explained how the law evolved to its present state. He started with the 18th century English system of riparian rights for surface water and how groundwater law developed before groundwater hydrology was even considered a science. This system was brought to America and modified by a concept of "reasonable use" which limited malicious use. Problems with this system were presented such as the prior appropriation doctrine of the western states. Prince also discussed the modification of these systems by statutes. For example, Minnesota defined "public waters" where use is allocated by permit rather than by riparian rights. The Crookston case was cited as an example where riparian rights, private rights, are subordinate to public rights. Another topic presented was the relationship of Federal to State laws and the current amount of Federal legislation regarding water (e.g., EPA). Prince summed up his presentation by stating that the future trend is towards a lessening of private rights and a greater emphasis on water quality. The law is also becoming more aware of the science.

Marlene Senechal, Attorney General's Office/MPCA, did the impossible when she succeeded in making the MPCA rules sound interesting. Senechal explained the MPCA's strategies for the protection of groundwater and discussed the MPCA's rules regulating ground water quality and statutes administered by the Agency. She also discussed the permit system required for operation of disposal practices and facilities which could have an impact on ground water quality, and how the MPCA rules, permits, and statutes are enforced in court. The PCA is currently working on amendments to hazardous and solid waste rules and the development of a ground water protection strategy.

Lee Paddock, Attorney General's Office/WMB, presented the legal approaches to ground water protection. Paddock explained both the common law and statutory causes of action. These actions were discussed under the topics of negligence, nuisance, trespass, abnormally dangerous activity, and various Federal legislative acts. Paddock included a discussion of the 301(e) Superfund Study and the Minnesota Environmental Rights Act and then concluded with a discussion of the State's Superfund Act. For those who attended our first meeting with Tom Johnson, Illinois Geological Survey, you might recall his discussion of the Wilsonville landfill. Paddock used the Village of Wilsonville vs. SCA Services case as an example of a public nuisance action resulting in the closing of a permitted hazardous waste disposal facility. The courts ordered SCA to remove all wastes that had been disposed at the site.

Loni Kemp, the Minnesota Project, discussed a current project that is developing public education materials, studying the legal and regulatory framework for groundwater protection, and developing a model ordinance to help counties in southeastern Minnesota. This part of the state is plagued by many groundwater contamination problems related to land use practice and the karst hydrology of the area. Kemp gave examples of point and non-point sources of contamination and the need to educate people in the area as to the contamination problems related to these sources. One example was the problem resulting from dumping garbabe in sinkholes. Besides public education, which Kemp feels is a crucial step in the process of passing ordinances and laws, the project will examine the current legal framework and make recommendations for establishment of ordinances and guidelines to protect groundwater resources.

Thanks to the speakers and those who helped.

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This summer the MGWA is planning a seminar on water-well and exploration drilling technology. The seminar will be one day or longer, sometime in August, and is still in the early planning stages. Many who work with ground water resources do not have a basic understanding of the tools and materials used in subsurface drilling. For instance, how many of you have a working knowledge of what goes into installing a well or taking samples from a split spoon sampler. The idea is to have presentations from members who use these techniques and have the equipment to use during a demonstration. Maybe we will even drill a hole! Much planning is still needed and I would like to hear from anyone interested in helping or setting up a demonstration.

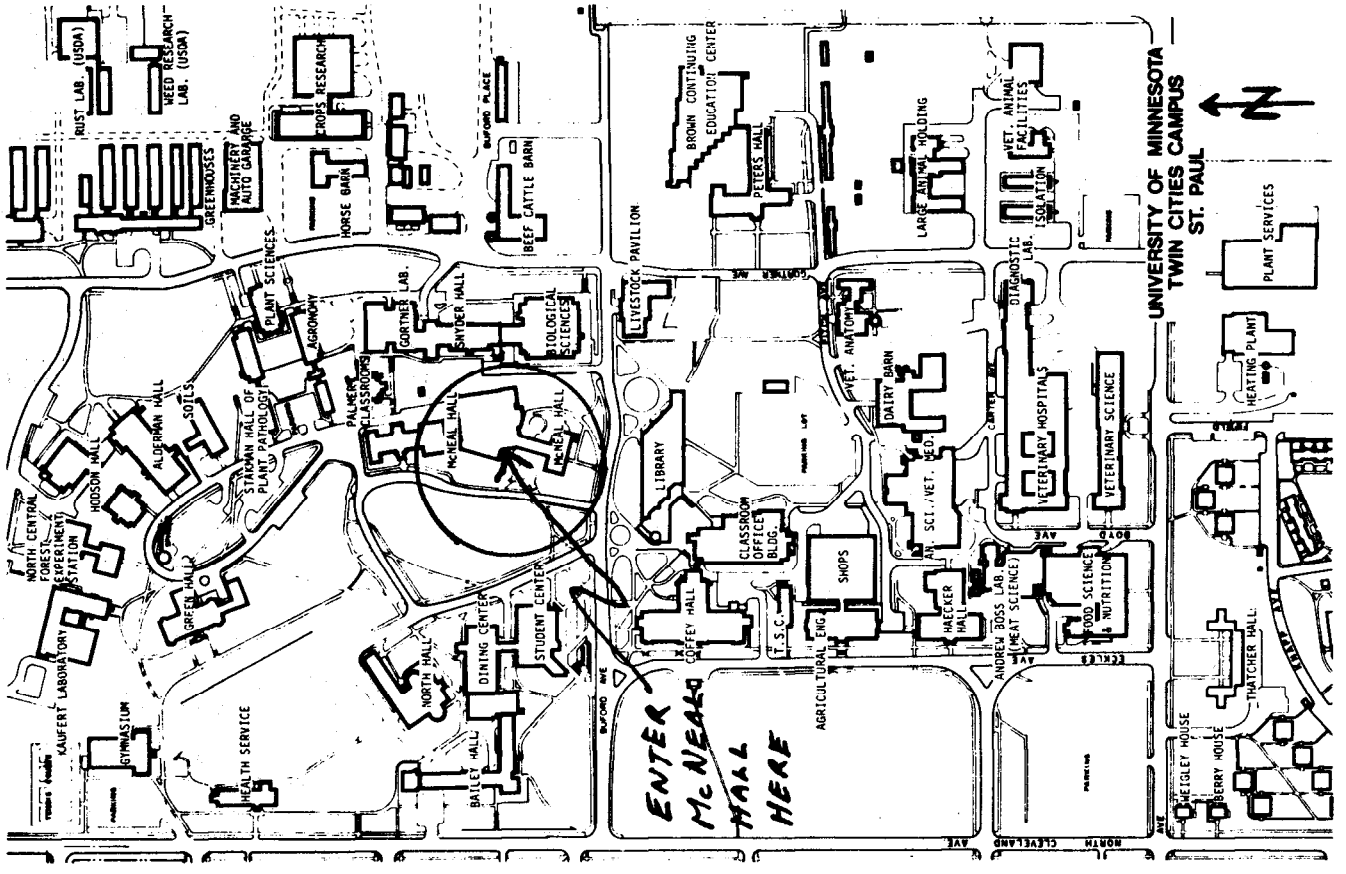
Other meeting topics that we are considering include groundwater and related energy topics; groundwater quality monitoring and related techniques and equipment; basic groundwater hydrology class (short course); ground water modeling class (short course); and legal issues of groundwater information involving both quality and quantity. Any other ideas, or volunteers, or moral support will be heartily welcomed.

Developing these topics into actual events requires planning, time, and money. The MGWA will be writing program descriptions to be used for soliciting donations/grants from interested companies. In short, we plan to start looking for financial backing for these seminars . I will discuss this at our May 19th meeting, any suggestions and/or assistance will be welcomed with open arms. Please consider any of the above requests for help, we need some volunteers to help out.

Short Notes: Buried in the newsletter is a request for comments regarding the MPCA's draft rules for land disposal of hazardous waste. I strongly urge you to review these rules. They can still be changed but once they are accepted, they are very hard to change. The newsletter should carry notices regarding proposed rules and other topics published in the State Register. We need a volunteer to tabulate these notices and write a short announcement for the newsletter. How about it! Check the May-June issue of Ground Water, should be a short note about MGWA. I attended the Minn. Water Well Association annual convention and presented a short pitch about the MGWA. I welcomed members in MWWA to join our group and they in turn requested the same. If you do have contact with any aspect of the water well drilling industry, I stronly urge you to join the MWWA. The best benefit is the opportunity to meet drillers, suppliers, etc. and exchange info, throughts, gripes, etc. For more info call Norville Petersen 218/741-4070 or Gerald Ramsdell 612/935-7100. Take my advice, no textbook will ever tell you what it takes to design and drill a well, the drillers can and will if you ask.

See you on May 19th.

Gilbert Gabanski, President



Minnesota Ground Water Association Spring Meeting

7:30 PM, Thursday, May 19, 1983
McNeal Hall Room 33
Saint Paul Campus, University of Minnesota

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Ground Water Modeling: Is it true that the Emperor has no clothes?

Dr. Mary Anderson

Momentum seems to be building for the widespread use of ground water models to aid in decision making. But there is concern over the lack of certainty in the parameters needed as input to the model and, in the case of contaminant transport, there is uncertainty over the formulation of the theory itself. In other words, some people argue that the model "has no clothes". The validity of these concerns, examples of model use, and a philosophy of modeling will be discussed.

Dr. Anderson received her BA in geology from SUNY-Buffalo and her MS and PhD degrees from Stanford University. She has been at the University of Wisconsin-Madison since 1975 and is currently an Associate Professor of Geology. Dr. Anderson teaches courses in hydrogeology and is active in research involving ground water-lake interaction and contaminant transport in ground water. Her area of specialty is the application of ground water models; she is a co-author of a recent book on ground water modeling.

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Following Dr. Anderson's presentation, Gil Gabanski will make a few remarks about current fund raising activities and the program being planned by the Board of Directors for the coming year. Refreshments will be provided.

This meeting is being sponsored by the Department of Geology and Geophysics, University of Minnesota. Dr. Anderson will also be speaking at the Geology Dept. Seminar on Thursday May 19 at 3:15, Room 110, Pillsbury Hall.

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PARKING INFORMATION

The best way to enter McNeal Hall is noted on the map. Please park only in metered areas and public lots such as the one south of the library or the lot by the Earle Brown Center. DO NOT PARK IN CONTRACT LOTS ! You probably will not be happy with the ticket you might get. Any questions, call Gil 612/296-0431.

# CURRENT GROUND WATER RESEARCH IN MINNESOTA

## Hydrologic Studies, Winona County, Minnesota

Two hydrologic and mapping studies have been underway in Winona County since 1980. The purpose of the first study was to determine the subsurface flow paths of the effluent lost and discharged from the failed Altura (Minnesota) wastewater facility. The study included two semi-quantitative fluorescent dye traces, and mapping of the multi-aquifer potentiometric surface and subsurface geology of the Altura Quadrangle. The study has been completed and the results are being prepared for publication.

The second study involved the completion of the mapping of bedrock geology, springs, and karst features for the RCWP Garvin Brook Watershed Project. The bedrock geology map and cross-sections have been completed for the fifty square mile watershed. The hydrologic flow regime and water chemistry studies are in progress. Isotope analysis may be added to the watershed study.

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## Use of NTRM Model in Land Application of Wastewater

Research is being conducted to adapt the Nitrogen-Tillage-Residue Management (NTRM) Model to the area of land application or treatment of wastewater. The NTRM model is a large, broad-based computer simulation model developed in the area of tillage, crop residue and nitrogen fertilizer management. The NTRM model simulates physical, chemical, and biological processes in the soil-water-crop continuum using integrated submodels for soil temperature, soil carbon and nitrogen transformations, unsaturated flow of water, crop and root growth, evaporation and transpiration, tillage, interception and infiltration, chemical equilibria processes, solute transport and crop residues.

The land application study will specifically address the water flow, nitrogen transformation and solute transport portions of the model. The specific objectives of the study will be to add an ammonia volatilization portion to the model and to verify the nitrogen transformation coefficients. The research will be conducted in the laboratory using three soil textures in soil columns measuring 60 cm in diameter and 120 cm in depth. The columns will be slug loaded with wastewater at 500 and 1500 kg of nitrogen per ha and then rained on. Data to be collected will be evaporation, ammonia volatilization and the quantity and quality of leachate from the column.

In a separate study, wastewater in the form of septage was applied to three soil textures in field plots measuring 3m by 3m. The rates of application were 1100 and 1500 kg of nitrogen per ha. Soil water samples were collected in the plots for three years. Preliminary results indicate that nitrate levels in the soil water exceeded the 200 mg/l level in all three soils, but at various times from the initial application.

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University of Minnesota

## Dye Tracing at a Proposed Landfill Site, Winona County, Minnesota

In November 1982, dye tracing was initiated in order to determine the hydraulic interconnections between a proposed landfill expansion site in Winona County and local springs, creeks, and wells. Rhodamine WT, a fluorecent dye, was poured into an 80 foot well at the site which is located on an interfluvial plain about 100 meters above East and West Burns Valley. Area residents are assisting by taking daily water samples.

This study is unique in that the dye was poured into the vadose zone of the bedrock in order to approximate the movement of leachate which may be lost from the landfill. Our purpose is to acquire information about the natural flow patterns which can be used to design an effective monitoring system for ground water pollution.

Short pulses of dye have been detected in several springs and wells indicating a hydraulic connection. A long continuous pulse has not been detected. Monitoring will continue until May 14, 1983.

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## Computer Model of the Ogallala-Sand Hills Aquifer, South-Central South Dakota

In recent years, the Rosebud Indian Reservation in south-central South Dakota has been extensively irrigated with water from the Ogallala-Sand Hills Aquifer. As a result, water levels measured in several monitoring wells have decreased steadily. A study has recently begun in order to use a computer model of the aquifer to predict declines in water level and stream baseflow due to irrigation. The model will also be used to predict water levels and baseflow which will result from the damming of the Little White River and from pumping of production wells for a rural water distribution system. The model used will be a 2-dimensional, numerical-finite difference model provided by the USGS.

The study area is approximately 1056 square miles and includes the northernmost fringe of the Ogallala Aquifer. The aquifer characteristics and boundary conditions have been defined and confirmed by field investigations. Currently, a work proposal is being considered by the Tribe. Field work, involving stream baseflow and water level measurement, is scheduled for this summer.

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## Water Quality Variations of a Southeastern Minnesota Karst Basin

A study of water quality variations in Forestville Creek is being undertaken to trace and evaluate the significance of agricultural and industrial pollutants in a karst basin in Fillmore County. Forestville Creek is the only body of water in Minnesota in which a trout population is entirely supported by natural reproduction and is strictly protected by environmental regulations. Forestville Creek rises in two large resurgent springs, Moth and Grabau. Dye trace studies by the Department of Geology and Geophysics at the University of Minnesota have identified a connected drainage pattern that includes Moth and Grabau Springs, a swallow hole in Fairview Blind Valley which is fed by agricultural runoff, and sinks in the Root River. The Root River is an influent river which flows past the Ironwood Sanitary Landfill, a major regional depository located 8 km upstream from a point where the river sinks. Weekly water samples will be collected from the four locations by the Hiawatha Chapter of Trout Unlimited. The study will contribute to the understanding of water chemistry fluctuations induced by a short underground residence time.

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## Determination of Hydraulic Parameters at the Thermal Energy Storage Project

Determination of the potential of the Franconia-Ironton-Galesville (FIG) confined aquifer as an effective thermal energy storage medium requires thorough knowledge of the geochemical, thermodynamic, and hydraulic parameters of the aquifer and its confining beds. This part of the investigation deals with hydraulic parameters of a system. A series of field measurements and experiments have been performed at the ATES site (St. Paul campus, University of Minnesota) prior to and during the first injection and withdrawl cycle of the aquifer thermal energy storage experiment. Hydraulic parameters being determined are: the hydraulic gradients, direction of ground water movement, transmissivity, permeability and storage coefficient of the FIG aquifer used for ATES, discharge and actual velocities of ground water, and permeability of the confining bed. Findings will be published in a report to Pacific Northwest Laboratories of Battelle Memorial Institute.

Roman Kanivetsky and Marc Hoyer (612) 373-3372
Minnesota Geological Survey

## Ground Water Recharge Rates in Minnesota as Related to Precipitation

Detailed quantitative estimates of the rates of ground water recharge are essential for effective management of the state's water resources. A method that uses amplitude of annual water level rise multiplied by the aquifer storage coefficient to determine annual recharge is being applied to derive these estimates for the unconfined aquifers in Minnesota. Storage coefficients have been estimated from pumping test data, empirical equations, lithology, and the neutron-meter soil moisture profile method. The storage coefficient multiplied by the average annual water-level rise, determined from the correlation of static water levels with precipitation and evaporation, equals annual recharge. Harmonic analysis and autoregression analysis of hydrographs for seasonal and long term cyclic components of ground water level fluctuations are also in progress. Correlations between ground water fluctuations and stream discharge are used to fill in gaps in the long term observation well records analyzed, including 50 well records from the states surrounding Minnesota.

Roman Kanivetsky and Barbara Palen (612) 373-3372
Minnesota Geological Survey

## Development and Use of Azimuthal Resistivity Surveys for Jointed Formations

In many near-surface, sedimentary formations in the Midwest, ground water flow is controlled primarily, or in part, by naturally occurring joints. The characteristics of the joints and of the jointed formation must be known by the hydrologist in order to accurately predict ground water flow, and would be useful in the design and interpretation of aquifer tests and in ground water monitoring. The Bureau of Mines is developing a surface resistivity method which can be used to measure characteristics of a jointed formation which are of interest to the hydrologist. The theory is based on an analogy between a vertically dipping sedimentary section and a jointed formation having a single set of vertical joints. The method involves the use of azimuthal surveys ("rotated" resistivity arrays) and interpretation of the apparent resistivity data obtained.

The resistivity method has been used at five study areas. The results of the field studies include the following: in a formation having a predominant, vertical joint set, the maximum value of the apparent resistivity ($\rho_a$) occurs in the same direction (azimuth) as the joint strike; the polar coordinate graph of $\rho_a$ for such a formation is approximately elliptical; the coefficient of anisotropy ($\lambda$) can be calculated from the field data, and the values of $\lambda$ for jointed formations are in the same range of values reported for layered formations. Although the method is still being developed and tested, it has been used in practical applications as well. Azimuthal surveys and horizontal profiling were used at a site in Pennsylvania in order to delineate a zone of intensely jointed and fractured bedrock which provided a flow path from a surface stream to an active coal mine. The success of the method achieved to date indicates the need for a more complex theoretical model and additional field data.

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## Chemistry if Interstitial Waters in Red Lake Peatland, Minnesota

A variety of vegetation and interrelated surface water chemistry patterns exist in northern peatlands. An understanding of the composition of interstitial waters in combination with stratigraphic and hydrologic investigations is needed to understand the processes involved in the development of these patterns and peatlands. Specifically of interest is the involvement of ground water in an area of the Lost River peatland which consists of a raised bog, a fen, and a peat mound and is located approximately 15 km east of Waskish in northwestern Minnesota.

The purpose of this study, the investigation of interstitial water chemistry, is accomplished by means of a modified sampling technique. The sampling device, used to sample vertical sections of peat 2 - 3 meters deep, consists of a hollow leucite tube, one meter long, divided into 10-cm compartments. De-ionized water sealed in dialysis tubing was placed in each compartment. Migration of disolved species into the dialysis tubing allows the determination of interstitial water composion while excluding larger organic compounds and solids. The sampler was inserted into the peat to the desired depth and the de-ionized water was allowed to equilibrate with the interstitial waters. After four days, the sampler was retrieved. The samples, collected from the bog and peat mound, are being analyzed for pH, specific conductivity, alkalinity, and a set of anions and cations to identify concentration gradients or patterns. The equilibration time is being determined by the collection of interstitial water samples at various test intervals from a cedar bog at Cedar Creek Natural History Area located north of Minneapolis. Preliminary results show concentration gradients with depth in samples from both locations.

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## Subsurface Water Flow in a Southeastern Minnesota Karst Drainage Basin

The study area is a portion of the South Branch of the Root River drainage basin, just southeast of the town of Spring Valley, Fillmore County, Minnesota. Karst features, including sinking streams, blind valleys, resurgent springs, and large caves, are abundant in the area's Upper Ordovician carbonate formations. The purpose of this study is to investigate subsurface flow through this karst aquifer.

The first part of the study involved quantitative dye tracing using Rhodamine WT and a field fluorometer. Dye tracing helped to delineate subsurface flowpaths and provided information about travel time and dispersion along the flowpaths. The recharge area for two large resurgent springs (Moth and Grabau) was defined. In the second part of the study, a gaging station was installed to measure the flow from Moth and Grabau springs. At this time, a year and a half of continuous record is available. A network of rain gages, including a recording gage, was installed in the recharge area of the springs. Together, the flow and precipitation data provide information on the way the system responds to recharge events. Sustained baseflow recession data from the stream gage can be used to determine the diffusivity (ratio of transmissivity to storage coefficient) of the karst aquifer.

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## Computer and Laboratory Simulation of Insitu Uranium Leaching

A computer and laboratory simulation of insitu uranium leaching chemical kinetics has been developed by the Bureau of Mines. The model is a predictive, analytic tool, used in determining the leachability and productive potential of an undeveloped roll front ore deposit and in the optimal design of an injection and recovery well pattern for a leaching operation.

The kinetic geochemical model is composed of three component models. Two of these, the hydrology and mass transport components, are computer-based. The third, oxidation rate chemistry, is a laboratory model of the leaching process. The hydrology model uses site-specific well, pumping, and aquifer characteristics of a leach site. The laboratory geochemical model requires samples of ore material and leach solution to empirically develop site-specific oxidation rate expressions. The mass transport model calculates the changing solution concentrations of uranium and oxygen due to chemical convection, dispersion, and mineral oxidation. The one dimensional chemistry and mass transport simulations operate on the individual streamline components of a 2-dimensional flow simulation. The geochemical simulation of an entire streamline pattern is then obtained by summing the results from individual streamlines. This approach permits the analysis of each streamline's contribution to the effectiveness and efficiency of a well pattern.

The predictive output from these three models includes the streamline flow pattern, the hydraulic head and fluid velocity throughout the aquifer, the concentrations of uranium and oxygen in the leach solution along each streamline, the uranium recovered and oxygen consumed by each streamline. A cummulative estimate of the uranium production of each recovery well, and of the entire pattern, is also computed.

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Bureau of Mines, Minneapolis

## Geohydrologic Interpretation of Glacial Geology near Williams Lake, Central Minnesota

The purpose of this study is to determine the lake-ground water interaction and the hydrologic importance of surficial materials at Williams Lake in Hubbard County, northcentral Minnesota. The lake is situated between the Itasca and St. Croix Moraines and has an area of 90 acres. It has no inlet or outlet, which makes it well suited for ground water investigation. The USGS is conducting ongoing research at the site to determine water and nutrient budgets, near-field, far-field, and inter-lake flow fields.

Currently, analysis of unconsolidated samples is being done to determine the details of the glacial terrain. Tests include grain size distribution, minerology, clay content, and permeability. From this information, the special relationship of the lake and the glacial features will be determined with particular attention given to the effects of the various surficial materials on the flow regime.

The details of a field study are being determined at this time. Ground water flow patterns will be determined using the 70 piezometers, including nested piezometers, installed at the site by the USGS. Data from meteorological recording instrumentation is also available.

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University of Minnesota

## Predicting Direct Recharge of Surficial Aquifers

This recently completed project funded by the Water Resources Research Center at the University of Minnesota had the following objectives:

1. To develop a mathematical model capable of predicting direct ground water recharge on a daily or weekly basis;
2. To apply the model to selected areas to determine the mean annual recharge of ground water and its variability;
3. To use the model to evaluate potential methods of increasing direct recharge.

The resulting ground water recharge model ia a one-dimensional Fortran computer program which simulates evapotranspiration, interception, snowmelt, surface storage, infiltration and soil-water redistribution. The model predicts water table levels on a daily basis. Model input requirements for evapotranspiration are either pan evaporation or daily temperature and humidity plus a "crop" coefficient curve. Other inputs are hourly rainfall data, minimum and maximum daily temperatures, data of soil freezing and date of soil thaw.

The model was verified using data from a heavily instrumented site in the Anoka sand plain aquifer near Andover, Minnesota. The model predicted both water table levels and soil moisture at this site with reasonable accuracy over a three-year period of continuous simulation.

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University of Minnesota

received too late to alphabetize...

'The Analytic Element Method'

The analytic element method is a method of modeling groundwater flow problems in an approximate fashion using analytic functions. Each of these analytic functions is applicable to a specific feature of an aquifer, and contains a number of parameters, which are adjusted in such a way that a good approximation of the boundary condition along the element is obtained. Examples of these functions are complex line integrals of a type similar to those used in boundary element methods. Other functions are obtained by generalizing exact solutions obtained by conformal mapping techniques. The method is particularly suited for large-scale regional groundwater models, where the efficiency of the elements makes it possible to generate a detailed model. The projects listed below all contain implementations of this analytic element method in one form or another. Currently, the method is being expanded to handle transient problems in aquifers of one or more layers, with inhomogeneities in the permeability, lakes, and rivers included. The method is restricted to aquifers with a horizontal base, and a permeability that is piecewise homogeneous. The method is described in detail by O.D.L. Strack in a text on groundwater mechanics that is scheduled to appear in print by Prentice Hall in the fall of 1983. (Current research by Drs. O.D.L. Strack (483-0954) and H.M. Haitjema (483-2030))

'Groundwater flow modeling near the divide-cut section of the Tennessee Tombigbee Waterway'

The divide-cut section of the Tennessee Tombigbee Waterway is located in Northern Mississippi. The waterway cuts deeply into the landscape; up to 150 feet. Groundwater flow studies have been performed to improve the dewatering schemes during construction, while studies are still in progress to assess the long term impact of the waterway on the groundwater environment. The Hydrogeology of the area is characterized by the presence of a system of two aquifers, separated by discontinuous clay strata.

A new computer program, SYLENS, has been developed by Strack and Haitjema, that models horizontal steady double aquifer flow in a large domain (~600 square miles). The model is the first implementation of the Analytic Element Method, described earlier. The simultaneous flow in the two aquifers is efficiently solved by a comprehensive potential formulation proposed by Strack. The program runs on the inter-active graphics system of the Department of Civil and Mineral Engineering and has been used frequently by geologists of the Corps of Engineers in order to gain inside in the Geohydrology of the area. (Research conducted at the Department of Civil and Mineral Engineering of the University of Minnesota under contract with the Nashville District of the US Army Corps of Engineers (Febr.1977-Sept.1983). The principal investigator is O.D.L. Strack).

'Analytic Modeling of Multi-layered Aquifer Flow'

The flow in a system of three leaky aquifers is solved by use of analytic elements. Mjatiev [1947] and Huisman [1972] independently introduced the solution to a well in a multi-layered leaky quifer system. This solution was integrated along a line element to obtain line sinks in leaky aquifers. These line sinks are used to model such flow features as canals and creeks similarly as is done in SYLENS for the case of non-leaky aquifers. The water table in the aquifer above the system is horizontal: the groundwater in that aquifer is stagnant. The approach has been implemented in a computer program. (Master's thesis of G. Heitzman at the Department of Civil and Mineral Engineering of the University of Minnesota).

'A Dupuit Analysis for Leaky Unconfined Aquifers'

This research also deals with the development of an analytic technique for modeling systems of leaky aquifers. The approach differs from the one applied by Heitzman in two respects. First, an unconfined aquifer is added above the system of confined aquifers separated by leaky layers. Second, the combined flow in the multi-aquifer system is solved more efficiently by use of a comprehensive discharge potential. The latter comprehensive potential was developed by Strack, specifically for leaky aquifers.The approach has been implemented in the program LEAKY and applied to systems of two and three aquifers. (Master's thesis of G.D. Keil at the Department of Civil and Mineral Engineering of the University of Minnesota).

'An Initial Study of Thermal Energy Storage in Unconfined Aquifers.'

Most studies on Aquifer Thermal Energy Storage (ATES) deal with injection and recovery of hot water in deep confined aquifers by means of wells. The costs associated with installing such systems form an incentive to study the use of shallow unconfined aquifers, where installment costs for wells are relatively low.

The present study will focus on the development of a computer model that solves transient heat flow problems in unconfined aquifers. The modeling of heat transport in an aquifer requires an accurate solution to the groundwater velocity field. Therefore, use will be made of the Analytic Element Method, whereby changes in the aquifer storage will be modeled by triangular areal distributions of sourses or sinks, which have been developed by Strack. (Research conducted at the Department of Civil and Mineral Engineering of the University of Minnesota under contract with Battelle Pacific Northwest Laboratory as part of a contract with the Department of Energy (Nov.1982-Aug.1983). The principal investigator is H.M. Haitjema.

# ONSITE SEWAGE TREATMENT IN MINNESOTA

By

Roger E. Machmeier
Extension Agricultural Engineer

Minnesota has a set of excellent standards for individual sewage treatment systems, commonly referred to as WPC-40 (6MCAR 4.8040). The use of these Standards, adopted by the Minnesota Pollution Control Agency in 1978, is mandatory for other state agencies such as the Department of Health and Department of Natural Resources. Since the Department of Natural Resources has statutory authority over the orderly development of shoreland in Minnesota, WPC-40 is the document which contains the design criteria for sewage treatment systems along shoreland. Establishments licensed by the Department of Health have their onsite sewage treatment systems designed and installed according to the criteria of WPC-40.

While WPC-40 is not mandatory in other areas of Minnesota, it has been officially adopted or is the standard in use by all of those counties in Minnesota which are interested in adequate onsite sewage treatment. Unfortunately, there are still counties where local interest is such that adequate onsite sewage treatment is not of high priority and which do not have a sanitary code and do not designate an individual to inspect onsite sewage treatment systems, grant permits or to make inspections of newly constructed systems. Consequently, in those counties, sewage systems which are inadequate in size or inadequate to provide treatment are still being installed even though adequate design criteria are available.

WPC-40 was developed by an Advisory Committee over a period of approximately three years. The basic criterion for the provisions contained in WPC-40 was adequate sewage treatment under the variety of site and soil conditions found throughout Minnesota.

A significant consideration in WPC-40 is the provision that sewage tank effluent shall not be discharged into soils having a percolation rate faster than 0.1 minute per inch. This restriction considers the fact that some soils are too coarse textured for adequate sewage treatment, a provision rarely found in other codes.

Another treatment provision of WPC-40 is that there be three feet of soil suitable for sewage treatment beneath the rock layer of a trench, bed, or mound. This three feet of soil suitable for treatment provides the assurance that sewage tank effluent will be adequately treated before percolating into the groundwater.

Where three feet of suitable soil is not available under natural conditions, WPC-40 provides for the installation of suitable fill soil so as to provide adequate treatment. WPC-40 also utilizes current technology and presents design criteria for pressure distribution systems, a technique which greatly improves the hydraulic and treatment efficiency of soil absorption systems, particularly on very heavy clay soils or on sandy soils. As a result of the criteria developed for elevated bed or mound systems, this type of construction has been widely accepted throughout Minnesota. In some counties with problem soils, approximately 80 percent of the sewage treatment systems currently being installed are mound systems. WPC-40 also provides for greywater or reduced area systems, the use of composting or other no-water use toilets, water conservation, holding tanks, and other alternatives to provide for adequate treatment of sewage.

WPC-40 contains the criteria upon which the three-day Onsite Sewage Treatment Workshops are based. These Workshops have been conducted throughout Minnesota since 1971 by the Agricultural Extension Service. The Workshops are currently conducted in cooperation with the Minnesota Pollution Control Agency. The Onsite Sewage Treatment Manual, a 240 page, 3-ring notebook, is used as the teaching text at the Workshops. Continuing education has been the key to achieve better sewage treatment systems in Minnesota.

Another development which is currently gaining momentum is the requirement that individuals involved with onsite sewage treatment systems be certified by the Minnesota Pollution Control Agency. The requirement for certification is not mandatory under state law, but can be required by local ordinance. Four Minnesota counties are currently requiring certification and more are in the process of enacting resolutions for such a requirement. Those who may be certified are installers, inspectors, site evaluators, designers, and pumpers.

One of the provisions of WPC-40 is that an Advisory Committee be established to advise the Minnesota Pollution Control Agency on various aspects of individual sewage treatment systems including revisions of standards, legislation, review of technical data, develop and revising a technical manual, educational materials and programs, and administration of standards and ordinances. When new research or better practices are introduced such that sewage treatment will be improved over the existing criteria of WPC-40, it is the responsibility of the Advisory Committee to make recommendations on necessary changes. Thus, WPC-40 is meant to be a dynamic document reflecting changes in technology.

In summary, Minnesota currently has a set of excellent standards for individual sewage treatment systems. Educational programs have resulted in trained individuals applying the provisions of WPC-40 throughout Minnesota. An Advisory Committee will assure that WPC-40 remains a dynamic document responding to improvements in technology so as to continue to provide for adequate sewage treatment.

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INDEX at LMIC

As a corollary to the newsletter theme of current ground water research in Minnesota, a second installment to the "consumer's guide to state programs" is in order. There is a project called INDEX at the Land Management Information Center (LMIC) which is a computerized catalog of environmental resources information. INDEX is the acronym for the project's full title, the Minnesota Environmental Resources INformation and Data EXchanage.

In the field of ground water, INDEX has listings of research projects, data collections, and resource people. The INDEX coordinator, Janeen McAllister, is always interested in additions to the resource files and to the list of contacts in the fields of water resources and environmental education. The system relies on individuals submitting information to INDEX in any of the categories.

Custom searches may be made to meet the needs of individual users. To obtain further information about these files or to submit information on research projects or to add your name as a resource person, contact Janeen McAllister, INDEX Coordinator at 296-2073, or Linda Canfield, Research Analyst, at 297-2613.

Linda Bruemmer

Information from Minnesota Pollution Control Agency, Division of Solid and Hazardous Waste

SITE RESPONSE UNIT HAZARDOUS WASTE INVESTIGATION SITES

O = Known/Suspected Waste Disposal  X = Ground Water Contaminant

| Hazardous Waste Facility | Volatile Hydrocarbons/ Solvents | Inks/ Dyes | Metals | Paint/ Paint Sludge | Plating Wastes | PAH/Nitrogeneous Heterocycles/PCP: Coal Tar Distillation/ Coking | PAH/Nitrogeneous Heterocycles/PCP: Wood Preservation | Acids/ Caustics | Petroleum/ Petroleum By-Products | Radioactive Wastes | Pesticides | PCBs | Miscellaneous |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ironwood SLF. | O/X | | | | | | | | | | | | Resins |
| FMC | O/X | | O | O | O | | | | | | | | |
| Isanti Solvent Sites | O/X | O | | O | | | | O/X | O/X | | | O | Resins |
| LaMillier/Mankato | O/X | | | | | | | | | | | | Possibly Arsenic |
| TCAAP | O/X | | O | O | O | | | O | O | O | | | Ammunition |
| Oakdale Dump | O/X | | X | O | | | | O | O | | | | |
| Reilly Tar and Chem. Co. | | | | | | O/X | O/X | | | | | | |
| South Andover | O/X | O | X | O | | | | | O/X | | | | |
| Burlington Northern | | | | | | | O/X | | O/X | | | | |
| Consolidated Cont. Corp. | O/X | O | X | O | | | O/X | O | | | O | | Ash |
| Hastings Dump | O/X | | | | O | | | O | | | | | |
| Hibbing Kittarille | O/X | | | | | | | | | | | | |
| Joslyn Mfg. and Supply | | | | | | | O/X | | O/X | | | | |
| Koppers Coke | | | | | | O/X | | | | | | | |
| MacGillis and Gibbs | | | O/X* | | | O | O/X | | | | | | *Metals from spill/ground water quality improving |
| National Lead | | | O/X | | | | | | | | | | |
| Nutting Truck and Caster | O/X | | O | O | O | | | O | | | | | |
| St. Regis Wheeler | | | | | | | O/X | | O/X | | | | Arsenic |
| Washington County SLF. | O/X | O | | O | | | O | | O | | | | |
| Waste Disposal Eng. SLF | O/X | O | X | O | O | | | O/X | O/X | | O/X | | |
| Airco | | | | | | | | O/X | | | | | |
| Arrowhead Ref. | | | X | | | | | O | O/X | | | X | |
| Boise Cascade | O | | O | O | | | | | | | | | |
| Duluth A.F.B. | O | | | | | | | | | O | O | | |
| DM and IR Rwy. | O | | | O | O | | | O | O | | | O | |
| Ford Motor Company | O/X | | X | O | | | | | O | | | O | |

| Hazardous Waste Facility | Volatile Hydrocarbons/ Solvents | Inks/ Dyes | Metals | Paint/ Paint Sludge | Plating Wastes | PAH/Nitrogeneous Heterocycles/PCP: Coal Tar Distillation/ Coking | PAH/Nitrogeneous Heterocycles/PCP: Wood Preservation | Acids/ Caustics | Petroleum/ Petroleum By-Products | Radioactive Wastes | Pesticides | PCBs | Miscellaneous |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maple Plain Dump | O/X | | | O | | | | | | | | | |
| N.W. Refinery | | | | | | | | O | O/X | | | | |
| General Mills | O/X | | | | | | | | | | | | |
| Hopkins Ag. Chem. | O | | | | | | | | | | O/X | | |
| Interlake Inc. | | | | | | O | | | | | | | |
| Marvin Windows | O/X | | | O | | | | | | | | | |
| MBK | X | | | | | | | | | | | | |
| Metronics (Boise) | | | | | | O/X | X | | | | | | |
| Metals Reduction Inc. | | | O/X | | | | | O | | | | | |
| Minnegasco | X | | | | | O/X | | | O/X | | | | |
| Morris Arsenic Site | | | X | | | | | | | | O | | |
| Onan (Boise) | | | | | | O/X | O/X | | | | | | |
| PCI, Inc. | O/X | | | | | | | | | | | | |
| Perham Arsenic Site | | | X | | | | | | | | O | | |
| Proform, Inc. | O/X | | | | | | | | | | | | Resins and wax |
| Rice Street Site | O/X | | | | | | | | O | | | | |
| 3M Chemolite | O/X | | | O | | | | O | | | | O?/X | |
| Tonka Corp. | O | | | O | | | | O | O | | | | |
| Trio Solvents | O/X | | | | | | | | | | | | |
| Union Scrap | | | O | | | | | O | | | | | |
| U.S. Steel | | | | | | O/X | | | | | | | |
| Wadena Arsenic Site | | | X | | | | | | | | O | | |
| Sam Weisman and Sons | O | | | | | | | | O/X | | | O/X | |
| White Bear Lake Dump | X | | | O | | | | | | | | | |
| Windom Municipal Dump | O/X | | | O | | | | | | | | | |
| Ashland Oil Co. | | | | | | | | O | O/X | | | | |
| Ashland Pine County | | | | | | | | O | O | | | | |
| Hutchinson Tech. Inc. | O/X | | | | O | | | | | | | | |
| Ritari Post and Pole | | | | | | | O/X | | | | | | |
| 3M-Kerrick | O/X | | | O | | | | | | O | | | Resins |
| Whittaker Corp. | O | | | O | | | | | | | | | |
| Winona SLF. | O | O | | O | | | | O | O | | | | Phenolic Resin |
| U.S. Navy (Fridley) | O/X | | | | | | | | | | | O | |
| Kurt Mfg. | X | | | | | | | | | | | | |
| Agate Lake | O | | | | | | | | | | O/X | | |
| Honeywell | O/X | | | | | | | | | | | | |

## Announcements

The Minnesota Pollution Control Agency, Solid and Hazardous Waste Division, is currently developing state rules governing the storage, treatment, and disposal of hazardous wastes. Draft rules pertaining to ground water protection, surface impoundments, waste piles, landfills, and land treatment have been completed. If you are interested in reviewing and commenting on any or all of these sections, please contact Bruce Nelson at (612) 297-2726.

GROUND WATER FOR LAWYERS - a special technical institute for lawyers, environmental managers, insurance risk managers, and others concerned with legal aspects which ground water contamination and overuse cause. May 23-25, 1983, University of Wisconsin-Extension, Madison, Wisconsin, fee - $495. For more information...Fletcher Driscoll (608) 263-7756.

Deadline extended - The deadline for returning the directory information form is extended to May 6, 1983. Please send in a directory form if you have not yet done so. The MGWA directory will be duplicated and mailed to MGWA members ONLY. You may submit any or all information indicated on the form below.

The Environmental Directory - is available from the Minnesota Environmental Quality Board, Capitol Square Building, 550 Cedar Street, St. Paul, Minnesota 55101.

Correction - Three phone numbers were incorrect in the article "A Consumer's Guide to Minnesota's Ground Water Problems" in the Winter MGWA Newsletter. The correct numbers are: MN Dept. of Health - Water Supply 623-5330, Water Well Program 623-5338; MN Pollution Control Agency - Division of Solid and Hazardous Waste 297-2735.

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Many thanks to those who contributed articles and research progress reports to the Newsletter.

Pat Leonard-Mayer, Newsletter editor

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MGWA Directory
return by May 6, 1983 to MGWA, P.O. Box 3362, St. Paul, MN 55165

Name _____

Business address _____

_____

_____

Business Phone _____

Home address _____

_____

Home phone _____

Professional interests _____

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