

## Job Announcement

GRA is contracting for a part-time data base administrator to provide membership services. The ideal candidate must be able to use relational data bases, send and receive faxes/e-mail, and return phone calls. It is expected that the job will take 2-3 hours a week. One of the major tasks will be to maintain GRA's mailing lists. The mailing list is updated based on information shared with the branches and provided by members. Send no more than a one page statement of qualifications to GRA, Membership Services, P.O. Box 1446, Sacramento, CA 95812. Statements may be e-mailed to [admin@grac.org](mailto:admin@grac.org). Applications will be accepted until the position is filled. It is anticipated work will begin November 1997. The position pays \$13-15/hour.

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## MTBE is not the only Ether in Town

BY BART SIMMONS, PH.D.

### *Fuel Oxygenates*

In earlier newsletters, we have discussed the measurement of MTBE in groundwater in California. Although MTBE is the major fuel oxygenate, it is not the only compound used to meet Reformulated Gasoline (RFG) standards, and it is not the only oxygenate which has been found in California groundwater from fuel releases. The relative composition of oxygenates in gasoline is variable, and not indicative of any one refiner or distributor. Furthermore, these compounds may have uses other than as fuel blending agents.

Fuel oxygenates include: Methyl *t*-butyl ether (MTBE), Ethyl *t*-butyl ether (ETBE), *t*-Amyl methyl ether (TAME), Diisopropyl ether (DIPE), methanol, ethanol, and *t*-butyl alcohol (TBA). There is a lack of validated methods to measure these compounds in groundwater and other media.

One California laboratory, Global Geochemistry Corporation (GGC), has modified an ASTM method to measure the oxygenates in groundwater. In one case, GGC found MTBE and TAME in groundwater near a gas station. Fuel taken from the pumps at the presumed source did not have detectable TAME, so it was not useful in predicting what oxygenate may be in the groundwater. There is currently considerable discussion about the measurement of oxygenates in water and soil. Although ETBE and DIPE have not been found in California due to fuel releases, it is recognized that there is a potential for soil and groundwater contamination with all of these ethers and alcohols.

Methanol and ethanol are difficult to measure by the usual purge-and-trap methods, e.g., EPA 8240 and 8260, because of problems with purging from water, hydrocarbon interferences, and potential for lab contamination. However, methanol and ethanol are generally considered to be a lower priority for measurement due to their relatively low toxicity and relatively low persistence.

### *Validation studies*

Lawrence Livermore National Laboratory has begun a validation study with the State Water Resources Control Board and other laboratories to validate methods for oxygenates, including modified ASTM D2887/D4815, EPA 8260, and EPA 8020 for the measurement of MTBE, TBA, DIPE, ETBE, and TAME in water, soil, and air. Preliminary work indicates that 8260 is viable for TAME, DIPE, and ETBE in groundwater, but additional validation is needed for water as well as air, soil gas, and fuel.

### *Monitoring*

Routine monitoring requires verified test methods. Some regional water boards have begun adopting requirements for the measurement of the oxygenated ethers by EPA 8260; additional work needs to be done to develop cost-effective monitoring programs for the fuel oxygenates.

The development of methods for all commonly used oxygenates is a high priority so that monitoring for releases can be done reliably and cost-effectively.

*Bart Simmons, Ph.D., is the Chief of the Hazardous Materials Laboratory, Department of Toxic Substances Control, Berkeley.*

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## **DATES & DETAILS**

### **1997 Board of Directors' Meeting Date**

All Members Welcomed

November 10, 1997 Downey, Brand, Seymour & Rohwer, Sacramento.

Contact: Steve Goldberg  
(916) 441-0131, ext. 231

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## New Groundwater Modeling Short Course

A new groundwater modeling SHORT COURSE will be offered through the University of California, Davis. The course, entitled "Principles of Groundwater Flow and Transport Modeling" is intended for professional consultants, technical personnel in engineering/geology firms and irrigation/water districts, regulatory agency specialists and managers, and those in the legal community specialized on groundwater issues. Participants should be familiar with PC Windows/Windows95 and are assumed to have some college training in groundwater hydrology, engineering, or science, but are not expected to have any experience with computer modeling. The course objective is to demystify the use of groundwater models by providing solid understanding of the principles, methods, assumptions, and limitations of groundwater models, and hands-on experience with the planning, preparation, execution, presentation, and review of a modeling project. The course will be held at UC Davis' Galleria in downtown Sacramento on October 8-10, 1997. The center provides state-of-the-art classroom computer facilities. Fees are \$650, which includes use of the computer facilities, course material, lunches, coffee-breaks, and one dinner. Early enrollment is encouraged as space is very limited. For more information on course content or to request a detailed brochure and enrollment form, contact Karen Fisher, University Extension, (916) 757-8899, [kfisher@unexmail.ucdavis.edu](mailto:kfisher@unexmail.ucdavis.edu).

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## Legislative Corner

*BY HARRISON PHIPPS*

SB 521 and SB 1189 regarding MTBE (reported in the last issue of HydroVisions) are still active and have been referred to the Committee on Appropriations.

AB 254 (Machado), the Flood Prevention Bond act of 1998.

This bill, and its companion Senate bill, SB 312, propose to deal with flood control in a manner that addresses a number of public policy goals including groundwater recharge. The bill includes the following:

**Watershed program**-Provides grants to local agencies for implementing coordinated watershed plans that eliminate chronic flooding and create watering ponds and groundwater recharge.

**Flood Easement program**-Gives priority to projects that have multiple benefits including groundwater recharge, wildlife habitat and recreational uses.

**Floodplain Management**-Finds that floodplains should be developed in a manner that prevents loss of life and economic loss due to excessive flooding.

Local agencies will be eligible for funding provided they prohibit building in a floodway and adopt land use policies consistent with floodplain management findings.

If passed, the bond measure would provide funds to purchase easements for the preservation of flood prevention corridors. Priority will be given to projects that have multiple benefits including groundwater recharge, wildlife habitat and recreational uses.

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## Letter to the Editor

### ***Price of Food May Need to Reflect the Real Price of Water Used***

Has anyone else given a thought as to where all the water is coming from that permits the ever-increasing farming now going on in the Antelope Valley? Today, many times more land is being farmed than has ever been known to be irrigated at any one period or past time. What effect does this have on the underground water? Does this pumping lower the water table and just who's water is being used? Are the persons doing the pumping required to replace a like amount of water used or is this legal thievery?

Most citizens are not aware that approximately 85% of all available water in California is devoted to agriculture, with some going to related industry. Residents and such bill and tax payers get the remaining 15% of available water. When you buy a pound of onions or such, a portion of the price you pay should be used to replace any water used in growing the product. I predict the current farming will run out of cost-effective water and the growers will move out, leaving the underground supply raped.

Richard Dougherty  
Palmdale

***Editor's Note:*** Richard recently joined GRA. We welcome his contributions to HydroVisions and his enthusiasm for groundwater issues. Floyd Flood

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## New In-Well Air Stripper Developed at UC Davis

BY JOSEPH STAGNER, P.E.

A new simple and low cost in-well air stripping system has been developed at the University of California, Davis for cleanup of groundwater contaminated with Volatile Organic Compounds.

The patented **Multi-Stage In-Well Aerator** (Aerator) was developed for the West Campus Groundwater Cleanup Project as an alternative to expensive and sometimes high maintenance packed tower and stacked tray type air strippers and has operated continuously at this site since October 1995 with an availability greater than 99%. Installation cost was less than 50% of a conventional air stripper and the four well 160 gpm system has treated over 100 million gallons of groundwater thus far and shown measurable cleanup of the contamination.

The Aerator system consists of an air compressor, compressed air piping to extraction wells, an Aerator in each well, and piping for in-situ or ex-situ discharge of the treated water. The Aerator uses only compressed air. Electrical wiring is not required.

### *Aerator System Schematic*

The Aerator itself is constructed almost entirely of common PVC pipe components to resist chemical and biological fouling. It has no moving parts to jam or wear out and can be installed in wells of at least 6" diameter. The Aerator provides multiple stages of air stripping using air lift pumping and gravity flow to draw groundwater through serial aeration passes in both the upper and lower sections of the well as shown in the following sketch. This allows groundwater to be completely treated by air stripping in one pumping pass, which air lift pumping alone cannot achieve.

VOC laden off gas and treated water are discharged separately at the surface. The off-gas may be discharged directly to atmosphere or captured for treatment if required. If desired the Aerator may be installed completely below ground if additional head for discharge is not needed when using reinjection, leachfield recharge, or other such methods.

### *Aerator Device Schematic*

Aerator performance varies based on the diameter of well used, pumping rate, type (volatility) of contaminant targeted for removal, and to a lesser extent the concentration of the contaminants to be removed. At the UC Davis site the prime contaminant is chloroform, which has a much lower volatility than most VOCs such as TCE and Carbon Tetrachloride and is therefore more difficult to air strip. Using 8" diameter wells, all VOCs except chloroform were removed to non-detect at all pumping rates, while chloroform removal varied from about 90% at 50 gpm to 99% at 10 gpm.

ore information about the Aerator is available on the Internet at the website listed below or by contacting:

Joseph C. Stagner, P.E.

Davis Environmental

2305 Inverness Place

El Dorado Hills, CA 95762

phone/hx/data: (916) 933-7710

email: [davisenv@softcom.net](mailto:davisenv@softcom.net)

website: <http://www.softcom.net/users/davisenv>

*Joseph Stagner is a registered Civil Engineer in California with over 18 years experience in a wide variety of civil and environmental engineering projects. He is currently employed as Manager, Solid Waste Division at UC Davis where he invented the Multi-Stage In-Well Aerator.*

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## **Call for Nominees for Statewide Officers**

The GRA Board of Directors is accepting nominees for the position of President, Vice-President, Secretary, and Treasurer for the 1998 Calendar Year. If the general membership accepted the proposed bylaw changes at the Annual Meeting, the President and Vice-President will also be board members. All nominees may be made to Anthony Saracino, Chairman of the Board, or any Board member. Nominees will be accepted until the vote for offices at the November Board meeting, scheduled for November 10, 1997, at Downey, Brand, Seymour & Rohwer, Sacramento.

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# PRESIDENT'S MESSAGE

BY SUSAN GARCIA

GRA recently received a letter from Cruz M. Bustamante, Speaker of the Assembly, California Legislature, requesting input and comments on California water issues from our perspective. In his letter, Assemblyman Bustamante indicates the following:

- "The distribution of California's variable water supplies has been the most controversial issue in the history of California. And this fight between competing interests over the development and management of California's most precious and vital resource will continue for decades given the state's unprecedented growth.

The California State Assembly began the 1997-98 legislative session with many new Democratic assembly members dedicated to finding reasonable and sensible solutions to the state's complicated water issues. Representing districts as diverse as central valley farmlands, urban big cities, and rural coastal areas, each Member's district faces unique needs and demands for an overall water policy that respects the requirements of all Californians."

Assemblyman Bustamante's office will be preparing a California water "guide" for caucus members. They hope that they can make this guide as thorough and comprehensive as possible, therefore, they have asked for comments and input from GRA and a variety of other organizations.

Because GRA's membership is diverse, I open this request to all our membership and ask, "from your perspective, what do you see as the most pressing California water issues?" We will be dedicating a portion of our next *HydroVisions* to publishing your responses. These responses will in turn be forwarded on to Assemblyman Bustamante's office. Please keep your responses brief and to the point. We reserve the right to edit those responses that we view as too lengthy for publication. Responses forwarded to Bustamante's office will not be edited. On your responses please provide your full name, address, and phone number that you can be reached during the daytime. Responses without proper identification, will not be published nor forwarded to Bustamante's office.

Please provide your response by e-mail to: [editor@grac.org](mailto:editor@grac.org) and cc a copy to me at [sgarcia5@compuserve.com](mailto:sgarcia5@compuserve.com). Hard copy responses with diskette will also be accepted at **GRA, CA Water Issues, P.O. Box 1446, Sacramento, CA 95812**. I encourage all our membership to please provide us with your input, such as provided by one of our newest members in the form of a letter to the editor in this issue.

I have prepared a brief list of items that I believe represent some of the most pressing water issues facing California. In addition, I pose a list of questions that may facilitate your preparing a response to this request. These items are not listed in any order of preference.

- Interbasin water transfers
- Groundwater overdraft conditions
- Seawater intrusion and saline waters
- Non-point pollution problems, who should pay for cleanup?
- Should we re-examine how we handle the treated wastewater and require re-use?
- What is the true cost of water and are we undervaluing our water?
- Can desalination plants become economically feasible and will deregulation of our electrical power have some impact?
- Should we continue to approve development projects that have nebulous plans for providing water to their future constituency?
- Should we expand our current use of tertiary-treated, reclaimed water to direct consumption?
- How do we implement statewide water management strategies that overcome historical local biases?
- Should we be transferring water from agriculture for urban use?
- Should the bottle water industry be permitted to remove groundwater supplies for out of basin and state water sales?

Here are some recent headlines from the Los Angeles Times that may spark your interest:

- "Southland's Water Future May Hinge on Bitter Dispute, Battle: L.A. - based agency fears San Diego's bid for Imperial Valley supplies will hurt region. Mediation, new law or courts could settle feud--and lead to higher rates." August 3, 1997
-

"Water Deal Splits San Joaquin Valley, Resources: MWD crafts plan for transfer from southern district to urban use. Northern farmers, fearing effects on agriculture, join environmentalists in opposition." July 29, 1997

- 
- "Reclaimed Waste Water May Ease State's Thirst, Recycling: Despite 'yuck' factor, the practice is on the rise. San Diego is at cutting edge of what backers see as wave of future: sending treated sewage back to the tap." August 17, 1997

Comments should be received by October 31 for inclusion in our next **HydroVisions**. I look forward to receiving your comments.

### ***Other Items***

GRA voted on revisions to their bylaws during our 1997 Annual Meeting being held as part of the 21st Biennial Ground Water Conference on September 16, 1997. Proposed revisions to GRA's Bylaws are provided in this HydroVisions. Steve Goldberg, GRA Director, has provided us with the rationale for these changes in this HydroVisions. We thank Steve and the Bylaw Committee for their time and effort in developing these changes.

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## Proposed By-Law Changes Will Benefit GRA

BY STEVE GOLDBERG

GRA marked its fifth anniversary. Membership has grown and much has been achieved. The leadership of our founding directors and members is steadfast and new leadership is being nurtured. It was also time to review GRA's original by-laws. How were they working? Had the original by-laws kept pace with GRA's growth over the last five years? How would they serve us in the future? And last, but most important, were changes needed to foster the growth and vitality of GRA? At the Board Retreat last January, we discussed these questions (and many others) and appointed a Committee to review the By-laws and recommend possible changes. The Committee concluded the by-laws were essentially functioning well, however, some recommended changes were proposed to the Board of Directors. After extensive discussion and several iterations the Board approved several changes which it is presenting to the membership for approval.

All the proposed by-law changes are provided below for all GRA members to ponder. Several are minor and do not merit much discussion. A few are worthy of mention since the Board believes the changes will strengthen GRA in the future. First and foremost, the Board proposes increasing the number of Directors from its current seven (only six are presently seated) to eleven Directors. Nine of the Directors will each serve three year terms which will be staggered so that only three of nine Director positions will turn over in any given year. The increase in the number of Directors is aimed at increasing the leadership ranks of the Association while the staggered three year terms will ensure some stability and continuity at the Board level. Further, the Board is committed to recruiting new Board members from its branches to increase their voice in GRA at the state level. The By-laws Committee is evaluating having the branch presidents serve as members of the Board. GRA members would continue to elect nine of the eleven Directors of the Board.

Another proposed change concerns the two remaining Director positions. The Board proposes the President and Vice President serve on the Board as full voting members for the duration of their term. This will give the two highest officers of GRA equal status with other Directors to vote on matters submitted to the Board. This should foster a closer relationship between the two highest officers of GRA and its Board.

Finally, a change is made to the quorum requirement at GRA's annual meeting of members. The current by-laws require 10 percent of GRA members for a quorum. Historically, this number has been difficult to achieve. The Board recommends lowering the quorum requirement for the annual meeting to 5 percent of its membership or a minimum of 30 members whichever is greater. This should give GRA flexibility to conduct business at its annual meeting, including the election of Directors and by-laws changes, while retaining sufficient membership control.

The proposed by-law changes were to be voted on at GRA's annual meeting, assuming a quorum of the members were present using the current 10 percent quorum requirement. If a quorum was not present GRA will have a postcard and/or electronic election on the proposed changes.

Below is a redline/strike-out of the proposed changes:

### ARTICLE 3 DIRECTORS

#### SECTION 1: NUMBER OF DIRECTORS

The corporation shall have seven (7) directors eleven (11) Directors and collectively they shall be known as the Board of Directors. The number may be changed by amendment of this Bylaw, or by repeal of this Bylaw and adoption of a new Bylaw, as provided in these Bylaws. The President and Vice-President shall serve on the Board of Directors and shall hold two (2) of the eleven (11) Director positions.

#### SECTION 4: TERMS OF OFFICE

Nine (9) of the eleven (11) Directors shall hold office for a term of three (3) years except for the Directors who hold office in 1997 who shall serve either one (1) year or (2) year terms depending on which class of directors they fall into. The nine Directors shall be divided into three (3) classes, such that terms of one-third (1/3) of the Directors shall expire each year. Each director shall hold office until the next annual meeting for election of the Board of Directors as specified in these Bylaws, and until his or her successor is elected and qualified. expiration of the term for which elected and until a successor has been elected. Two (2) of the eleven (11) Directors shall also serve as the President and Vice President of the Association and shall serve as Directors during the term of their office.

Directors with three year terms shall be elected at the annual meeting of the Association. Such elected Directors shall hold office for a term of three (3) years until the third annual meeting following their election.

#### SECTION 13: QUORUM FOR MEETINGS

A quorum shall consist of not less than three directors or one-fifth of the total number of directors, whichever is larger a majority of the Directors seated.

### **ARTICLE 4**

#### **OFFICERS**

#### SECTION 6: DUTIES OF PRESIDENT

The President shall be the chief executive officer of the corporation and shall, subject to the control serve as a voting member of the Board of Directors, supervise and control the affairs of the corporation and the activities of the officers during his/her term. The President shall serve as a voting member of the Board of Directors during his/her term.

#### SECTION 7: DUTIES OF VICE PRESIDENT

In the absence of the President, or in the event of his or her inability or refusal to act, the Vice President shall perform all the duties of the President, and when so acting shall have all the powers of, and be subject to all the restrictions on, the President. The Vice-President shall work closely with the President and become familiar with all aspects of the corporation's affairs and programs. The Vice-President shall also serve as a voting member of the Board of Directors.

### **ARTICLE 14**

#### **MEETING OF MEMBERS**

SECTION 5: QUORUM OF MEETINGS shall be amended as follows:

A quorum shall consists of ten five percent (10%) of the(5%) or no less than thirty (30) voting members of the corporation whichever is greater in order to conduct general business.

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## **UC Extension, in cooperation with GRA offers: Applied Groundwater Short Course Offered for the Novice**

Due to its great success last year, this groundwater SHORT COURSE will be offered for a second time through the University of California, Davis. The course, entitled "Introduction to Applied Groundwater Hydrology: Principles, Measurements, and Interpretation" is provided specifically for technical management personnel employed by natural resources conservation districts, consulting companies, irrigation districts, water districts, local and state agencies, for farm advisors, and members of environmental groups and citizens alliances and other interested professionals with little or no background in groundwater hydrology. The intensive three-day SHORT COURSE will review the fundamental principles of groundwater occurrence, groundwater movement and recharge, groundwater quality and contaminants transport, and give an overview of the most common field and modeling tools for measuring and interpreting groundwater characteristics. This year, the course will be held at the Hyatt Regency in downtown Sacramento on November 4-6, 1997. Fee is \$375, which includes course material, lunches, coffee-breaks, and one dinner. Early enrollment is encouraged as space is limited. For more information on course content or to request a detailed brochure and enrollment form, contact Karen Fisher, University Extension, (916) 757-8899, [kfisher@unexmail.ucdavis.edu](mailto:kfisher@unexmail.ucdavis.edu).

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## Waterloo Short Course in San Francisco

The University Consortium, Solvents-In-Groundwater Research Program presents a short course: **DNAPLs in Fractured Geologic Media: Behavior, Monitoring and Remediation**, November 10-12, 1997, Cathedral Hill Hotel, San Francisco. The course is taught by John Cherry, Ph.D., Bernard Kueper, Ph.D., and Beth Parker, Ph.D. This course makes use of recent information from laboratory and field experiments, mathematical models and case studies of actual DNAPL sites to gain insight on DNAPL behavior, distribution and fate in fractured geologic media including fractured sedimentary and crystalline rocks and fractured clayey strata. For more information or concerning registration, contact Robin Jowett at Waterloo Educational Services Inc., call (519) 836-3102 or fax (519) 836-3381. The fee for the course is \$975. The course fee includes one set of course notes, lecture sessions, coffee break refreshments and complimentary icebreaker.

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## Sponsor Acknowledgment 1997

GRA operations are funded through membership dues and donations made by members and their affiliated companies. We would like to recognize those that have contributed to GRA's future in 1997:

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# State to Develop Groundwater Protection Program

BY HARRISON PHIPPS

The 1996 Safe Drinking Water Act amendments require states to develop source water assessment programs (SWAP) for public drinking water systems (PWS) and submit to U.S. EPA for approval. As part of a SWAP, states are required to 1) delineate the boundaries of the areas providing source waters to the PWS (groundwater and surface water) and, 2) identify, to the extent practicable, the origins of regulated and certain unregulated contaminants in the delineated area to determine the vulnerability of the PWS to those contaminants.

Goals of the Drinking Water Source Assessment and Protection Program:

- Encourage a proactive approach to protecting drinking water sources. Water suppliers, communities, planners and the public at large will be encouraged to actively manage and plan activities around sources and their delineated contribution areas to reduce or eliminate the threat of contamination.
- Refine/focus/target the monitoring requirements for drinking water sources. State and federal regulations require water suppliers to monitor for a long list of inorganic and organic chemicals. With proper identification of contaminated sources, monitoring requirements can be targeted to the needs of the source. The result is enhanced health protection with a potential saving in monitoring costs.
- Meet federal requirements of establishing Wellhead Protection and Source Water Assessment Programs.

There are about 15,000 active groundwater sources in California that serve as drinking water sources and will be included in the SWAP.

U.S. EPA requires the programs to include at least the following:

- Delineation of areas that contribute water to the wells
- Inventory of source contaminants within the protection areas
- Assessment to determine susceptibility to contamination
- Protection elements at state and local level (regulatory and non-regulatory)
- Contingency planning for alternative water supplies
- Siting criteria for new wells
- Public participation in developing the SWAP
- Implementation activities

A technical advisory committee has been formed to review and comment on the technical elements of the program. The GRA Executive Director and Chair serve on the committee.

The Department of Health Service, Drinking Water Program (DHS) is coordinating the effort with support from the State Water Resources Control Board.

## ***For more information, contact***

Alexis Milea, DHS, 2151 Berkeley Way, Room 461, Berkeley, CA 94707 (510) 540-2177 or Leah Walker, DHS, 50 D Street, Suite 200, Santa Rosa, CA 95404 (707) 576-2295

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## The Battle for Mono Lake Premiere

A premiere of the public television documentary "The Battle for Mono Lake," chronicling the Mono Lake Committee's efforts to save Mono Lake, will be held on Sunday, October 19 at 3p.m. in Wheeler Auditorium, University of California's Berkeley campus. At the premiere the Mono Lake Committee (MLC) will formally announce its decision to donate its papers to the Water Resources Center Archives (WRCA). Proceeds from this event will help support the work of the two sponsoring organizations.

Following the screening, Rita Schmidt Sudman, Executive Director of the Water Education Foundation, will moderate a panel discussion. Members of the panel will include Martha Davis, former Executive Director of the Mono Lake Committee, Stephen Fisher, author and director of the film, two additional members and a representative of the State Water Resources Control Board. A reception at Alumni House will follow. The Archives, located at 410 O'Brien Hall, will be open to visitors before and after the screening.

John Hart, author, will also be on hand to sign copies of his book, Storm over Mono.

The film's premiere may coincide with the State Water Resources Control Board's vote, expected imminently, on the Mono Basin restoration plan. If approved the settlement will guide the restoration activities and annual monitoring of the Basin through the year 2014.

The donation of MLC's papers to WRCA assures that scholars, students, lawyers, environmental organizations, policy makers, and the general public will have access to legal briefs, transcripts, and correspondence, scientific documentation, legislation, and a blueprint for solving complex environmental issues.

Tickets for the event are priced at \$10 (students), \$25, \$50 and \$150. To order or charge tickets, please call (818) 716-8488 or write to the address below. For information about the premiere or the Water Resources Center Archives, please call (510) 642-2666.

### ***For more information, contact:***

Kathy Dieden  
Library Assistant  
Water Resources Center Archives  
410 O'Brien Hall  
University of California  
Berkeley, CA 94720-1718  
(510) 642-2666

### ***To order tickets, contact:***

Shelly Backlar, Director of Development,  
Mono Lake Committee  
6616 Kentfield Avenue  
West Hills, CA 91307

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# Unreliability of Groundwater Monitoring at Lined Landfills

BY G. FRED LEE, PH.D., PE, DEE AND ANNE JONES-LEE, PH.D.

In 1988, the US EPA proposed RCRA Subtitle D municipal solid waste landfilling regulations which recognized that a single composite liner for a landfill would not prevent groundwater pollution by landfill leachate for as long as the wastes in the landfill would be a threat. The US EPA Solid Waste Disposal Criteria (August 30, 1988a) stated,

- *"First, even the best liner and leachate collection system will ultimately fail due to natural deterioration, and recent improvements in MSWLF (municipal solid waste landfill) containment technologies suggest that releases may be delayed by many decades at some landfills. "*

The US EPA Criteria for Municipal Solid Waste Landfills (July 1988b) stated,

- *"Once the unit is closed, the bottom layer of the landfill will deteriorate over time and, consequently, will not prevent leachate transport out of the unit. "*

While in 1988 the US EPA developed the conclusion that a single composite liner would not protect groundwaters from impaired use for as long as the wastes in the landfill represent a threat, the general understanding by professionals of the significant shortcomings associated with the use of high density polyethylene liners or, for that matter, other plastic liner (flexible membrane liner-FML) systems were just beginning to be understood. Today, these deficiencies are well understood. The wastes in a Subtitle D "dry tomb" type landfill will be a threat to pollute groundwaters, effectively forever. The flexible membrane layer in the composite liner has a finite period of time when it can be expected to function effectively to collect leachate. While no one can predict the length of this time before groundwater pollution will occur associated with a minimum Subtitle D single composite landfill liner system, there is increasing evidence that it could be as short as a few decades if high quality liner construction occurs and the placement of wastes in the landfill is done in such a way as to prevent penetrating the liner by waste constituents. This situation has been understood in the field for a number of years. There are now eight states or parts of states that will not allow the construction of a single composite lined municipal solid waste (MSW) landfill.

## Detection of Liner Failure

The US EPA, as part of developing Subtitle D landfills, established fairly rigid monitoring requirements which were, in principle, designed to detect at the point of compliance for ground water monitoring the pollution of groundwaters by landfill leachate before off-site pollution occurs. The point of compliance for groundwater monitoring for Subtitle D landfills must be on the landfill owner's property and be no more than 150 meters from the downgradient edge of the waste management unit. It was the Agency's position at the time of the adoption of Subtitle D regulations that the inevitable failure of the single composite liner in preventing leachate from passing through it while the wastes in the landfill are still a threat would be detected by the groundwater monitoring system before off-site pollution occurred.

The Subtitle D monitoring approach requires that the landfill owner implement an extensive groundwater monitoring program once leachate-polluted groundwaters are detected at the point of compliance. Further, Subtitle D regulations require that once the extent of groundwater pollution has been defined, the landfill owner must initiate a groundwater remediation program to stop the spread of the pollution and start to clean up the polluted aquifer to the extent that it is possible. It is understood, however, that it will never be possible to clean up an MSW leachate-polluted aquifer system so the groundwaters associated with such a system would ever be considered safe for domestic consumption and many other purposes.

## Reliability of Groundwater Monitoring Under Subtitle D

Unfortunately, the US EPA in developing its groundwater monitoring system for Subtitle D landfills did not critically analyze the ability of groundwater monitoring wells of the type that are typically used to monitor groundwater pollution at classical unlined sanitary landfills to be able to detect the leachate-polluted groundwaters that would occur when the flexible membrane liner in a composite liner for a Subtitle D landfill first starts to degrade/deteriorate. The classical unlined sanitary landfill can be reliably monitored by placing groundwater monitoring wells at about any location down groundwater gradient from the landfill since the classical sanitary landfills produce large plumes of polluted groundwaters. However, the plastic sheeting-lined landfills, such as the minimum Subtitle D landfills, will first start to leak leachate through the liner system in small areas compared to the total area of the landfill.

The US EPA (1991) in Subtitle D groundwater monitoring system requirements stated:

- *"The design must ensure that the concentration values listed in Table I of this section will not be exceeded in the uppermost aquifer at the relevant point of compliance..."*

and specify that

- *"(a) A ground-water monitoring system must be installed that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield ground-water samples from the uppermost aquifer (as defined in 258.2) that: (2) Represent the quality of ground water passing the relevant point of compliance..."*
- *"(c) The sampling procedures and frequency must be protective of human health and the environment."*

The Agency did not understand that the implementation of this requirement at the state and regional regulatory agency level would be based on mechanical application of the approach that had been used to monitor classical unlined sanitary landfills, i.e. a few downgradient monitoring wells spaced hundreds to a thousand or more feet apart. Dr. John Cherry (1990) was the first to point out that the approaches that were being adopted for monitoring plastic sheeting-lined landfills had a low probability of detecting landfill leachate-polluted groundwaters at the point of compliance before off-site pollution occurs. Cherry and his associates at the University of Waterloo had conducted a number of field experiments in which dyes were injected into a sand aquifer system at a specific source and the lateral spread of the dyed groundwater was assessed. It was found that the lateral spread of groundwater pollution plumes were limited near the source of pollution.

While Dr. Cherry's original publication on this topic was in a conference proceedings that was not widely read by hydrogeologists who work in the landfill field, he discussed these issues at the American Society for Testing and Materials symposium, Current Practices in Ground Water and Vadose Zone Investigations, held in San Diego, California in January 1991 where he indicated what should have been obvious to the US EPA and others—that the typical groundwater monitoring systems that are being used for lined landfills involving vertical monitoring wells spaced hundreds to a thousand or more feet apart at the point of compliance for groundwater monitoring have a low probability of detecting leachate-polluted groundwaters at this point before widespread, off-site groundwater pollution occurs by landfill leachate. Based on the work of Dr. Cherry and his associates, a two-foot long line source of leachate, such as would occur from a rip, tear or point of deterioration in an FML, would be expected in a sand aquifer system to spread laterally to about ten feet within 150 meters of the source.

The typical leachate-polluted groundwater plumes developed initially from an FML-lined landfill liner failure would be finger-like with limited lateral spread near the landfill. This means that since the typical groundwater monitoring well used for monitoring groundwater pollution by landfill leachate where three borehole volumes are purged prior to sampling, that the monitoring well samples groundwater only within about a foot of the well. If the monitoring wells are spaced 200 feet apart, which is close for many groundwater monitoring systems for Subtitle D landfills, there is 198 feet between each well where leachate plumes generated by initial leakage through the landfill liner system can pass without being detected by the wells. Dr. Cherry developed Figure 1 to show this relationship.

Therefore, the basic premise of the US EPA Subtitle D regulations that the inevitable failure of the single composite liner from preventing leachate from passing through it for as long as the wastes represent a threat would be detected with a high degree of reliability before widespread offsite groundwater pollution occurs is fundamentally flawed. The groundwater monitoring systems that are used today at Subtitle D landfills with monitoring wells spaced hundreds or more feet apart are highly unreliable in detecting the pollution of groundwaters by landfill leachate at off-site properties where there is an inadequate landfill owner-owned bufferland between the edge of the waste management unit and adjacent properties.

Unfortunately, the US EPA in developing Subtitle D and most state landfilling regulations allow landfilling of waste essentially up to the property line. This means there is no bufferland space between where the initial leakage of leachate through the liner system occurs and off-site/adjacent property groundwaters are located that can be polluted by landfill leachate. The authors are involved in several classical sanitary landfill investigations where small area sources of constituents, such as the dumping of chloroform into the landfill for waste disposal, has occurred. These landfills have produced chloroform plumes that extend over a mile from the landfill. These plumes exist in sand and gravel aquifer systems which are not atypical of many aquifers where Subtitle D landfills are located.

The situation could be much worse in a fractured rock aquifer system, where as described by Haitema (1991)

- *"An extreme example of Equation (1) (aquifer heterogeneity) is flow through fractured rock. The design of monitoring well systems in such an environment is a nightmare and usually not more than a blind gamble."*

\* \* \*

*"Monitoring wells in the regional aquifer are unreliable detectors of local leaks in a landfill. "*

While the initial work of Cherry, pointing out the deficiencies in groundwater monitoring of lined landfills was not widely recognized, today, as a result of subsequent publications by a number of individuals such as Parsons and Davis (1991), Lee and Jones-Lee (1994 ) and others, the highly significant deficiencies in the typical groundwater monitoring approach that is proposed by landfill applicants and allowed by regulatory agencies is well understood. It has been the authors' experience that typically the regulatory agency personnel and boards have chosen to ignore this situation and proceed as though flexible membrane lined-landfills where leachate leakage occurs throughout the entire bottom area of the landfill and a few groundwater monitoring wells spaced hundreds to a thousand or more feet apart can be expected to comply with Subtitle D requirements of ensuring that the concentrations of constituents in Table 1 are not exceeded in the uppermost aquifer at the point of compliance.

### *Professional Competence*

The current landfill groundwater monitoring program development approach is basically the ostrich approach in which the professional consultants who recommend this type of monitoring and the regulatory agencies who approve such monitoring are carrying out their responsibilities in a technically incompetent manner. Both consultants to landfill applicants and regulatory agency staff are required to use high-quality science and engineering in carrying out the responsibilities with respect to the development of a landfill. To ignore, as is typically done, the grossly inadequate groundwater monitoring that is occurring at Subtitle D landfills will ultimately represent significant liabilities to the consultants and to the regulatory agencies. This consultant liability arises from the fact that the consultant is signing off on the landfill projects as complying with regulations when they only meet minimum prescriptive standards for design, but obviously do not conform to the Water Resources Control Board's Chapter 15 and Landfilling Policy which incorporates US EPA Subtitle D requirements of protecting groundwaters from impaired use for as long as the wastes in municipal solid waste "dry tomb" landfills will be a threat-effectively, forever. The liner cover and groundwater monitoring systems will not prevent leachate from being generated and leaving the landfill and being detected at the point of compliance for groundwater monitoring for as long as the wastes will be a threat.

The current approach for development and implementation of groundwater monitoring systems for minimum Subtitle D landfills focuses considerable resources on collection and analysis of chemicals in vertical monitoring wells at the point of compliance as well as upgradient from the landfill. Comprehensive statistical procedures have been developed to determine when an increase in a waste-derived constituent above background has occurred. While such approaches are appropriate, they fail to address the fundamental issue of the overall reliability of the groundwater monitoring system being used. The issue that should be first addressed is whether the groundwater monitoring well array is a reliable array for a particular site to detect leachate-polluted groundwaters at the point of compliance. The approach that is used today of ignoring this essential step in developing groundwater monitoring programs for lined landfills is highly inadequate and technically invalid.

### *Recommended Approach*

There is need to immediately terminate the facade that exists today in the permitting of Subtitle D landfills with respect to the reliability of the groundwater monitoring systems that are being allowed in detecting leachate-polluted groundwaters before they cause off-site groundwater pollution. There is need to immediately change how groundwater monitoring programs are developed for lined landfills. The current seat-of-the-pants approach for designing monitoring systems in which a few monitoring wells are arbitrarily installed along the point of compliance must stop. Regulatory agencies must start requiring that landfill applicants, through their consultants, develop a reliable estimate of the reliability of the groundwater monitoring system proposed for the landfill in detecting leachate-polluted groundwaters at the point of compliance. These estimates should be based on a site-specific evaluation of the initial size and lateral spread of leachate pollution plumes produced from leaks at any location through the landfill liner system, including near the downgradient edge of the waste management unit. Development of this type of information will show that the typical groundwater monitoring system being permitted today for minimum Subtitle D landfills cannot comply with either Chapter 15 or Subtitle D groundwater monitoring requirements.

The state of Michigan addressed this problem several years ago and adopted a double composite liner for municipal solid waste landfills in which there is a leak detection system between the two composite liners. The lower composite liner is not a containment liner, but is the base of the leak detection system for the upper composite liner. As discussed by Lee and Jones-Lee (1994), this approach can be an effective approach for preventing groundwater pollution by Subtitle D landfills provided that the landfill owner is required to take the necessary action to stop leachate leaking through the upper composite liner when it occurs. Because of the impossibility of repairing the liner, this action would likely involve repairing the landfill cover. Since Subtitle D landfill covers are not designed to prevent moisture from entering the wastes and since their ability to control moisture input to the landfill will deteriorate significantly over time and this deterioration cannot be observed through visual inspection of the landfill surface, the approach that should be followed is to install a leak detectable cover over the landfill that the landfill owner operates and maintains in perpetuity, i.e. for as long as the wastes in the landfill will be a threat. The key to this type of operation is the development from

disposal fees of a dedicated trust fund of sufficient magnitude to operate and maintain the leak detectable cover. Lee and Jones-Lee (1994) recommend that if a landfill owner is unable or unwilling to stop leachate from being found in the leak detection layer between the two composite liners, then the landfill owner must exhume (mine) the wastes and properly manage them at a geologically suitable site where there are either no groundwaters or natural protection of the groundwaters that could be polluted by landfill leachate.

The additional costs of these systems compared to the conventional minimum Subtitle D MSW land filling is estimated to be from 10 to 20 cents per person per day more for solid waste management than is being paid under minimum Subtitle D landfilling. This is a small cost compared to the large Superfund-like costs that will ultimately have to be borne by future generations in groundwater clean-up at minimum Subtitle D landfills, potential damage to public health of those within the sphere of influence of the landfill and the lost groundwater resources that will occur because of leachate pollution.

### *Summary*

Today's minimum Subtitle D groundwater monitoring systems are fundamentally flawed in complying with Subtitle D requirements of protecting groundwaters from impaired use by MSW landfill leachate for as long as the wastes in a "dry tomb" landfill will be a threat. The typical groundwater monitoring well array being allowed at Subtitle D landfills today has a low probability of detecting landfill leachate-polluted groundwaters at the point of compliance before trespass of leachate-polluted groundwaters occurs under adjacent properties. There is immediate need to require, as part of permitting a Subtitle D landfill, that the landfill applicant critically analyze the expected reliability of the groundwater monitoring system in complying with regulatory requirements of preventing groundwater pollution beyond the point of compliance. Such an analysis would show for many Subtitle D landfills that vertical monitoring wells spaced more than about ten feet apart at the point of compliance cannot comply with Subtitle D groundwater monitoring requirements.

Alternative, more reliable groundwater monitoring approaches are available, such as those adopted by the state of Michigan, in which a double composite liner is used where the lower composite liner is a leak detection system for the upper composite liner. This approach, if properly funded and implemented in perpetuity, could significantly improve the monitoring of landfill liner failure over that being achieved today. The cost of this approach is from 10 to 20 cents per person per day more for waste disposal than is being paid now for minimum Subtitle D landfilling. Payment of these costs now will be highly cost-effective in terms of protecting groundwater resources for use by future generations and preventing Subtitle D Superfund site clean-up costs that will evolve from most of the Subtitle D landfills that are being developed today.

### *Additional Information*

Additional information on these topic areas is available from the authors' web site (<http://members.aol.com/gfredlee/gfl.htm>).

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## **Call for Nominees for Board Members**

If the proposed bylaw changes were accepted by the general membership at the Annual Meeting, GRA will be expanding their number of Board Members from seven to eleven. If you would like to be nominated for a 1-3 year term, send a one page statement about your interest in the position to Anthony Saracino, Chairman of the Board, or to any Board Member. It is hoped that Branch Presidents will become future Board members to improve the communication between the branches and the statewide board. The bylaws may be further changed to institute this procedure.

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