

HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION
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Emerging Contaminants in Groundwater: A Continually Moving Target — Symposium Highlights and Summary

BY ELISABETH L. HAWLEY, P.E. AND RULA A. DEEB, PH.D.,
MALCOLM PIRNIE, INC.

Unregulated and emerging chemical contaminants present numerous technical and institutional challenges to society and to environmental and public health professionals. Over the past four decades, increasingly sensitive analytical techniques have chronicled the emergence of specific chemicals in actual or potential sources of drinking water. As our ability to detect these agents has improved, the number of contaminants regulated under various environmental statutes has also increased, and the universe of regulated agents has grown dramatically. Despite these advances, many contaminants remain unregulated, and environmental professionals must make difficult risk management decisions regarding water is-



Symposium Planning Committee. From L to R, Dr. Rula Deeb (Malcolm Pirnie), Dr. Reid Bowman (Applied Process Technology), Elisabeth Hawley (Malcolm Pirnie), Dr. Andy Eaton (MWH Laboratory), Phyllis Stanin (Todd Engineers), Tom Mohr (Santa Clara Valley Water District) and Dr. Jennifer Nyman (Malcolm Pirnie)

issues in the face of considerable regulatory uncertainty. Emerging chemical contaminants, such as industrial solvent stabilizers, fuel oxygenates, disinfection byproducts, pharmaceuticals, personal care products, pesticides/herbicides, and other persistent compounds, illustrate many technical and institutional challenges. While technologies are available to remove many of these contaminants from water, such technologies are often expensive, and costs may not balance the estimated reduction in risk. Risk management decisions in the future will require more complex assessments of the vulnerability of a water supply source to unregulated contaminants, and an analysis of the appropriate combination of

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treatment processes in the context of water quality uncertainties to meet both current and future hazards.

In response to the challenges posed by emerging contaminants in water, the 18th Symposium in GRA's Series on Groundwater Contaminants was held on June 7 and 8, 2006, at the Hilton Hotel in Concord, California. The symposium was dedicated to the topic of emerging groundwater con-

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The Groundwater Resources Association of California is dedicated to resource management that protects and improves groundwater through education and technical leadership.

2006 Legislative Summary

Prop. 1E- Flood Control:	Passed
Prop. 84- IRWM Planning:	Passed
SB 1640- Groundwater:	Vetoed

Details on page 6



President's Message

BY THOMAS K.G. MOHR

Technical Leadership in Groundwater Management

The Groundwater Resources Association of California continues to grow in many directions. 2006 has been a solid year for GRA, with growth in membership, the quality and scope of GRA's professional symposia and courses, and GRA's voice in advocating for the role of sound groundwater management in a balanced state water supply policy. The symposia GRA stages continue to serve the membership well, according to feedback obtained from evaluation forms and the much appreciated verbal comments and e-mails. This comes as no surprise, given that the committees who organize our symposia are made up from members willing to spare some time to share their ideas for how best to cover a topic.

GRA's events are pretty well assured to satisfy the interests of our members because it's the members who organize the subject matter, select the invited papers, and review the abstracts. The result is that GRA's events are contemporary and highly relevant, and we've often managed to include roundtable panel discussions reflecting ongoing debates on groundwater controversies. At Perchlorate 2006, we managed to bring to one table the legal counsel from both sides of a recently concluded case, as well as key stakeholders. GRA has frequently established a neutral forum to enable discussion of topics in the regulatory arena, bringing together regulators and regulated parties in a set-

ting where the merits of positions can be considered apart from the interests of a particular case. The exchange of ideas and lessons learned from field experiences strengthens our collective wisdom, and has on occasion led to a shift in positions and attitudes. Participating in the creation of a dynamic forum for advancing understanding on groundwater issues has proven to be its own reward, as is evident from the pattern wherein those who serve on one committee invariably return to serve on another.

If it were necessary to choose one term to describe GRA's membership, "diverse" is apt. How best to serve a group whose members include geologists, engineers, planners, attorneys, chemists, toxicologists, managers, service providers, equipment vendors, regulators, water purveyors, and more? GRA seeks to cover all the bases by hosting a diverse array of events staged at a variety of locations throughout California. In 2006, GRA covered perchlorate, nitrate, and emerging contaminants, marginal groundwater and a host of other topics at our annual meeting, two groundwater modeling courses, a hydrology class, high-resolution site characterization and monitoring, and our annual legislative symposium. GRA hosted events in San Jose, Modesto, Sacramento, Redwood City, Concord, San Diego, San Francisco, and Long Beach in 2006. In 2007, GRA seeks to answer to the diverse needs of our membership with symposia and courses on groundwater law and policy, isotope hy-

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Save the Date

GRA Legislative Symposium and Lobby Day

All Day at the Capitol

MARCH 20, 2007

Agenda will include:

- ◆ Kick-off with morning Keynote by groundwater industry leader
- ◆ Briefings on important current legislative issues of interest to groundwater professionals
- ◆ Dialogue with key legislators on the future of California groundwater
- ◆ Lunch Keynote to be delivered by Legislator
- ◆ More dialogue with key legislators on the future of California groundwater
- ◆ Visits with legislators and decision makers, including your local representatives to educate them on the concerns and technical expertise of GRA members ◆

Upcoming Events

GRA Groundwater Law & Policy Conference

MARCH 2, 2007

HYATT REGENCY EMBARCADERO, SAN FRANCISCO

The Groundwater Resources Association of California's First Annual Groundwater Law & Policy Conference will be held March 2, 2007, at the San Francisco Hyatt Regency Embarcadero Hotel.

Led by Hatch and Parent's Stephanie Hastings and Steven Hoch, this event will keep you current on developments in California Groundwater Law. California's foremost experts on the law affecting the management and use of groundwater will be on hand to provide detailed and relevant presentations on:

- ◆ Recent changes in the law affecting groundwater supply and quality issues
- ◆ Legal controversies in groundwater: basin adjudication, regulation of aquifer storage and recovery, contaminant disputes, and more

- ◆ Practical legal mechanisms for groundwater use and management
- ◆ Analyses of the availability of groundwater for future development and associated legal issues
- ◆ Many more topics to be announced.

A full program will be announced in mid-January. Be sure to save March 2, 2007 for this event; sign up now to be notified when the full program and registration becomes available: <http://www.grac.org/joinemail.asp> MCLE credit will be available for this conference.

For more information or to join a growing number of water attorneys who recognize the value of membership in GRA, please visit GRA's website at www.grac.org or call 916-446-3626. ◆

Mark Your Calendar!

2007 GRA Events

Groundwater Law and Policy Conference

March 2, 2007 – San Francisco

Isotope Methods Course & Applications Symposium

March 28-29, 2007 – Concord



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Antelope Valley Adjudication Completes Basin Boundaries Trial

BY MICHAEL FIFE,
HATCH & PARENT

On October 10-12, 2006, the Court in the Antelope Valley groundwater adjudication heard evidence concerning the establishment of the boundaries of the area to be adjudicated. The primary question at issue in the hearing was whether the McCarren Amendment requires the adjudication of the watershed area, or whether a more traditional groundwater basin boundary is sufficient.

The McCarren Amendment is a federal statute that waives the sovereign immunity of the federal government in the event of a comprehensive stream adjudication. The federal government has been named as a party in the Antelope Valley adjudication because of the presence of Edwards Air Force Base. Edwards occupies a large portion of the surface area of the Antelope Valley arguably making the federal government a necessary party to the adjudication.

The Department of Justice (DOJ) has taken the position that in order to comply with the McCarren Amendment, that is, in order for the adjudication to be "comprehensive," it must involve not just the groundwater basin, but also the surface water sources that act as recharge to the groundwater basin. DOJ argues that since virtually no recharge occurs in the Antelope Valley due to precipitation on the Valley floor, the groundwater supply in this basin is particularly susceptible to interference from activities that occur outside of the basin, but within the watershed. Not including the watershed therefore creates

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Technical Corner

Using Pharmaceuticals and Protective Care Products as Forensic Indicators

BY WILLIAM E. MOTZER, PH.D., PG, TODD ENGINEERS

Introduction

Pharmaceuticals and Protective Care Products (PPCP), a large class of organic chemicals, have been designated as emerging contaminants because they are disposed or discharged to the environment on a continual basis from domestic and industrial sewage, including septic sewage, landfills, and wet weather runoff. PPCPs include pharmaceutical drugs, cosmetics, household and industrial chemicals, organic and wastewater contaminants, and nutritional supplements. Some of these compounds are very persistent in the environment and therefore could be potential forensic tracers.

Classification

There are three classes of PPCP chemicals:

Pharmaceuticals are chemicals formulated into drugs for treatment of diseases (cure/mitigation), as chemopreventatives (chemicals that reduce chances of disease or slow its onset; e.g., tamoxifen for breast cancer), or those that enhance health or structural functioning of the human body (e.g., by use of steroids and hormones). They also include diagnostic agents (e.g., X-ray contrast media), illicit (recreational), and veterinary drugs.

Protective Care Products include cosmetics (e.g., hairsprays), fragrances (e.g., musks), soaps, detergents, insect repellants, sun-screen agents, skin anti-aging preparations, and disinfectants.

Nutriceuticals are bioactive chemicals contained in nutritional supplements.

Excluding antimicrobials and steroids, over 50 individual PPCPs exist with more than 10 classes of therapeutic agents. These range from simple low molecular mass compounds to large, complex molecules, and from inert to extremely bioactive compounds. Production is worldwide in quantities ranging from kilograms to thousands of metric tons per year for some individual PPCPs.

Environmental Sources

PPCPs may enter the environment through several different routes, including:

- (1) Sewage and domestic wastes;
- (2) Disposal via municipal refuse in landfills that leach to groundwater;
- (3) Storm water overflow from residential sources, "straight piping" disposal, and disposition of massive quantities of drugs contributed for humanitarian purposes largely to third world countries; and,
- (4) Recharge of groundwater from tertiary (and higher) treated waste water.

Environmental Transport/Fate in Soil and Groundwater

PPCP environmental transport and fate is quite variable depending on the individual chemical. Some PPCPs are produced in small quantities, are highly soluble, are readily degradable, are difficult to analyze, and have very small detection limits (occurring in nanogram per liter or part per trillion quantities). These PPCPs would not make good groundwater tracers. Other PPCPs are

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2006 Legislative Summary

BY GRA LEGISLATIVE COMMITTEE

The 2005-06 Legislative Session adjourned August 31, 2006. Senate Pro Tem Don Perata claimed the Legislature “defied political physics” by having a very productive session in an election year. Among the rare feats accomplished this year was an on-time state budget, an infrastructure package of bonds placed on the ballot by the Legislature, a groundbreaking bill to combat global warming and a bill to create competition in the cable television industry.

In January Governor Schwarzenegger released his Strategic Growth Plan to rebuild California. The theme of the Governor’s State of the State address was, “I say build it!” Following the release of the Plan, weekly hearings were convened by the Senate Natural Resources and Water Committee to take testimony on the finer points of the water infrastructure proposal. It became clear to legislators over the course of the month of hearings that there is a great need for funds to improve water infrastructure, however, the big question on the table is who is going to pay for it. The Governor’s proposed water user fee was flatly rejected by the Legislature and the Legislature was unable to place a comprehensive water bond on the ballot.

The Legislature and the Governor did agree to place four infrastructure bonds on the November ballot, which the voters passed by a wide margin. Specifically, the measures are: Proposition 1B, \$19.9 billion for transportation (passed 61%-38%); Prop. 1C, \$2.9 billion for affordable housing (passed 57% -42 %); Prop. 1D, \$10.4 billion for schools (56% -43%); and Prop. 1E, \$4.1 billion for flood control (passed 64% - 36%).

California Legislative Corner

In addition to the infrastructure bond package placed on the ballot by the Legislature and Governor Schwarzenegger, environmental groups were able to place a bond on the ballot via signature gathering, Proposition 84, which passed by a 53%- 46% margin. Prop. 84 has \$1 billion for Integrated Regional Water Management Planning. The Department of Water Resources has stated that it will conduct hearings in 2007 to address some of the issues and concerns that have been raised with the Integrated Regional Water Management Planning Program. Prop. 84 also contains \$60 million for Groundwater Cleanup Loans and Grants, administered by the Department of Health Services.

With the election only days behind us, efforts are already underway to develop a water bond for the 2008 ballot. Hatch & Parent has had preliminary discussions with legislators and others that are working to develop a water bond package that stresses water supply and infrastructure needs that were not addressed by Prop. 84.

The 2006 Legislative Session demonstrated that surface storage remains the “third rail” of water politics. As a result of environmental objections to surface storage, groundwater storage and conjunctive use is being lauded by many as the preferred storage alternative to help meet California’s future water needs.

In the specific area of groundwater legislation the most significant bill of 2006 was Senate Bill 1640 by Senator Sheila Kuehl. GRA actively supported SB 1640 and worked closely with Senator Kuehl’s staff and other policy experts in the Capitol to help craft this legislation. The bill was once again vetoed by Governor Schwarzenegger. Following is a summary of this important legislation.

SB 1640 was identical to the enrolled version of SB 820 authored by Senator Kuehl in 2005, which Governor Schwarzenegger also vetoed, with two important exceptions.

- It removed the groundwater reporting requirements some found objectionable and instead established a locally based groundwater monitoring program.
- It improved the agricultural water planning provisions developed in conjunction with the Agricultural Water Management Council.

SB 1640 removed the groundwater reporting requirements that the Governor found objectionable in SB 820 and instead established a groundwater monitoring program that is consistent with the following goals:

- That all groundwater basins and sub-basins be regularly and systematically monitored locally for groundwater elevations and that the groundwater data be made freely and widely available.
- That, for those groundwater basins and sub-basins not being locally monitored, voluntary cooperative groundwater monitoring associations be allowed to form to monitor groundwater elevations.
- That, for those groundwater basins and sub-basins not being locally monitored, as a last resort, and only after DWR demonstrates to the Board of Mining and Geology that the existing monitoring network is insufficient to demonstrate seasonal and long term trends in groundwater elevations, DWR be authorized to monitor groundwater elevations and to assess a fee to well owners within the DWR monitored area to recover its direct costs.

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USEPA Happenings

BY JOHN UNGVARSKY

Ground Water Rule

EPA has finalized the Ground Water Rule! The rule provides increased protection against microbial pathogens in public water systems that use ground water sources. EPA is particularly concerned about ground water systems that are susceptible to fecal contamination, since disease-causing pathogens may be found in fecal contamination. The rule applies to any public water system that utilizes ground water and any system that mixes surface and ground water if the ground water is added directly to the distribution system and provided to consumers without treatment. For more information, go to: <http://www.epa.gov/safewater/disinfection/gwr/index.html>.

Underground Injection Control and Carbon Dioxide Sequestration

EPA has created a new web site discussing geologic sequestration - - the process of separating and capturing carbon dioxide (CO₂) from a source and injecting it through a well into the deep subsurface. Underground injection of CO₂ for the purpose of sequestration is regulated under the Safe Drinking Water Act by the Underground Injection Control program. Because the earth has widely-distributed geologic formations which have the capacity to contain and store the injected CO₂, geologic sequestration may become a major technology used to mitigate climate change. For more information, go to: http://www.epa.gov/safewater/uic/wells_sequestration.html.

Efforts Identify and Distinguish Military, Non-Military, and Natural Sources of Perchlorate

Current estimates indicate perchlorate is present in groundwater in at least 30 states and may affect the drinking water supplies of more than 20 million people in the southwestern United States. While

perchlorate in water supplies has long been attributed to the Department of Defense, National Aeronautics and Space Administration, and defense contractor facilities, non-military sources of perchlorate also have been documented. With support from various federal agencies, researchers are identifying and assessing anthropogenic and natural sources of perchlorate as well as developing and demonstrating innovative tools capable of distinguishing perchlorate origins. For more information, go to <http://www.serdp.org/upload/06%20Summer.pdf>.

2007 Ground Water Summit

The 2007 Ground Water Summit will be held in Albuquerque, New Mexico from April 29-May 3, 2007. The National Ground Water Association, USGS and GRA are among the sponsors. The event will engage local, national, and international science partners in a setting that facilitates the exchange and dissemination of technical information and new science developments, allows a means for discussion of policy and regulatory issues pertaining to ground water, and

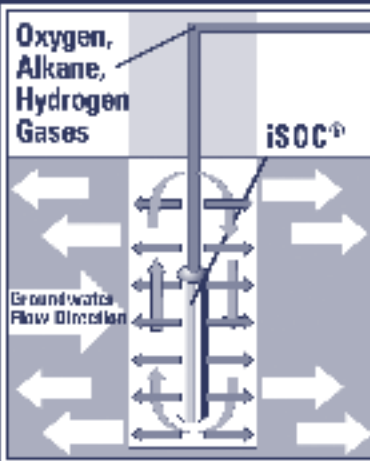
promotes goodwill between scientists and engineers worldwide. For more information, go to: <http://www.ngwa.org/e/conf/e/conf/0704295095.cfm>.

Contaminant Candidate List 3 Nominations

EPA has begun the process of developing the third Contaminant Candidate List (CCL3) to help identify unregulated contaminants that may require a national drinking water regulation in the future. The CCL3 contaminant nominations process is an opportunity to provide information on contaminants you think should be considered for the CCL. The Agency will also accept nominations until midnight December 15, 2006. For more information, go to: <http://www.epa.gov/safewater/ccl/ccl3.html>.

John Ungvarsky is an Environmental Scientist at the U.S. Environmental Protection Agency, Region 9. He works in the Water Division's Ground Water Office and oversees source water protection efforts in CA and NV. For information on any of the above topics, please contact John at 415-972-3963 or ungvarsky.john@epa.gov.

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Really Serious Groundwater Contamination

BY BART SIMMONS

In the last edition of Hydrovisions, Tom Mohr wrote about the “contaminant du jour” syndrome and the role of bored chemists in discovering novel groundwater contaminants. Well, this not-so-bored chemist has a real problem and a real solution. The problem is a familiar one – arsenic. The solution, however, is relatively new – treatment with sand filters. Arsenic is clearly a major problem. Epidemiologists measure the relative toxicity of substances by attributable risk, which is a measure of how much disease and death can be attributed to a specific cause. On a global basis, arsenic has a huge attributable risk compared with other groundwater contaminants. Bangladesh and Vietnam have truly toxic levels of arsenic due to both natural and anthropogenic effects. In the case of Bangladesh, a well-intended effort to provide groundwater from tube wells as

an alternative to pathogen-contaminated surface water led to the unintended (and unpredicted) poisoning of millions of people. As discussed previously in this column, a significant effort has been made to screen wells using field test kits and visibly identify those producing arsenic above the current World Health Organization (WHO) limit of 10 µg/L.

What’s the best treatment method for developing countries? Iron oxides provide an effective, but not necessarily practical, treatment option. In a well designed treatment plant, iron oxides may add an important arsenic removal step, but crude treatment of groundwater with iron oxides may produce colored rice and stained clothing. A newer treatment uses sand filters (*Environ. Sci. Technol*, 2006, 40, pp 5567-5573). It’s surprising that sand filters work as well as they do – the removal was more effective than predicted by coprecipitation experiments with artificial groundwater. Iron obviously plays a role in arsenic removal, since the removal efficiency increases with iron concentration. This leads to the fortuitous result that sand-

Chemist’s Corner

filtered water appears cleaner because of the iron removal, even though the arsenic concentration is not apparent. In fact, residents of rural areas in Vietnam began using sand filters to remove iron and improve the taste. Subsequent investigation found that the filters were also removing arsenic.

Vietnam, like Bangladesh, has an arsenic issue because of the use of tube wells in the 1990s as an alternative to using surface water. The anoxic groundwater is high in dissolved Fe(II), and the typical ratio of As(III) to total arsenic is 0.55. The removal of arsenic is apparently dependent on oxidation of Fe(II) by atmospheric oxygen, oxidation of As(III) to As(V) and subsequent sorption of both arsenic species on hydrous ferric oxide; however, additional research is needed to confirm this mechanism. Local conditions, including Mn, Fe, As, and dissolved organic matter can affect the efficiency of arsenic removal.

The poisoning of millions of people is, by any account, a real groundwater issue, and not another case of “contaminant du jour.” Sand filters may not be an acceptable technology to meet the stricter water quality standards of California or the U.S., but they may be a good interim technology until a more cost-effective solution is found.

Bart Simmons can be reached at bartonps@aol.com. 💧

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National Ground Water Research and Educational Foundation Awards First-Ever Grants

BY CLIFF TREYENS, NGWA

The National Ground Water Research and Educational Foundation has awarded three grants totaling \$14,000 for projects exploring MTBE, the use of nanoscale iron in remediation, and the sustainability of ground water resources. These grants, the first ever from the Foundation's Research Fund, were made following a blind review by a panel of evaluators selected from the membership of the National Ground Water Association.

The following projects were funded:

- ◆ **MTBE: Will It Ever Disappear?** Lead researcher: John M. Peckenham, University of Maine, Orono. This proposal will provide needed measurements to determine the lag between changing fuel composition and the disappearance of MTBE from ground water. It will examine the spatial distribution and persistence of MTBE in a setting with a well-documented MTBE contamination in ground water. This project is a continuation of a collaborative effort between the University of Maine, the U.S. Geological Survey, and the Maine Dept. of Environmental Protection.
- ◆ **Nanoscale Iron for the Remediation of Chlorinated Hydrocarbon Source Zones.** Lead researcher, Gwynn R. Johnson, Ph.D., Portland State University, Portland, Oregon.

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Alliance Corner

California Groundwater Association Notes

BY MIKE MORTENSSON, CGA EXECUTIVE DIRECTOR

CGA Holds Session on Annular Seals

CGA expanded its educational offerings at the recent 58th Annual Convention and Trade Show in Lake Tahoe, Nevada. An all day Annular Seal technical workshop drew almost 50 participants, with presentations on laws and standards, equipment and installation, sealing materials, local agency requirements, inspections and testing. Presenters included Jeremy Wire, Geoconsultants, Inc.; Carl Hauge, DWR (ret.); Jim Piasecki, CETCO; Don Huckfeldt, Huckfeldt Well Drilling and Liz Karis, Monterey County Env. Health Dept and CEHA representative. Expanded seminars were also offered on well development, well rehabilitation, geology and groundwater hydrology, motor controls, well disinfection, water treatment and well sealing cements. Demonstrations of tools of the trade and rigging and forklift safety were also offered as was the NGWA McEllhiney Lecture "The Basic Drill Rig for your Geology" given by Fred McAninch.

CGA Elects New Officers

CGA members recently confirmed the organization's officers for 2007. Augie Guardino, Guardino Well Drilling is the 2007 CGA President. John Kratz of Multi Water Systems is the new Vice President while Bruce Hunter of Sam Jorgenson Pump will handle Treasurer duties. They had previously served in other Executive Committee capacities. Joining the Executive Committee as CGA Secretary is Gary Mickelson of Jerry & Don's Yager Pump and Well. Jim Loughlin of Weeks Drilling and Pump is the Immediate Past President.

Jeremy Wire Gets Award

In 1992 CGA established the Jeremy Wire Award to recognize outstanding technical contributions to the groundwater industry. The first award was given to Jeremy Wire of Geoconsultants, Inc. for his long time commitment to improving the California groundwater field. But Jeremy did not rest on his laurels but continued to serve other groundwater professionals as a member of the CGA Standards and Education Committees. He assisted in CGA/EPA/CEHA workshops for regulatory personnel. For those continuing efforts, Jeremy was surprised again this year by receiving the CGA Technical of the Year award.

Joint Water Well Info Task Force

The Joint Well Info Task Force formed by CGA and GRA earlier this year has been "on hiatus" during the busy part of the year. The group is composed of the following representatives: David Abbott, Mike Duffy, John Hofer, Tom Johnson, Dave Landino, Jim Loughlin, Mike Mortenson, Tim Parker, Steve Phillips. Earlier efforts focused on quality of information, uses of well information and transmittal methods. With the onset of winter rains, the task force plans to reconvene to continue its work. Watch for further reports in future *HydroVisions*. ◆

Lifetime Achievement Award and Kevin J. Neese Awards presented at Annual Meeting

On September 21, 2006 at GRA's annual meeting, president Tom Mohr presented two annual GRA awards. The *Lifetime Achievement Award* was presented to Glenn A. Brown and the *Kevin J. Neese Award* was presented to California State Senator Sheila Kuehl.

Lifetime Achievement Award:

Glenn Brown has been continuously practicing in our field since he graduated with a degree in geology from UCLA in 1951, resulting in an active career of over 55 years and still counting! His contributions include state civil service, consulting, and professional service. Glenn has the distinction of holding certificates as California Registered Geologist No. 4 and Certified Engineering Geologist No. 3.

Glenn began his career working for the California Department of Water Resources (DWR) where he worked on dam, tunnel and groundwater investigations. During his ten years with this agency, he investigated the geology, hydrology and water quality of 46 basins in the Colorado River Basin region. He delineated and characterized 30 groundwater basins in San Diego County and 80 basins in the Lahonton and Mojave Desert Region. Glenn conducted studies of the Southern California coastal region, including



Glenn A. Brown, recipient of GRA's 2006 Lifetime Achievement Award at GRA's 15th Annual Meeting in San Diego, proudly shows off his award.

assessing groundwater storage and the feasibility of recharging imported water, that were incorporated into the California Water Plan, Bulletin No. 3. He also supervised field investigations for the routing of the Feather River Project, identified numerous dam sites for regulatory storage, and evaluated the extent of sea water intrusion in Orange, Los Angeles, and Ventura Counties. In 1958, Glenn served as Senior Geologist on the State Water Rights Board, working on the water rights litigation over the San Fernando Valley. Also during his tenure with the DWR, Glenn was requested by the U.S. State Department to assist in developing a water supply in East Africa.

For the next decade, he worked in the private consulting sector, for Hood & Schmidt, Inc., Geotechnical Consultants, Inc., Glenn A. Brown and Associates, Inc, LeRoy Crandall and Associates, and Law Environmental. His work included foreign assignments for state agencies, irrigation districts, water agencies and numerous private companies. His expertise includes engineering geology applications such as seepage and landslides, environmental audits, aquifer testing and well construction, groundwater monitoring networks,

regulatory compliance, and water rights projects, among many, many others, and he continues to provide this expertise as a private consultant. Additionally, since 2001 Glenn has served on the board of the Metropolitan Water District representing the City of Burbank and ten of its committees, most recently chairing the Water Planning, Quality and Resources Committee.

Organizational Corner

Perhaps his greatest contribution has been his service to the profession. In 1968, he was appointed to the newly created Board of Registration for Geologists by Governor Reagan, where he sat on the Professional Affairs and Technical Assistance Committees for 20 years, and helped develop the first exam for the hydrogeology certification. Also, he served on the Engineering Geologists Qualifications Boards for the City of Los Angeles and Orange County. And to all who know this fine gentleman, he effervesces with enthusiasm for groundwater issues and generously offers his

Continued on page 18

GRA Extends Sincere Appreciation to the Co-Chairs and Sponsors for its November 2006 *Tools & Technologies Series Symposium, "High Resolution Site Characterization & Monitoring"*

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As GRA approaches 2007 with nearly 1,350 members, the goal of having 1,500 members by the end of 2007 is attainable. To make this happen, please renew your membership and recruit one new member to GRA. Recruiting a new member is a way to introduce your colleagues to a credible, innovative organization that provides many benefits for only \$100.

Thank you for your interest and continued participation in protecting and improving California's groundwater resources. 💧

GRA Extends Sincere Appreciation to the Co-Chairs and Sponsors for its 2006 15th Annual Meeting, "Assessment, Use and Management of Groundwater in Areas of Limited Supply"

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Emerging Contaminants in Groundwater: A Continually Moving Target — Symposium Highlights and Summary — Continued from Page 1

taminants. The symposium attracted over 160 participants, and showcased speakers from universities, research organizations, national laboratories, regulatory agencies and industry. The symposium was organized into 7 sequential sessions which are described in detail below. In addition, a poster session and student paper competition were organized for the evening of June 7. The symposium was sponsored by Locus Technologies, Malcolm Pirnie, Inc. and MWH Labs. Lunch, reception and refreshment sponsors included RMC Water & Environment, MWH, Daniel B. Stephens & Associates, Inc. and Shaw E&I, Inc.

The conference was organized to correspond with the GRA San Francisco Branch dinner meeting, a panel discussion that focused on setting regulatory standards for emerging contaminants. The three panelists were Dr. Rhodes Trussell of Trussell Technologies, Inc., Dr. Bruce Macler from US Environmental Protection Agency (EPA) and Dr. Robert Howd of California Office of Environmental Health and Hazard Assessment (OEHHA).

Session 1: Overview of Emerging Contaminants — Technical, Political and Institutional Challenges

The symposium began with an overview of technical challenges posed by emerging contaminants, presented by Dr. David Sedlak from the University of California at Berkeley. Dr. Sedlak discussed ways that emerging contaminants are first recognized, including examination of high-volume production chemicals, discovery of biological effects, and the development of analytical techniques. Case studies including perchlorate, NDMA, estrogens and selected PPCPs were used as examples to illustrate this process.

Dr. Bruce Macler, a drinking water risk assessor from US EPA Region 9, summarized his perspective on emerging contaminants as a regulator. He summarized



Jim Strandberg, GRA Vice-President, at the evening reception on Day 1 of the conference which included a student paper competition

groups of emerging contaminants, the scarcity of data on human health effects at environmental levels, effects on aquatic organisms, and other harmful effects. He described the Contaminant Candidate List (CCL) process and status of key compounds, concluding that Federal regulation and inclusion on the CCL is premature or unlikely for many emerging contaminants.

Dr. Janis Hulla, a pharmacologist for the US Army Corps of Engineers, provided an overview of Department of Defense's (DoD's) strategic priorities for emerging contaminants. DoD is improving their responsiveness to emerging contaminants through the Materials of Evolving Regulatory Interest Team (MERIT). The MERIT program focuses on identifying, assessing, and managing DoD risks, improving science, and engaging internal and external stakeholders. A legal perspective was presented by Brian Haughton, Esq. of Barg, Coffin, Lewis and Trapp, LLP. Mr. Haughton raised several philosophical questions about our attitudes towards environmental contaminants, science and policy.

The next talk, by Jon Rohrer of Worley Parsons Komex, provided a retrospective evaluation of MTBE as a case study of an emerging contaminant. Lessons learned from MTBE data include the importance of data collection (i.e., number of releases, mass released, fate and transport) and the need to revisit predictions as data and conceptual models improve. Joseph Domagalski of USGS provided some perspective on pharmaceuticals in groundwater by relating USGS's ongoing efforts to monitor for a priority list of pharmaceuticals in the Groundwater Ambient Monitoring and Assessment (GAMA) program. Pharmaceuticals of interest were selected based on previous knowledge of occurrence, frequency of use and availability of analytical methods.

Session 2: Analytical Issues and Emerging Contaminants

The analytical challenges and recent advances in method development and approval were summarized by Dr. Jean Munch (USEPA Office of Research and Development). Dr. Munch described recent method development advances for nitrosamines, degradation products of acetaldehyde herbicides (alachlor, acetachlor and metolachlor), perfluoroalkyl compounds, and water-soluble volatile compounds. Dr. Andrew Eaton, laboratory director of MWH Labs, described the cycle of "discovery" of an emerging contaminant and the corresponding evolution of analytical methods for emerging contaminants. Dr. Eaton related the aspects of a highly evolved analytical method and used several examples to illustrate how methods for emerging contaminants have evolved over time.

Session 3: 1,2,3-Trichloropropane

During the second day of the conference, sessions focused on the latest developments and recent understanding of individual compounds, including 1,2,3-Trichloropropane (TCP), one of the more recent contaminants of concern. An overview of this compound was presented by Dr. Paul Tratnyek (Oregon Health and Science University), with an emphasis on treatment and remediation alternatives. Several case studies of 1,2,3-TCP plumes in agricultural areas of California were presented by John Fortuna of GeoSyntec Consultants to illustrate the effect of regulatory notification levels and laboratory detection limits on site management strategies. Dr. Reid Bowman of Applied Process Technology, Inc. (APT) described the biological reduction of 1,2,3-TCP and other emerging contaminants by four orders of magnitude, or to below drinking water standards, using a hollow-fiber membrane biofilm reactor (MBfR). The technology was developed by Dr. Bruce Rittman at Northwestern University and has been licensed by APT.

Session 4: 1,4-Dioxane

Conference co-chair Tom Mohr of Santa Clara Valley Water District presented an overview of 1,4-dioxane, providing background on the history of 1,4-dioxane usage, plumes in the Santa Clara Valley Water District area, analytical methods, treatment/remediation methods, and state regulatory guidance. Farsad Fotouhi of Pall Corporation described efforts to characterize and remediate a large 1,4-dioxane plume in Michigan. Shaily Mahendra of UC Berkeley demystified aerobic biodegradation of 1,4-dioxane by identifying monooxygenase enzymes, showing biodegradation pathways and bacterial strains shown to degrade 1,4-dioxane in controlled laboratory studies. Patrick Evans of CDM summarized the performance of different biological treatment reactor configurations for removing 1,4-dioxane.

Session 5: N-Nitrosodimethylamine (NDMA)

An overview of NDMA occurrence, fate and transport in California groundwater was presented by Phyllis Stanin of Todd Engineers, drawing from five different case studies. Common themes included the persistence, length and shape of NDMA plumes at each of the sites and the commonality of plume spreading by pumping. Elisabeth Hawley from Malcolm Pirnie, Inc. described an alternative source of NDMA in groundwater, namely the formation of NDMA as a disinfection byproduct when wastewater is chloraminated followed by indirect potable reuse. The talk focused on NDMA and NDMA precursor removal during wastewater treatment, and control strategies for utilities. After lunch, Matthew Davie, from Stanford University, presented findings from his doctoral research investigating metal-catalyzed reduction of NDMA using powdered Fe, Fe-Ni, Pd, Pd-Cu, Ni, and Mn catalysts. This was followed by Bill Guarini from the Shaw Group illustrating an application of catalytic treatment for NDMA- and TCE-contaminated groundwater and the bench-scale and pilot-scale using Ni catalyst.

Session 6: Pharmaceuticals and Personal Care Products

Although the occurrence of PPCPs at trace levels has been established in surface waters, the human health effects are still uncertain. Dr. Richard Pleus from Intertox, Inc. summarized an ongoing AWWA Research Foundation study to review published literature on the toxicological significance of selected pharmaceuticals, measure concentrations in water supplies, and conduct a risk assessment. Dr. Jean Moran from Lawrence Livermore National Laboratory summarized the fate and transport of wastewater indicators (e.g., caffeine, DEET, alkylphenol carboxylic acids and selected pharmaceuticals) as a tracer for recycled water to quantify the fraction of recycled water in groundwater aquifers. Dr. Peter Fox, a professor from Arizona State University, summarized the fate of different pharmaceuticals and other trace organic compounds during soil aquifer treatment, following injection of tertiary treated wastewater.

Session 7: Other Emerging Contaminants

The final session of the day broadened symposium attendees' concept of the next emerging contaminants and reminded them of the difficulty in assessing risks when little is known about chemicals of concern. Virginia Yingling of the Minnesota Department of Health related a case study investigating highly persistent and mobile perfluorinated compounds in groundwater. Dr. Eduard Hoehn of the Swiss Federal Institute for Water Science and Technology (EAWAG) shared preliminary results of a study of natural attenuation of emerging contaminants in downwelling reaches of streams augmented with recycled water. The final talk, given by Jenny Sterling of Daniel B. Stephens & Associates, Inc., addressed the nanotechnology industry as a source of new contaminants of concern as well as a useful tool for solving environmental problems. Ms. Sterling discussed the implications of nanoparticle behavior in the absence of a framework for assessing risks and setting regulations.

About the Authors

Elisabeth L. Hawley, an environmental engineer at Malcolm Pirnie, Inc. in Emeryville, CA, participated in the GRA symposium planning committee. She is working on a number of projects investigating the environmental fate and transport of emerging water quality contaminants and the effectiveness of a range of technologies for the removal of these contaminants from water resources.

Rula A. Deeb is an Associate and Director of Applied Research/Strategic Consulting at Malcolm Pirnie, Inc. in Emeryville, CA. Dr. Deeb chaired the GRA symposium on emerging contaminants. She is currently managing several projects related to emerging contaminants.

Editor's Note: This article was reduced to conserve space. The unabridged article is on the GRA website at www.grac.org/emergingcontaminants. 💧

President's Message — Continued from Page 2

drology, environmental information management systems, groundwater modeling, site closure strategies, DNAPL, and artificial recharge/aquifer storage and recovery and more. Sound familiar? 2007 will be the year of the sequels: GRA has received many requests to hold events a second or third time. Some of GRA's successful past events with repeat performances have included nitrate, arsenic, perchlorate, investigation and remediation of dry cleaner impacts, and vapor intrusion to indoor air. If the event you were hoping to see has not surfaced, perhaps GRA has not heard from you!

GRA's successes are primarily attributable to a stalwart core of volunteer Branch Officers, Directors, and Committee members. GRA is open to all who wish to contribute. If you wish to help GRA conduct its operations, there are many committees on which to serve, including committees established to organize individual events, as well as standing committees for operational activities such as membership, legislative committee, communications committee, finance, events, awards, nomi-

nations, and more. The greatest challenge to organizing events is the logistics of advertising, booking hotels, registering attendees, preparing binders, and the like. GRA's Board wisely chose to set event fees at a level sufficient to sustain a competent staff to handle the logistics, leaving the brainstorming on technical content to our knowledgeable member volunteers. GRA's Board also hired a professional Executive Director, Kathy Snelson, to guide the association through the many challenges faced by a growing organization, and to ensure consistent execution of GRA's events. Have you visited GRA's new website? Our contract webmaster, Kevin Blatt, has continued to distinguish GRA with elegant website design and solid functionality. Renew your membership online today – it's a snap!

The formula is working. Thanks to the significant contributions of GRA's hard-working Branch officers, GRA's sage Board of Directors, GRA's excellent staff, and a list of brilliant volunteers too long to include here, GRA has established itself as the pre-

miere forum for California groundwater issues. GRA has cultivated the well-deserved reputation as the "go-to" organization for groundwater matters among California's legislators and policy chiefs. Judging from a very solid trend, GRA will continue to rise as the technical leader in California groundwater management.

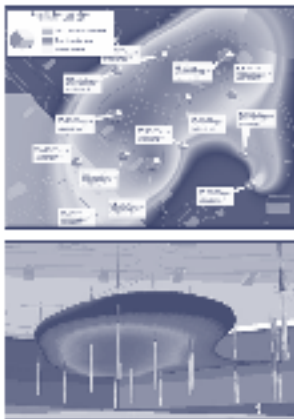
GRA encourages you to leverage your membership for all that you can obtain from it. The foremost benefit to attending GRA's excellent branch meetings and symposia is the networking contacts. Take your networking to another level by volunteering to assist your local GRA branch, or participate in a GRA committee. I look forward to serving GRA's Board, branches, and members as President in 2007, and I welcome your comments, questions and suggestions: tmohr@grac.org; 408-265-2607x2051.

Thomas Mohr is GRA's President and a hydrogeologist with the Santa Clara Valley Water District. ♠

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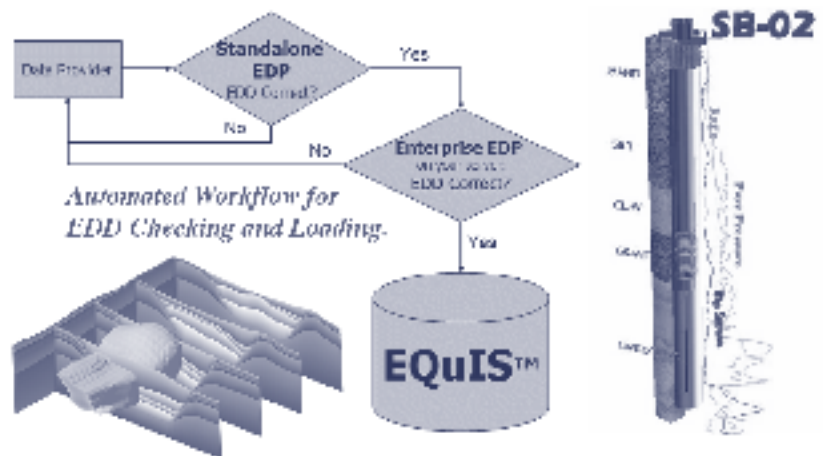
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the risk that the federal government will be subject to piecemeal litigation over the years as these activities in the watershed arise and become problematic.

The other side of the issue was occupied primarily by the municipal water suppliers. These parties did not dispute that the recharge to the groundwater basin enters the basin at the sides from the watershed area. Their argument was that the likelihood of a significant disruption to the groundwater supply arising from activities in the watershed area are remote and therefore do not pose a significant risk of piecemeal litigation. They argued that the remote possibility of future problems does not justify the significant burden that would be created by attempting to adjudicate the entire watershed area.

Perhaps the greatest number of parties took no particular position on the physical aspects of the issue and instead argued that the risk of a failure to appropriately comply with the McCarren Amendment implies that the Court should take the most conservative approach possible. According to these parties, it is better for the Court to err on the side of inclusiveness rather than run the risk that the litigation will proceed, possibly for years, only to have the issue of jurisdiction over the federal government render the whole thing moot.

On November 3, 2006, the Court issued its order rejecting the watershed approach and instead concluding that the alluvial basin as described in Department of Water Resources Bulletin 118-Update 2003 should be the basic jurisdictional boundary for purposes of the adjudication. The Court reasoned that the purpose of the adjudication is to resolve claims of parties to the groundwater in the basin. While there may be parties who use water outside of the basin but within the watershed, these parties do not assert a right to the groundwater in the basin. The court acknowledged that virtually all of

the recharge to the basin comes from the surrounding watershed area, but did not find, based on the evidence presented at trial, that the threat of interference was actual as opposed to merely theoretical. The court concluded that water users in the watershed, “. . . need not be joined absent some evidence that they . . . are claiming a right to act beyond the parameters of their permit or regulated use to interfere with recharge of the basin aquifer in a material way.” This is a quizzical conclusion as it seems to imply that there would be conditions under which a water user could interfere with the recharge of the basin, but still be beyond the reach of the adjudication.

The Court’s decision contains virtually no discussion of the McCarren Amendment, but is a complete rejection of DOJ’s position. It is not clear whether DOJ will choose to appeal the decision, but an appeal by DOJ could delay the progress of the adjudication significantly. Unfortunately, since jurisdictional defects never go away, without an appeal it is not clear how the decision will satisfy the concerns of the many parties who worry that the jurisdictional problem will create a cloud of uncertainty, and that the adjudication could be undone at any moment.

Michael Fife is a partner in Hatch & Parent’s Water Practice Group. ♣

(plotted as t/t' and residual drawdown; see page 259, *Groundwater and Wells*, 1986) can qualitatively assess whether the pumping test removed groundwater from storage, intercepted a recharge boundary, or neither.

Drawdown data from multiple nearby OWs are superior to data collected from the PW, which can be affected by well inefficiency. The water level data collected in an OW are impacted less by pump discharge fluctuations. However, to demonstrate a clear stabilized drawdown trend, the OW should have an interference impact of at least one-foot. Also, OW drawdown data are usually not influenced by PW inefficiencies, thereby allowing calculations of aquifer properties (especially the storage coefficient).

It is standard professional practice to collect and analyze both drawdown and recovery data during formal pumping tests on the PW. Sometimes drawdown data will be more representative than recovery data and vice versa. It is the specific limitations and operating parameters of the pumping tests that will determine whether recovery data or drawdown data are appropriate for the analysis.

David W. Abbott is with Todd Engineers in Emeryville and may be reached at dabbott@toddengineers.com. ♣

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manufactured in large quantities (resulting in continual environmental replacement), can be more easily analyzed because they occur in microgram per liter or part per billion quantities, do not readily degrade or produce known and detectable metabolites, and are environmentally persistent. These PPCPs may be useful as groundwater tracers.

Environmentally Persistent PPCPs

U.S. Geological Survey (USGS) research and other studies have found the most frequently detected PPCPs in surface and wastewater (Table 1). Because PPCP usage varies with type and amounts used or consumed, groundwater concentrations are not reliable indicators of contamination intensity.

PPCP Analyses and Analytical Laboratories

Many PPCP compounds do not have analytical standards, and analytical methods vary depending on compound type. However, most PPCPs are analyzed by either:

- (1) Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS);
- (2) Gas Chromatography/Mass Spectrometry (GC/MS); or
- (3) High Performance Liquid Chromatography/Tandem Mass Spectrometry (HPLC/MS/MS).

The USGS conducts analytical testing for PPCPs but only for non-commercial entities. Currently they can analyze for at least 158 emerging contaminants, including PPCPs, in aqueous samples. Few commercial laboratories exist that can analyze PPCPs in groundwater; those that do, primarily analyze drugs.

Environmental Forensics

The more persistent PPCPs may be useful source indicators, particularly for contaminants emanating from treated municipal waste water effluent and septic systems. Based on first manufactured and use dates, individual PPCP chemicals may be used to determine time of introduction to groundwater (Table 2). As in other forensic investigations, PPCPs as source indicators should be used with other environmental forensic techniques such as stable isotopes (i.e., oxygen-deuterium isotopes of water,

nitrogen-oxygen isotopes in dissolved nitrate) and tritium/helium-3 ratios to age date groundwater recharge.

In summary, additional studies on the transport and fate of individual PPCPs will lead to specific chemicals being found use-

ful in particular environments for specific purposes. This technology is in its early stages, so stay tuned!

William Motzer is Senior Geochemist with Todd Engineers in Emeryville, CA. He may be contacted at bmotzer@toddengineers.com.

TABLE 1

Some Frequently Detected PPCP Chemicals in Surface and Wastewater

<i>Chemical Name</i>	<i>CAS No.</i>	<i>General Classification</i>
caffeine	58-08-2	stimulant
carbamazapine	298-46-4	prescription drug
carbaryl	100-46-9	household and industrial chemical
cholesterol	57-88-5	plant and animal steroid and Organic Wastewater Compounds
cotinine	486-56-6	non prescription drug
N-N-diethyltoluamide (DEET)	134-62-3	insect repellent
tributylphosphate	126-73-8	household and industrial chemical
tri(2-chloroethyl) phosphate	115-96-8	fire retardant
sulfamethoxazole	723-46-6	veterinary and human antibiotic

TABLE 2

Representative Classes and Members of PPCPs Reported in Sewage Treatment Work (STW) Systems and Environmental Samples

<i>Therapeutic Class</i>	<i>Example Generic Name</i>	<i>Example Brand Name</i>	<i>OTC Date* Introduced</i>
Analgesics/non-steroidal anti-inflammatories (NSAIDs)	acetaminophen (analgesic)	Tylenol	1955
	diclofenac	Voltaren	1974
	ibuprofen	Advil	1984
	ketoprofen	Oruvail	1994 (OTC)
	naproxen	Naprosyn	1995 (OTC)
Contraceptives	17-estradiol	Diogyn	1960
	17-ethinyl estradiol	Oradiol	1960s**
Lipid regulators (anti-lipidemics; cholesterol-reducing agents and their bioactive metabolites)	clofibrate (active metabolite: clofibrac acid)	Atromid-S	1967
	gemfibrozil	Lopoid	1982
Musks (synthetic)	nitromusks	Musk xylene	1990s
	polycyclic musks	Celestolide	1951
	avobenzene	Parsol A	mid 1960s
	octyl methoxycinnamate	Passol MOX	mid 1970s
X-ray contrast agents	diatrizoate	Hypaque	1980s

Notes: *OTC = date introduced over the counter

**Naturally produced and excreted by humans and animals

Further, SB 1640:

- Removed the State Water Resources Control Board from playing any role in the groundwater reporting provisions.
- Clarified that DWR is to “defer to existing monitoring programs” and made clear that DWR may only recommend improvements to an existing monitoring program.
- Included numerous safeguards to ensure that DWR would establish a groundwater monitoring district only as a last resort, and only where the monitoring is demonstrated as necessary.
- To alleviate any fears that this bill might expand the state’s authority over groundwater rights, the bill specially states that nothing in the new groundwater monitoring provisions are to be construed to expand or otherwise affect the department’s powers or duties relating to groundwater beyond those expressly granted by the bill.

It is clear from the Governor’s veto message of SB 1640 that the main concern was how the State would fund the efforts outlined in the bill. It is likely that this will be a topic of discussion in the year ahead.

Other legislation relating to water issues is summarized below:

AB 984 by Assembly Member John Laird authorizes the Department of Water Resources to work in collaboration with the federal government and other Colorado River basin states to control or eradicate the tamarisk plant in the Colorado River basin. Tamarisk is an imported plant species that is spreading across the West including thousands of acres in the Colorado River basin. This plant species takes up more water than the native plants it replaces. Governor Schwarzenegger signed this bill.

In the area of water conservation AB 2496 (Laird) would phase in water closets and urinals that have lower flush volumes. The water community in general has an ongoing commitment to water conservation and encourages progress in this area. The statewide standards for toilet flush volume was last revised in 1992. Updating standards can potentially save California billions of gallons of water per year. Governor Schwarzenegger vetoed this bill.

AB 2951 by Assembly Member Jackie Goldberg is critically important to retail water providers to ensure the financial stability of local public agency utilities. AB 2951 would preserve the authority of

local public agencies to charge commodity rates that include a capital facilities fee component to pay for the costs of capital improvements needed to serve their customers. Governor Schwarzenegger signed this bill.

As a result of efforts in the Capitol over the past several years, GRA is well positioned as the leading voice for California groundwater. Policy makers, legislators and staff regularly consult GRA to provide information and expertise. With groundwater taking center stage in the surface water storage controversy, we anticipate a big year in 2007! 💧

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knowledge to those who care to visit with him. No other individual seems to have as much knowledge about the geology, hydrology and water resources management of the Southern California groundwater basins, as well as the key issues and the people who work in them, as Glenn Brown. GRA is pleased to recognize Glenn Brown for a lifetime of service to the groundwater profession.

Kevin J. Neese Award:

The GRA's *Kevin J. Neese Award* recognizes significant accomplishment by a person or entity within the most recent 12-month period that fosters the understanding, development, protection and management of groundwater. Kevin Neese was a partner of Hatch & Parent, A Law Corporation, and member of the GRA. This year, the *Kevin J. Neese Award* was presented to California State Senator Sheila Kuehl for her work to improve the production and availability of information about the state

of our groundwater resources, information on which reasonable and sensible groundwater management may be developed.

At the GRA's Annual Meeting and Conference in San Diego this year, Dennis O'Connor accepted the award on Senator Kuehl's behalf. Paul Bauer, Legislative Advocate for Hatch & Parent, presented the award and made the following remarks:

During the 2006 legislative session, Senator Kuehl presided over the Senate Natural Resources and Water Committee and was actively involved in the development of significant legislation affecting groundwater resources. During her



On behalf of CA State Senator Sheila Kuehl, Dennis O'Connor (left) accepts the 2006 Kevin J. Neese Award from GRA president Tom Mohr (right) at GRA's 15th Annual Meeting in San Diego.

tenure, Senator Kuehl convened weekly meetings of the Senate Natural Resources and Wildlife Committee to review every aspect of the Governor's Water Bond proposal. The hearings were devoid of the normal partisan rancor associated with proposals of this magnitude. It was clear that Senator Kuehl's Water Committee was the epicenter of all water issues.

Concurrently, Senator Kuehl authored SB 1640 relating to groundwater monitoring. Groundwater monitoring is central to the GRA's mission. After a previous version of the bill was vetoed by Governor Schwarzenegger in 2005, Senator Kuehl introduced SB 1640 and sought to address the concerns of the groundwater community. In fact, she and her staff reached out to GRA and its membership seeking advice regarding technical aspects of the bill and recommendations for improving it. The Senator's bill proposed a process for obtaining good, reliable groundwater information, and making that information available to state and local planning entities, while at the same time respecting current groundwater management processes.

Despite Governor Schwarzenegger's subsequent veto of SB 1640, the GRA is pleased to have honored Senator Kuehl's commitment and dedication to the development, protection and management of groundwater with the *Kevin J. Neese Award*. The GRA's participation in the drafting of SB 1640 bodes well for the GRA's influence and role in the development of all legislation affecting groundwater resources throughout the state.

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The presence of nonaqueous phase liquids in the subsurface environment is recognized as a significant, long-term threat to ground water resources. With the application of traditional pump and treat remediation requiring years and even decades of pumping, alternative remediation schemes are necessary to protect this vital resource. The objective of this study is to investigate the feasibility and risk of employing nanoscale iron particles for the reductive dehalogenation of chlorinated solvents, with a specific focus on nonaqueous phase liquid remediation in a two-dimensional, laboratory-based flow cell.

Assessment of Ground Water Age and Rate of Recharge Using Environmental Tracers. Lead researcher: Kurt C. Koella, Lakeshore Environmental Inc., Grand Haven, Michigan. This research will address sustainability of

ground water resources. Ground water use and diversion is a politically sensitive issue in the Great Lakes Basin, as illustrated by the December 13, 2005, Great Lakes-St. Lawrence River Basin Water Resources Compact agreement to prohibit new or increased diversions within the basin. Assessing ground water age and rate of recharge will enhance understanding of the impact of withdrawal on a local ground water system.

Established in 1994, NGWREF is operated by NGWA as a 501(c)(3) public foundation and is focused on conducting educational, research, and other charitable activities related to a broader public understanding of ground water. The Foundation is an arm of NGWA that is focused on activities related to a broader understanding of ground water. For more information on NGWA, as well as NGWREF, visit www.ngwa.org.

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Central Coast Branch Highlights

BY BRAD HERRERA
BRANCH PRESIDENT

On October 4, 2006, the Central Coast Branch welcomed Dr. David Sunding, Professor of Economics with the University of California Berkeley's Department of Agricultural and Resource Economics. Dr. Sunding gave a talk entitled "*The Economics of Groundwater Management*" regarding the economics of groundwater management, including issues of property rights, risk and sustainability. His talk set the stage for a lively discussion on the ways in which economics affect water management decisions.

On December 6, 2006, Dr. Hugo Loaiciga will be our guest. Dr. Loaiciga is a hydrologist and professor at the University of California Santa Barbara. He will speak on groundwater forces and their geotechnical and geomorphic implications. Elections for 2007 Branch officer positions will also be held. 💧

Sacramento Branch Highlights

BY STEVE LOFHOLM,
GOLDER ASSOCIATES

The April meeting featured Randy Hanson, a research hydrologist working for the US Geological Survey in San Diego, who presented the Survey's latest research into the *Hydrogeologic Framework of the Santa Clara Valley*. The Survey has been working on redefining the hydrologic framework in the Santa Clara Valley in order to evaluate the sustainability of the aquifers within the Santa Clara

Valley. The results of their research show that the Santa Clara Valley is a pull-apart basin that has dropped approximately 1,000 feet over the past 78,000 years, while also experiencing compressional tectonics from the Calaveras and Hayward Faults. The drop in the basin has resulted in the deposition of multiple, irregular, and cyclic sequences of alluvial sediments, corresponding with deposition from interglacial cycles. The USGS has discovered six major aquifers, generated during these glacial cycles, which are separated by fine-grained, low permeability units ranging from about 500 to 900 feet below land surface. Depth dependent sampling has shown that artificially recharged water is contained within the upper 500 feet of the aquifer system. In addition, their data indicates that wellbores are the main path for vertical flow between aquifer layers, and that the deepest aquifers within the valley do not appear to be recharging. The USGS generated a ground-water flow model, using the new hydrogeologic data, which demonstrates the importance of the aquifer layering, faults, and stream channels, in relation to groundwater flow and infiltration of recharge.

At the May meeting, Gary Hall and John Church, from GHH Engineering, Inc., gave a presentation titled "Uncertainty and Defensibility in Modeling." Their case study illustrated how results from various models commonly used by environmental professionals can be used by attorneys to cast doubt on the results, and in some cases, on the expert's credibility. The large number of parameters required to develop a successful model, and interpretation of the results by an expert witness, provides an attorney unique resources to discredit the model. Also, modeling technology and terminology, when used in a trial setting, can be confusing to a jury of laypersons, which the attorneys will use in their favor.

The Sacramento Branch's June meeting featured a presentation by Megan Cambridge on Brownfields. Ms. Cambridge presented a general overview on the brownfield issues and the challenges posed to communities in redeveloping brownfield

sites. These properties, identified as abandoned or underutilized where the reuse is complicated by contamination, often face financial, regulatory, and liability hurdles.

The August meeting featured "Iron Mountain Mine Superfund Site – Its Remediation and its Future." The presenter, Don Mandel, a geologist with the DTSC, has been the project manager for the remediation of the Iron Mountain Mine Superfund site for the past 11½ years. The Iron Mountain Mine (IMM) evolved from an underground gold and silver mine between 1867 and 1897 to an underground copper and zinc mine from 1896 to 1956. Finally, the Brick Flat orebody was mined by open-pit methods for sulfur from 1955 to 1963. All of this resulted in the IMM becoming a "world class" acid mine drainage (AMD) site that historically dumped over a ton of copper and zinc into the Sacramento River, which is designated the most important habitat for Chinook Salmon spawning in California. Reduction of AMD is being accomplished through a combination of total metals reduction and limiting metals releases from IMM during high flow periods. To keep meeting Basin Plan Standards, it is estimated that remedial activities will need to continue for about 3,000 years.

For the third consecutive year, the Sacramento Branch has donated \$700 to the CSUS Natural Science and Mathematics (NSM) Community Advisory Council Fund, with a matching donation of \$300 by GRA Board member Brian Lewis. This year, the GRA Board of Directors authorized a matching contribution of \$700, for a total donation of \$1,700. The NSM fund at CSUS is earmarked for the support of NSM students participating in research. Students need to write a letter of request to the Dean and have a recommendation by a faculty member within the college of Natural Sciences and Mathematics. Funds are awarded by the Dean of Natural Science and Mathematics with the advice of department chair in the College of Natural Sciences and Mathematics. 💧

San Francisco Bay Branch Highlights

BY KATRIN SCHLIEWEN,
BRANCH SECRETARY

July and August are vacation months and therefore the SF Branch did not have regular dinner meetings. To kick off the fall season, 34 members and non-members met on September 27, at the Biltmore Hotel, in Santa Clara for the South Bay venue hosted by Mark Wheeler, our South Bay Coordinator. Dr. Jean Moran, Senior Geochemist with Lawrence Livermore National Laboratory's Isotope Tracers and Transport Group, and a GRA Board Member, was our speaker. She gave an excellent talk entitled: *Groundwater Age Dating*. Her presentation reviewed the research and techniques used to esti-

mate elapsed time since groundwater has entered the saturated zone. Because theory is catching up with applied science, these techniques are becoming more acceptable to hydrogeologists as a tool to determine groundwater sources, recharge flow rates, and flow direction. Dr. Moran reviewed the methods currently used in academia to age date both old and young groundwater. These include isotopes of krypton-25, silicon-32, chlorine-36, iodine-129, and carbon-14 and chlorofluorocarbons (CFCs). However, the most useful and favored technique, at this time, is that of tritium and helium-3. Tritium is the radioactive isotope of hydrogen with one proton and two neutrons. Because of its radioactivity, it has a decay half life of 12.43 years. Tritium was incorporated in large quantities into the hydrosphere from the atomic bomb testing of the 1950s and 1960s. We know its decay rate and therefore, can estimate how much tritium remains once it enters the subsurface, where it is no longer affected by

atmospheric processes. However, tritium analysis alone has its limitations and is misleading in that the derived age dates are "qualitative" only being either pre or post modern. Tritium/helium-3 ratios are more advantageous and quantitative because helium-3 is the radiogenic daughter product of tritium and it begins to accumulate once precipitation enters groundwater. Because the tritium-helium system is complicated, corrections must be made for terrigenic (e.g., mantle-derived) helium and excess helium in the vadose zone air. Dr. Moran showed us several case studies that used the tritium/helium method for the Groundwater Ambient Monitoring and Assessment (GAMA) program and concluded her talk, noting that for young groundwater, the tritium/helium-3 method is the most robust technique currently available. 💧



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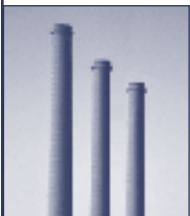
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AUGUST 30, 2006 THROUGH NOVEMBER 14, 2006

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Daly, Kristen

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Edelman, Steve
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Leserman, James
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Martin, Jim

Miller, Jeffrey
Morrison, Wendy
Morse, Lee
Nelson, Paul
O'Neil, Michael
Pak, Eugene
Pavlik, John
Pennington, Robert
Platt, Evan
Purchase, Mike
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SF Bay Region

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Stettler, Robert
Stiles, Gary
Stoddard, Robert
Swope, Jonathon
Tatnall, Tom
Thams, Peter

Thometz, Michael
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Weir, Don
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Wilson, Ed
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Dates & Details

GRA MEETINGS AND KEY DATES

(Please visit www.grac.org for detailed information, updates, and registration unless noted)

GRA Board of Directors Planning Meeting	January 13-14, 2007 Irvine, CA	GRA Course <i>Isotope Methods for Groundwater Investigations</i> GRA Symposium <i>Applications of Isotope Tools to Groundwater Studies</i>	March 28-29, 2007 Concord, CA
GRA Conference <i>Groundwater Law & Policy</i>	March 2, 2007 San Francisco, CA		
GRA Legislative Symposium & Lobby Day	March 20, 2007 Sacramento, CA	GRA 16th Annual Meeting	September 18-19, 2007 Sacramento, CA



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