

HYDRO VISIONS

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Environmental Forensics in an Era of Emerging Diagnostic Methods

By Emily Vavricka (Environmental Engineering and Contracting, Inc.),
Ioana Petrisor (Haley & Aldrich), and Steve Koenigsberg (The Adventus Group)

Environmental forensics focuses on re-construction of past contamination events and related fate and transport of contaminants in the environment. There have been major advances during the past decade in the development and application of molecular biological, isotopic and other advanced methods that can enable groundwater stakeholders and practitioners to answer some of the major questions often posed with respect to contaminated groundwater:

- Who is responsible for contamination, when did it occur and what are the sources?
- What insights can be gained with regard to remedy design and management?
- Can new lines of evidence be assembled to support accelerated closure strategies?



Conference committee from left: Elie Haddad, Emily Vavricka (Co-chair), Mary Megarry (Program Coordinator), Tom Mohr, Steve Koenigsberg and Peter Bennett

To provide a forum for sharing information and experiences on the use of classical and emerging forensic methods, GRA coordinated a one-day symposium on April 12, 2011, in Irvine, CA. The goals and objectives of the symposium were to share the results of case studies where classical forensic methods were applied, and to introduce many of the powerful new tools and emerging diagnostic techniques such as Compound Specific Isotope Analysis (CSIA) to molecular biological techniques.

More than 90 people attended this event, including groundwater consultants and engineers, regulatory agency staff, environmental attorneys, and academics. Experts from academia,

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vocal group, want to have a say in how groundwater is managed, who controls it, and how it is protected.

Like most socioeconomic issues affecting the citizens of this state, there generally are two camps of opinion on how to manage groundwater; one says the challenge is so great and complex that it requires centralized control by the state and federal governments. The other camp's position is that because of the complexity of the problem, only local control by individuals working every day to provide water to their customers can result in effective groundwater management.



Management of groundwater supplies...resides mainly at the local level and thus, by its very nature, does not address water needs from a statewide perspective." LAO, 2010

"Groundwater – Invisible No More" –ACWA, 2011

By Bill Pipes

Groundwater has fueled California's growth and economic success and has enabled Californians to literally "feed the world." Home to some of the most robust and reliable groundwater basins in the country, California has for more than 100 years relied on groundwater as a primary supply and as a critical safety net during times of drought. During the last few decades, reliance on groundwater has only increased with the combination of unrelenting growth in population and limits imposed on surface-water deliveries. In the last few years, nothing has caught the attention of those that produce, convey, manage, and regulate water in California quite like this incredible resource. Truly, groundwater is invisible no more. Given the attention being paid to groundwater in California and its increased value, it's no wonder that its stakeholders, a diverse, large, and

I would like to call your attention to two recent documents that present these two general approaches to managing California's groundwater resource. These documents are attracting widespread interest from politicians, water managers and the public, and I urge you as a groundwater professional to become familiar with the arguments presented in each—they represent the current and future battle lines being drawn over groundwater use in this state.

The first document is from the Legislative Analyst's Office (LAO), which provides fiscal and policy advice to the Legislature and serves as their "eyes and ears" to ensure that the Executive Branch is implementing legislative

policy in a cost efficient and effective manner. In March 2010, the LAO published *"Liquid Assets: Improving Management of the State's Groundwater Resources."* In this report, distributed widely to legislators and their staff, the LAO recognized the importance of groundwater to California's water supply and recommended more active management of the resource as a tool for addressing future water demand/supply imbalances. The LAO believes that the challenges ahead for managing groundwater are associated with the gaps of oversight that complicate management, including the lack of statewide regulation of groundwater use, the patchwork of state and local rules that govern proscribed aspects of groundwater, and that disparate state agencies are responsible for various aspects of groundwater management. The LAO also sees the disconnect between groundwater law and science as a challenge, noting that current law does

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"...the state Legislature should encourage and support local management policies that appropriately reflect California's geographic and hydrologic diversity..." ACWA, 2011

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"Groundwater – Invisible No More" – Continued

not acknowledge the physical connection between groundwater and surface water. To address these challenges, the LAO recommends an approach slanted towards top-down, centralized control and management from Sacramento. They recommend:

- Developing a more comprehensive groundwater monitoring system
- Establishing Active Management Areas (where specific rules are established to govern the use of groundwater)
- Bringing science and law together to modernize groundwater law
- Implementing statewide groundwater permitting.

You can find the LAO report on the web at: http://www.lao.ca.gov/reports/2010/rsrc/groundwater/groundwater_032410.pdf.

The other side of the management and control issue is well represented by the Association of California Water Agencies (ACWA), the largest statewide coalition of public water agencies in the country. ACWA's 450 public agency members collectively are responsible for 90% of the water delivered to cities, farms, and businesses in California. ACWA's report *Sustainability from the Ground Up: Groundwater Management in California - A Framework* (<http://www.acwa.com/sites/default/files/post/groundwater/2011/03/acwa-groundwater-framework.pdf>) was published in April 2011 as a companion to their *No Time to Waste – A Blueprint for California Water*, published in 2009.

Like the LAO, ACWA recognizes the importance of groundwater as a current and future source of water and that our growing dependence will continue to stress the resource unless proactive steps are taken. Similarly, ACWA also believes that a better and more comprehensive program for data collection and management is critical to groundwater basin management. However, in contrast to the LAO, ACWA believes

that there are existing mechanisms that provide an excellent foundation for sustainable groundwater management. They argue that because of the state's hydrogeologic diversity, only the local entities that produce, convey and use the groundwater can best understand local issues and local effects of management actions. ACWA believes that top-down statewide permitting and regulation would undermine the effectiveness of existing and planned local investments. For sustainable groundwater management in California to succeed, ACWA recommends that the state invest in improvements to its water storage and conveyance infrastructure to optimize both surface water and groundwater supplies.

Where does GRA stand on this issue? As an association dedicated to resource management that protects and improves groundwater supply and quality, GRA

stands steadfast in advocating for sound groundwater stewardship and protection through professional education and legislative outreach. In essence, GRA represents the best interests of probably the only special interest not being represented here—that of the groundwater resource itself. GRA agrees with both the LAO and ACWA on the critical importance of groundwater, that proactive steps are needed to better manage groundwater in the future, and that better data collection, transparency, and management are necessary. GRA also supports increased groundwater governance, to the degree that it promotes our policy objectives.

However, because each groundwater basin is unique in its physical characteristics, beneficial uses, water rights, stakeholders and other features, GRA supports regionally coordinated, local

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"Groundwater – Invisible No More" – Continued

control over groundwater management. Because we advocate for sound science, we believe that local entities are best equipped to select and apply the appropriate sound scientific principles and methods.

GRA's role will always be to promote management of groundwater through sound science. We look to serve as a facilitator, educator, and as a promoter of cooperation amongst the various stakeholders and the two "camps." For example, we recently held our **10th Annual Legislative and Lobby Day** in Sacramento. A sold-out audience heard from many legislators from both sides of the aisle and both sides of the local-versus-centralized control issue about how they are grappling with complex water issues and trying to come up with solutions—and we had technical folks there answering their groundwater questions.

On June 14, 2011, we will put on a symposium, **"Groundwater - Surface Water Interaction: California's Legal and Scientific Disconnect."** Both sides of the technical and legal aspects of this issue, possibly the hottest issue right now in the California water community, will be heard and debated.

An example of GRA's promotion of increased governance that supports our principles is our recent strong support of **SB263 – the well confidentiality bill**. This bill would make well completion reports (e.g., drillers' logs, well logs) public information. Well completion reports contain critical information for groundwater managers, consulting hydrologists, academics, and others interested in conducting studies on the geologic, hydrologic, and water quality characteristics of groundwater basins; earthquake risk assessments; and other geologic hazards. Unfortunately, those who would benefit from and need this information for these critical studies currently do not have unfettered access to it. For over 50 years, public access to well completion reports has been

prohibited by law, except under certain circumstances. GRA believes that this information in the right hands allows for more sound science in the public debate over groundwater management.

Our legislative advocates from Brownstein, Hyatt, Farber & Shreck and the Chairman of our Legislative Committee, Tim Parker, have been active in assisting State Senator Fran Pavley in crafting the bill and moving it through committee. Our members have sent in letters of support, and on May 2 one of our Board members, Jim Strandberg, testified before the Senate Committee on Environmental Quality in support of the bill. The bill passed out of committee that night; we'll keep you updated on its progress.

One last example: DWR has invited GRA to participate in preparation of the

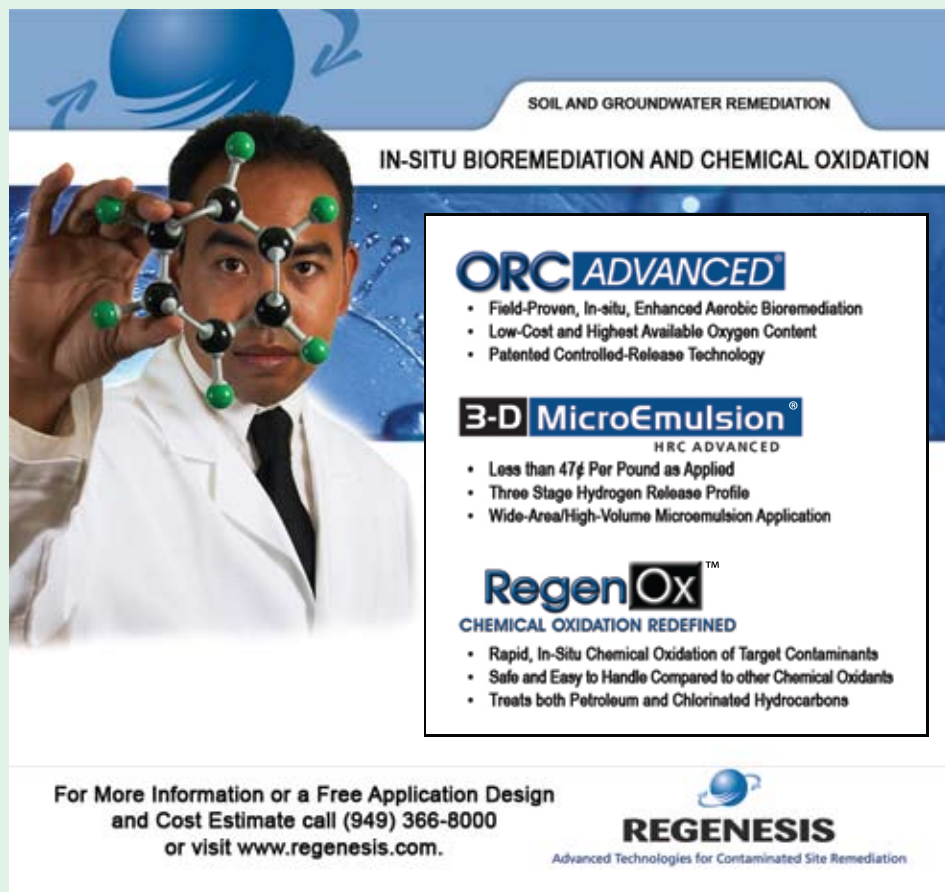
California Water Plan 2013 Update. GRA Board members Vicki Kretsinger and Tim Parker will be co-chairing the Groundwater Caucus as part of the preparation of the update.

So, as the winds of change, politics, and position papers swirl with mighty force around the topic of groundwater, you can count on GRA to be anchored solidly in scientific principles and the best interests of the resource. Join us—we want your input and help! If you are not a member, I urge you to join today at www.grac.org. Thank you.

And thank you for reading *Hydro-Visions*! Until next time,



Bill Pipes, GRA President



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Environmental Forensics in an Era of Emerging Diagnostic Methods –

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government, and industry presented on a wide range of environmental forensics topics. Their presentations are summarized below.

Session 1 focused on the New and Emerging Diagnostic Tools and opened with a talk by **Dr. Mike Hyman**, North Carolina State University, on “Isotopes and Environmental Diagnostics: A Microbiological Perspective.” Dr. Hyman is noted for his pioneering work in environmental microbiology and his talk was a broad and very informative overview of his long standing activity in these fields. **Dora Ogles** of Microbial Insights (Knoxville, TN) then spoke about “Examining Gene Expression in Environmental Samples” and a very key emergent issue with regard to supporting DNA analysis with RNA analysis in certain cases. Advances in RNA preservation and extraction have made quantification of gene expression more applicable to groundwater issues. **Rebecca Mora** of AECOM (Orange, CA) presented “Revealing Intrinsic Biodegradation of 1,4-Dioxane and TCE Using Advanced Tools.” This was a case study at a large and complex site which overlies groundwater impacted with relatively high concentrations of 1,4-dioxane and TCE. The study investigated the potential for aerobic bioremediation with MNA as an important component of the overall remedy based on information from a variety of diagnostic tools. Lastly, our moderator of the session, **Steve Koenigsberg** of the Adventus Group (Irvine, CA), gave an overview paper on “Advanced Diagnostics for Cost Management and Expedited Closure.” This was a broad review of the strategic use of a variety of tools and strategies that focused on how a comprehensive integrated program can be used to expedite site closure through better informed site management decisions and more effective remedial strategies.



Dr. Neil Sturchio of the University of Illinois presenting

Session 2 focused on isotopic fingerprinting techniques. Isotopic ratios may be linked to natural and anthropogenic sources, manufacturing processes, and natural degradation. Thus, revealing the isotopic composition of contaminants provides key forensic evidence regarding their sources, fate and transport. Various talks in this session illustrated recent advances in isotope characterization and their practical application:

- Providing reliable proof of biodegradation, investigating metabolic

pathways and characterization of microbial communities using stable isotope probing, as presented by **Greg Davis** of Microbial Insights, Inc.

- Differentiation of contaminant sources and monitoring of natural attenuation processes, as demonstrated by **Dr. Paul Philp**, Professor at University of Oklahoma; Dr. Philp has made many contributions in this area, including the recent use of multi-dimensional (2D and 3D) isotopic testing
- Evaluating the anthropogenic versus natural sources of perchlorate was illustrated by **Dr. Neil Sturchio**, Professor and Head of Department at University of Illinois at Chicago; Dr. Sturchio is well known for his advanced isotopic research, which may shed light on the mechanisms of natural perchlorate formation and help understand perchlorate occurrences all over the world
- Identifying nitrate sources and groundwater age-dating as illustrated through the talk by **Bradley Esser** of Lawrence Livermore National Laboratory and **Rob Gailey** from The Source Group, Inc.

Continued on the following page...



Rob Gailey (left), The Source Group, co-presenting with Bradley Esser (right), Lawrence Livermore National Laboratory, and Moderator Tom Mohr (middle) Santa Clara Valley Water District

Environmental Forensics in an Era of Emerging Diagnostic Methods –

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John Dodge (right), Daniel B. Stephens & Associates, presenting, and Moderator Elie Haddad (left)

Next, both classical and emerging tools used to solve forensic puzzles were discussed in Session 3A. Each tool has advantages and limitations, but their combined use increases the chances for success in any particular case. This session included compelling case studies and associated forensic tools, including:

- Commonly used statistical methods in environmental data analysis and their potential pitfalls were well illustrated by **Dr. Yue Rong** of California Regional Water Quality Control Board, Los Angeles Region, who has rich experience in environmental forensics
- The use of radioactive and stable isotopes, along with hydrogeologic characterization, to evaluate hydrogeologic zone connectivity at over 2,000 acres of known and potentially impacted industrial property re-developed into a new community at Henderson, Nevada was presented by **John Dodge** of Daniel B. Stephens & Associates, Inc.

- Forensic applications of 1,4-dioxane and solvent stabilizers in chemical fingerprinting for source identification and allocation between multiple sources was greatly illustrated by **Thomas K.G. Mohr** of Santa Clara Valley Water District, former President of GRA, and author of *Environmental Investigation and Remediation: 1,4-Dioxane and Other Solvent Stabilizers*, published in March 2010; he provided pioneering and comprehensive information emphasizing the hidden potential of commonly used solvent stabilizers to solve intricate forensic cases.

- The combined use of chemical fingerprinting (classical tool) and tree-ring fingerprinting (emerging tool), along with site history and monitoring data in order to evaluate multiple petroleum releases at a former gas station (in operation since 1930's) in New York state was presented by **Mr. Elie Haddad**, Vice President of Haley & Aldrich, Inc. on behalf of his colleague **Dr. Ioana G. Petrisor**, who is also Editor-in-Chief of *Environmental Forensics Journal* and Co-Chair of this Forensic GRA Symposium.

Stable isotopes were again the topic of discussion within Session 3B, which emphasized CSIA case studies, including:

- Multiple source differentiation at a chemical waste management facility surrounded by industrial properties was illustrated by the talk of **Dr. Silvia Mancini** of Golder Associates Ltd., Canada; both ^{13}C and ^2H were used in this investigation (for benzene)
- The use of 3D-CSIA analysis (including ^{13}C , ^{37}Cl and ^2H by GS-IRMS) to evaluate multiple releases of chlorinated solvent plume (PCE, TCE and 1,2-cis-DCE) at FAMU Law School in Florida was described by **Dr. Yi Wang Director** of ZymaX Forensics; the results were relevant to Florida DEP
- Distinguishing manufactured TCE from TCE as a biodegradation product of released PCE is now possible

Continued on the following page...



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Poster presenters

through CSIA of ^2H isotope; a case study where 2D-CSIA of ^{13}C and ^2H was used for this purpose at an industrial site in Southern California was presented by **Arun Wahi** of Daniel B. Stephens & Associates, Inc.

- The use of CSIA analyses in order to assess the source and fate of TCE and its less chlorinated breakdown products in groundwater affected by discharge of untreated industrial wastewater was demonstrated by **Peter Bennett** of AMEC Geomatrix; both TCE and its degradation products (1,2-cis-DCE, VC) were tested and results showed greater than 90% degradation of TCE., thus proving that intrinsic remediation was a viable remedial alternative at the site.

Session 4A focused on environmental forensics in the courtroom and other legal perspectives. **Steven Hoch, Esq.**, with Brownstein Hyatt Farber and Schreck, discussed trial presentations, providing a summary of the rules of evidence in a court room and the admissibility of evidence and expert testimony into a case. Following Mr. Hoch was **Peter**

Mesard, with Exponent, Inc., who presented a case study examining multiple lines of evidence in order to determine the timing of a gasoline release in the Central Valley. **Mr. William Motzer** of Todd Engineers discussed how to select environmental forensic methods for investigating contaminant sources. Lastly,

Jeff Caufield, Esq. of Caufield & James discussed the use of environmental forensics in the courtroom, including graphic depictions, emerging methodologies, surviving a Daubert challenge and effective communication with the regulatory agency, judge and jury.

Forensic fingerprinting and source identification were the topics of session 4B. Speakers included **Richard Hurst** of Hurst & Associates who discussed evaluating gasoline release ages; **Eric Cherry** of Arcadis U.S., Inc., presented a talk on assessing PCB impacted NAPL using integrated methods such as fluid properties and laser induced fluorescence; and **Dawn Zemo** of Zemo and Associates, who focused on a case study that used parent PAH proportions to attribute different PAH sources in sediments.

The Environmental Forensics Symposium proved to be a successful event for 2011. It is anticipated that GRA may organize another environmental forensics symposium in the future, based on the positive feedback and evaluations of the attendees. GRA thanks all those who contributed to a successful event! 💧



Exhibitors hall

Dates & Details

GRA EVENTS & KEY DATES

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

GRA Symposium

Groundwater – Surface Water Interaction: California's Legal and Scientific Disconnect

Jun. 14, 2011 | Sacramento, CA

GRA Cast

The National Ground Water Monitoring Network: Design Considerations, Pilot Results, and Network Data Portal

Jun. 28, 2011

GRA Board Meeting

Aug. 26, 2011 | Berkeley, CA

28th Biennial Groundwater Conference & 20th Annual GRA Meeting

Oct. 5-6, 2011 | Sacramento, CA

The 7th Symposium in the Water Resources Series

Groundwater – Surface Water Interaction: California's Legal and Scientific Disconnect

JUNE 14, 2011 – SACRAMENTO, CALIFORNIA

Groundwater and surface-water are connected in the physical system, but not in the legal system, and the regulatory framework places pseudo boundaries to define under the influence. A debate has been heating up over the past few years as to whether the legal and regulatory system need to be changed to reflect physical reality and to protect the environment from further damage, whether local management initiatives and practice can effectively address the challenges, or some sort of hybrid needs to be developed for parts of the state. Our esteemed speakers and panelists will debate the pros and cons of the current system, and discuss their vision for California's future groundwater policy. Speakers include:

- Jared Huffman, Chair, Assembly Water Parks & Wildlife Committee (invited)
- Ellen Hanak, Senior Fellow, Public Policy Institute of California
- Tim Quinn, Executive Director, Association of California Water Agencies
- Danny Merkeley, Director, Water Resources, California Farm Bureau Federation
- John Bredehoeft, Principal, The HYDRODynamics Group
- Dr. Stanley Leake, US Geological Survey

Session Topics

- Technical, Legal & Regulatory Basics
- Groundwater-Surface Water Technical

- Legal Status in Several States
- Bringing it All Together – What's the Future?

Following the sessions, there will be a reception and Poster Session. 💧

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About the Conference:

For more than 50 years, the Biennial Groundwater Conference has provided policy-makers, practitioners, researchers, and educators the opportunity to learn about the current policies, regulations, and technical challenges affecting the use and management of groundwater in California. This year's conference will focus on the unprecedented water resources challenges that California faces, including conditions exacerbated by climate change, drought, the debate over groundwater management at local or state levels, legal decisions, infrastructure funding, a failing Delta ecosystem, and a tenuous economy. Collaborative efforts have begun to create the framework for California Water Plan Update 2013, and decisions during the next few years may cause groundwater policies to change in dramatic ways. Groundwater will assuredly play an even greater future role in dealing with future water resources challenges.

The two-day Conference features a plenary session, concurrent sessions with policy and technical presentation, and a final general assembly. The session topics include:

- Groundwater remediation – successful approaches, lessons learned, regional significance
- Green remediation – application of sustainable technologies and approaches
- Groundwater quality and protection – programmatic, regulatory and regional issues (such as groundwater salinity, irrigated lands regulatory program, GAMA, California Department of Public Health Drinking Water Source Assessment Program update (DWSAP), National Water Quality Assessment Program (NAWQA), or related, including assessment, monitoring and trends
- Nitrate in groundwater – current and future status and implications, approaches to improve source control, monitoring and assessment, policy changes
- Groundwater management – local and regional approaches, planning and implementation; dealing with climate change; regulatory and policy changes

- Managed aquifer recharge – spreading basins and aquifer storage recovery approaches, evolving from imported water to recycled water and stormwater for recharge sources
- Local success stories – case studies on groundwater management, recycled water recharge, supply augmentation
- Remote sensing – technologies and applications, including surface water/groundwater interaction, subsidence, groundwater level and storage change)
- Groundwater monitoring – network design and function, addressing new California Statewide Groundwater Elevation Monitoring program (CASGEM)
- Managing data – tools and methods for organization, visualization, assessment, and reporting
- Groundwater modeling – latest approaches and tools; case studies of enhanced regional physical conceptualization and updated model structure, calibration and results.

Collegiate Groundwater Colloquium:

GRA seeks to increase participation by university and college faculty and students in its programming. The Collegiate Groundwater Colloquium presents students who are conducting highly relevant research in the general area of the conference theme. The Colloquium and reception provide students with an excellent opportunity to showcase their research and attendees an opportunity to learn from the frontier of groundwater science.

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Wells and Words

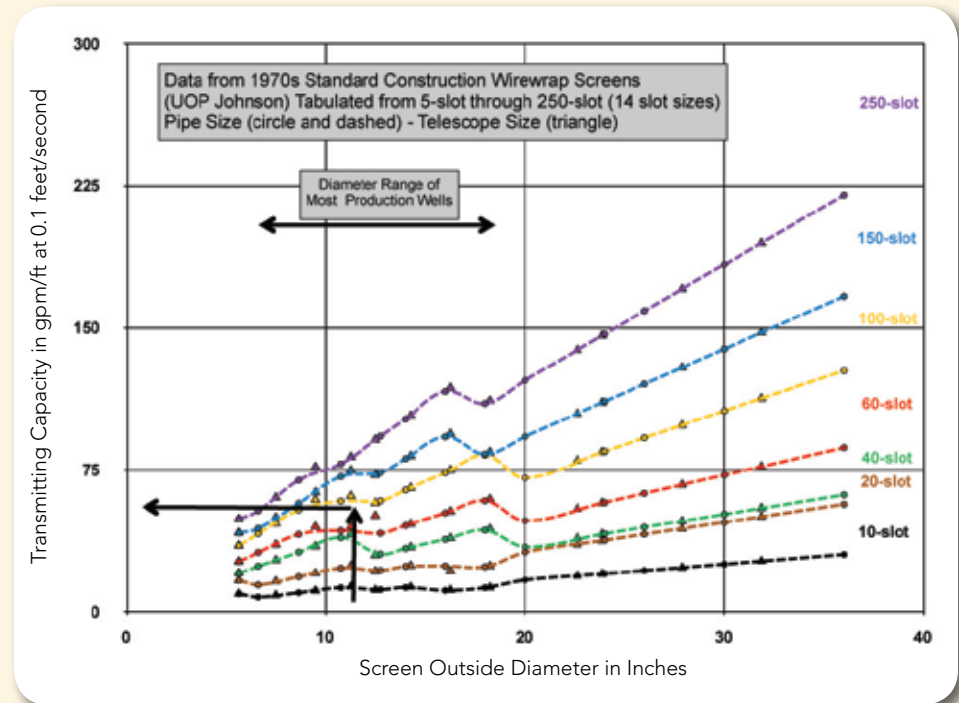
By David W. Abbott P.G., C.Hg., Senior Hydrogeologist, Daniel B. Stephens & Associates, Inc.

The Role of Well Screen Transmitting Capacity in Well Design

Achieving the maximum discharge from a production well tapping an aquifer is determined by aquifer parameters (transmissivity and storativity), water level depth, boundary conditions, and the efficiency of groundwater transfer from the aquifer through the aquifer/well interface. The parameters and aquifer conditions are intrinsic to the subsurface hydrogeology, cannot easily be changed, and provide a baseline or optimal goal for achievable well yields. In contrast, the interface is critical to well efficiency and is designed to maximize well yield and longevity. The interface design includes the selection and type of well screen (wire wrap, louvered, perforations, etc.), well screen material (stainless steel, low carbon steel, PVC, etc.), and filter pack. *Wells and Words* (HydroVisions, v. 17 nos. 3 and 4 and v. 20 no. 1) discussed the methodology for selecting a proper filter pack and screen aperture size from sieve analyses.

The well screen transmitting capacity (TCap) is the yield in gallons per minute per foot (gpm/ft) of screen that minimizes friction and prevents turbulent flow at the entrance or exit of the well screen. TCap is determined from the open area of the screen (A , in square inches) and the recommended entrance velocity (V , in feet per second; see *HydroVisions* v. 18 no. 2), applied to the following formula: $Q = V \times A = \text{TCap}$ with appropriate conversion factors. Velocities that are too large cause turbulent flow, which decreases the well efficiency and results in deeper pumping water levels and greater energy and maintenance costs to operate the pump.

Well efficiency is a complex interplay between the aquifer/borehole, filter pack, screen aperture size, and total



open area. How well these are matched to each other determines the efficiency of the well. Poor well efficiencies also can result from inappropriate drilling methods and/or ineffective well development procedures.

TCap varies with screen design components and structural constraints. Figure 1 shows the relationships between the screen diameter (ϕ ; X-axis), TCap (Y-axis), and slot or aperture-size for *standard construction* of stainless steel wire wrap screens manufactured in the 1970s. TCap, open area, and screen ϕ data are usually provided in table form by the manufacturers rather than graphically. Custom designed well screens and specifications have continued to evolve since the 1970s to include variations of the size and shape of surface profiles of the wire and support rods in order to enhance screen collapse strengths for deeper well settings and other special environmental conditions¹. These custom designed screens result in varying TCap.

For example, the TCap for a 10-inch ϕ screen (60 slot) ranges from about 23 to 58 gpm/ft of screen depending on the well screen construction materials (stainless, galvanized, or low carbon steel) and the depth of the screen setting. Screens set at shallower depths have greater TCap. Pipe-size screens (circles and dashed line) and telescope screens (triangles) are shown on Figure 1. A 10-inch telescope screen fits inside a 10-inch ϕ pipe. It is no surprise that TCap increases as the screen ϕ increases since per-foot surface area of the screen is equal to $\pi \times \phi$; TCap also increases as the aperture size increases. Changes in the screen components (wire and rod shapes) results in the wavy curves between 6- and 18-inch ϕ .

In general, good well design techniques for production wells include the following: (1) install the well screen five feet below and five feet above the overlying and underlying aquitards, respectively, (2) use solid blank casing

Continued on the following page...

Wells and Words – Continued

opposite the finer-grained layers in an aquifer, and (3) in general, screen between 30% and 50% of an aquifer. For example, a water purveyor requires a well that yields 250 gpm. This will need an optimum pump chamber of 10-inch ϕ (minimum 8-inch ϕ)². If the confined unconsolidated sandy aquifer is 120 feet thick and has a transmissivity of 10,000 gpd/ft, then the estimated specific capacity of a 100% efficient well is about 5 gpm/ft of drawdown (10,000 gpd/foot \div 2,000)³, yielding a required minimum drawdown of about 50 feet (250 gpm \div 5 gpm/ft of drawdown).

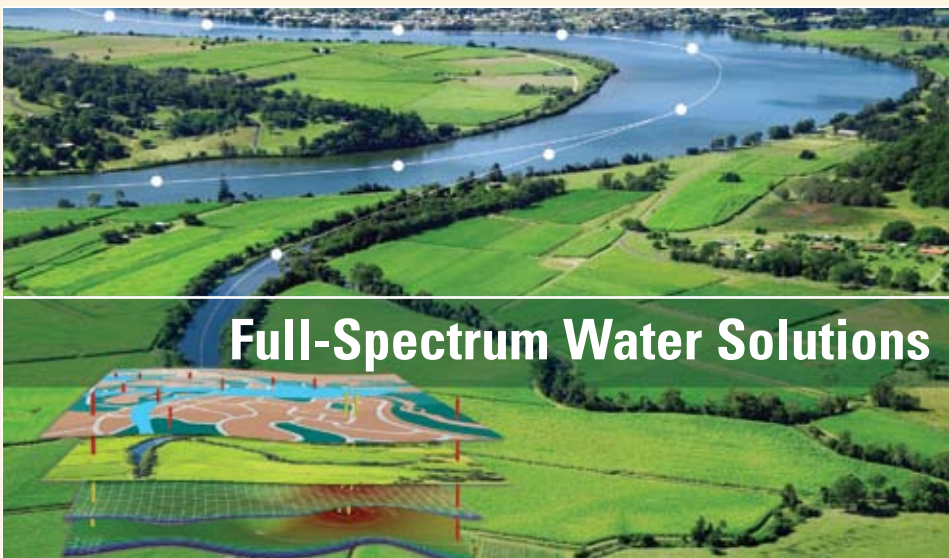
In this example, the sieve analysis of the aquifer materials suggests a 0.060-inch aperture size screen (60 slot) is appropriate. TCap (from Figure 1) for a 10-inch ϕ standard wire wrap screen is about 43 gpm/ft; 5.8 feet (250 gpm \div 43 gpm/ft) of screen would be enough to transmit water if the formation/filter pack/screen interfaces were 100%

efficient. Assuming that the effective area of the screen is 50% (i.e., 50% of the open area of the screen is plugged) then 11.6 feet of screen would transmit efficiently the 250 gpm. Installing 120 feet of screen would yield a total TCap of 5,160 gpm (43 gpm/ft \times 120 feet of aquifer), or over one order of magnitude more than the purveyor needs and could possibly ever pump from a 10-inch ϕ well; the well would clearly be over-designed. In addition, valuable well development time would be spent on 120 feet of screen rather than focusing the development energy on significantly shorter screen. Screen length coupled with TCap can be tailored to each well and aquifer. Think twice before screening 100% of an aquifer; smart well designs will yield more efficient and longer lasting wells, reduce installation and operational costs, and may provide better water quality. 💧

¹ Several well screen specifications (1970s, 1990s, 2000s, and 2011) for this article were reviewed. The 1970s standard construction specifications were in a more convenient format allowing for construction of Figure 1 for this article.

² Driscoll, Fletcher G. (editor), 1986, *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota, see page 415.

³ Ibid. page 1041.



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Legislative Update

By Tim Parker, GRA Legislative Committee Chairman,
Chris Frahm and Duncan McFetridge, GRA Legislative Advocates

On April 27th, GRA hosted its annual Legislative Symposium and Lobby Day at the Citizen Hotel in Sacramento, California. This year's Symposium was once again hosted in cooperation with the California Groundwater Coalition. The Symposium broke past attendance records and was "standing room only," building on the momentum of past Symposia and GRA's educational and legislative efforts in California.

This year's featured Symposium speakers included the Speaker of the Assembly, John Perez, who discussed the budget and his experience with groundwater contamination in his district; the Chair of the Senate Natural Resources and Water Committee, Senator Fran Pavley, who discussed her well log legislation, SB 263; and Secretary of Resources John Laird, who spoke on the Delta and the future of the water bond.

Our day also featured a report from DWR on the status of groundwater monitoring implementation and State Water Plan update. The afternoon session closed with a provocative discussion on the future of California groundwater management including speakers from ACWA, LAO, The Nature Conservancy and water rights attorneys. We ended the session with a case study from the Water Replenishment District of Southern California.

Finally, during the afternoon session, GRA members and attendees were able to witness one of GRA's sponsored bills, AB 359(Huffman) pass out of the Assembly Local Government Committee. GRA members provided expert testimony and support for the bill.

As always, the Legislative Symposium provided a unique opportunity for GRA members to talk directly to the elected officials in Sacramento who will determine the future of Cali-

fornia groundwater law and management. Thank you to all of our GRA members who attended this year's event – we look forward to seeing you again next year!

GRA Legislation

AB 359(Huffman) – GRA again is sponsoring legislation to require mapping of groundwater recharge areas and providing those maps to local planning agencies in order to provide greater coordination and protection of such recharge areas. The bill is currently in the Assembly Appropriations Committee. GRA's advocates and the author are working with agriculture groups to remove their opposition. We anticipate having this bill signed into law.

AB 1152(Chesbro) –This legislation attempts to clarify and strengthen technical deficiencies in the Groundwater Monitoring statute. This bill includes the need for an "alternative monitoring" process for specified types of groundwater basins including those where (1) groundwater elevations are unaffected by current or planned land use activities, or naturally occurring total dissolved solids within the groundwater preclude the use of that water; (2) the basin is underlying land that is wholly owned or controlled, individually or collectively, by state, tribal, or federal authorities, and

groundwater monitoring information is not available; or (3) the basin is underlying an area where geographic or geologic features make monitoring impracticable, including, but not limited to, a basin or subbasin that is inaccessible to well-drilling equipment. This bill has moved quickly through the committee process and will soon be voted on in the full Assembly.

SB 263(Pavley) – Legislation to make well logs public information similar to other western states. Senator Pavley and her staff are extremely appreciative of the GRA and assistance that GRA has provided on behalf of her bill. Both Tim Parker and Jim Strandberg have testified in committee in support of the bill and have helped move the bill through the committee process. The bill is currently in the Senate Appropriations Committee and will soon be on the Senate Floor for a vote.

Looking Ahead

We anticipate that all three bills being sponsored or strongly supported by GRA will make their way to the Governor's Office and ultimately be signed into law. Furthermore, the GRA Legislative Committee and its Legislative Advocates will be closely involved in all discussions surrounding the water bond and new directions that it is likely to take. 💧



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The Federal Corner

By Kelly Manheimer, U.S. EPA

An Update on EPA's New Approach to Protecting Drinking Water and Public Health

Almost one year ago, U.S. EPA Administrator Lisa P. Jackson [announced the Agency's new Drinking Water Strategy \(DWS\)](#), which was aimed at finding ways to strengthen public health protection from contaminants in drinking water. The new vision was intended to streamline decision-making and expand protection under existing laws and promote cost-effective new technologies to meet the needs of rural, urban and other water-stressed communities. Some of the key accomplishments for each of the four goals are noted in the table below:

Review of the Fluoride Drinking Water Regulation

On January 7, 2011, EPA announced its intent to review the national primary and secondary drinking water regulations for fluoride. By initiating the current review, EPA is following up on a commitment made in the second [Six Year Review \(SY2\)](#) to update its health and exposure assessments, review the existing drinking water regulations, and determine whether revisions are appropriate.

[The Agency released the new risk and exposure assessments on January 7, 2011.](#) These assessments address recommendations made by the National

Research Council (NRC) in a report entitled *Fluoride in Drinking Water: A Scientific Review of EPA's Standards*. In this report, the NRC recommended that EPA update its fluoride risk assessment to include new data on health risks and better estimates of total exposure.

Good News, Bad News About Nitrogen and Phosphorus in Major California Rivers

Nitrogen and phosphorus concentrations decreased in streams of the Santa Ana Basin during 1975–2004 as improved wastewater treatment was implemented basinwide. Nutrient concentrations in the San Joaquin Basin during the same period increased in association with increased land application of nutrients. In the Sacramento Basin nutrient trends were mostly downward. “Long-term nutrient trend studies like this one can help managers understand where watersheds are most vulnerable to contamination, to what extent cleanup efforts are working, and where more investment is needed in strategies designed to reduce nutrient inputs,” said Charlie Kratzer, lead scientist for the USGS study. “We found that strategies that reduce nutrients in California waters, such as improved wastewater treatment, seem to be working, but that many waters are still vulnerable to nonpoint-source contamination.”

Santa Ana River Basin

With the exception of nitrate, nutrient concentration trends in the urbanized Santa Ana Basin were downward during 1975–2004, despite a nearly three-fold increase in the volume of wastewater discharged in the basin during the same period. The decreased nutrient concentrations likely result from

Continued on the following page...

Drinking Water Strategy Goal

*Accomplishment(s)**

Address contaminants as groups rather than one at a time so that enhancement of drinking water protection can be achieved cost-effectively.

In January 2011, identified carcinogenic volatile organic compounds as the first group that the Agency plans to address.

Foster development of new drinking water technologies to address health risks posed by a broad array of contaminants.

In January 2011, promoted the formation of a Regional Water Technology Innovation Cluster to bring together public and private partners to focus on finding new ways to simultaneously treat multiple contaminants in drinking water.

Use the authority of multiple statutes to help protect drinking water.

Currently developing pesticide health benchmarks that can be used as tools in assessing the occurrence of contaminants in drinking water (when regulatory values are not available).

Partner with states to develop shared access to all public water systems (PWS) monitoring data.

In 2010 developed a Memorandum of Understanding between EPA and our State partners to facilitate sharing of drinking water monitoring data.

*For more detailed information, see [Additional Information about the Four Drinking Water Strategy Goals](#).

The Federal Corner – Continued

improved wastewater treatment from primary to tertiary, which increases nitrogen and phosphorus removal. Nitrate trends were upward during the first part of the study period, but decreasing concentrations during the latter part of the period are consistent with the basin-wide changes to tertiary wastewater treatment.

San Joaquin River Basin

Trends in nitrate and total nitrogen concentrations in the agricultural San Joaquin Basin were mostly upward and are associated with increasing fertilizer applications (75–100 percent), increasing manure applications (40–49 percent), and increasing discharges from tile drains. Trends in ammonia, orthophosphate and total phosphorus concentrations were mostly downward and consistent with improved wastewater treatment practices during the sampling period.

Sacramento River Basin

In the Sacramento Basin, trends in concentrations of nutrients were predominantly downward despite increasing fertilizer applications of 47–67 percent. Some of the downward trends are attributed to a change, during the study period, of the discharge point for Sacramento metropolitan area wastewater to a location downstream from the area sampled.

This study was supported by the USGS [National Water-Quality Assessment Program](#), which has assessed the physical, chemical and biological characteristics of streams, rivers and groundwater across the nation since 1991. The USGS report, entitled, “Trends in Nutrient Concentrations, Loads, and Yields in Streams in the Sacramento, San Joaquin, and Santa Ana River Basins, California, 1975–2004,” by Charles R. Kratzer, Robert H. Kent,

Dina K. Saleh, Donna L. Knifong, Peter D. Dileanis and James L. Orlando, can be found [online](#).

ITRC: Mining Waste Treatment Technology Selection Website

This Web-based Mining Waste Technology Selection site assists project managers in selecting an applicable technology, or suite of technologies, which can be used to remediate mine-waste contaminated sites. The site consists of decision trees, overviews of applicable technologies, case studies where these technologies have been implemented and regulatory challenges. The decision trees, through a series of questions, guide users to a set of treatment technologies that may be applicable to that particular site situation. The technology overviews include information to help project managers

Continued on the following page...

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The Federal Corner – Continued

decide how well the technology may fit their particular site and remedial/reclamation goals. These technology overviews are not meant to be technical design manuals; this information can be found in other resources (ADTI, GARD Guide).

Treating Contaminants of Emerging Concern: A Literature Review

EPA has published the results of an extensive literature review on wastewater treatment technologies and their ability to remove chemical contaminants of emerging concern (CECs). EPA is also making available the data from this literature review. The report discusses 16 of the over 200 CECs present in the database, and the average percent removals achieved by full-scale treatment systems that employ six of the more than 20 reported treatment technologies. Wastewater treatment plant operators, designers, and others may find this information useful in their studies of ways to remove CECs from wastewater. The peer-reviewed [literature review](#) is not designed to promote any one technology nor is it intended to set agency policy or priorities in terms of risk.

From Lab to Consumer: EPA Research at Work

Arsenic is an odorless, tasteless element that enters groundwater through erosion of natural deposits or from human-made sources such as agricultural and industrial runoff. Arsenic is a human carcinogen. Chronic exposure to low levels of arsenic has been linked to skin, kidney, lung and bladder cancers, as well as neurological and cardiovascular effects. The EPA allowable limit for arsenic in drinking water of 10 parts per billion, established in 2001, impacted about 5,000 water systems, the majority of them serving fewer than 10,000 people. Recognizing the technical and financial burden the new standard could impose on small drinking water systems,

EPA, with additional Congressional earmark funding, conducted a technology demonstration program to test a variety of arsenic-removal technologies in small systems across the country. Beginning in 2003, EPA drinking water specialists worked with communities at 50 sites in 27 states to select an optimum removal technology. The technology selection depended on variables such as quality of the local source waters, estimated capital and operating cost, quantity and type of waste produced and disposal options available. For more information, please go to the [Arsenic Research website](#).

Arsenic Removal from Drinking Water by Iron Removal

This [report](#) documents the activities performed and the results obtained at the EPA Arsenic Removal Technology Demonstration site in Sabin, MN.

Arsenic Removal from Drinking Water by Coagulation/Filtration

This [report](#) documents the activities performed during and the results obtained from the arsenic removal treatment technology demonstration project at the Town of Felton, DE.

New Cost and Performance Information on Cleanup Technologies

The Federal Remediation Technologies Roundtable (FRTR) recently announced the release of 26 new case study and technology assessment reports. These reports document the cost, performance, and lessons learned in implementing a wide range of hazardous waste site cleanup technologies in the field, ranging from large-scale demonstrations to full-scale applications. The remediation case studies and general technology assessment reports and other related FRTR information are available at the FRTR web site.

USGS - PHAST

USGS has developed a new computer model for simulating groundwater flow, solute transport, and multicomponent geochemical reactions. PHAST

(PHREEQC And HST3D) simulates multicomponent reactive solute transport in 3-D saturated groundwater flow systems. PHAST is a versatile groundwater flow and solute-transport simulator with capabilities to model a wide range of equilibrium and kinetic geochemical reactions, and is applicable to the study of natural and contaminated groundwater systems at a variety of scales. PHAST is not appropriate for unsaturated-zone flow and does not account for flow and transport of a gas phase or a nonaqueous liquid phase.

EPA Proposes 15 New Sites to the National Priority List

The U.S. EPA added ten new hazardous waste sites that pose risks to human health and the environment to the General Superfund section of the National Priorities List of Superfund sites, two of which are located in California. EPA also proposed to add 15 other sites to the list, all to the General Superfund section. Superfund is the federal program that investigates and cleans up the most complex, uncontrolled or abandoned hazardous waste sites in the country.

The EPA is proposing to add two abandoned mines that discharge toxic pollutants to California waterways. The New Idria Mercury Mine site in San Benito County is associated with mercury contamination and acid mine drainage that affects waterways leading to the San Joaquin River and San Francisco Bay. Blue Ledge Mine in Siskiyou County discharges metals and acid mine drainage at levels toxic to aquatic organisms into streams in the Rogue River-Siskiyou National Forest and ultimately the Applegate Reservoir, a popular recreation area.

To date, there have been 1,637 sites listed on the NPL since 1980, 128 of which are in California. Nationally, construction has been completed at 1100 of the 1627 sites. Public comments on the proposed listings were accepted

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The Federal Corner – Continued

between the proposal on March 9, and May 10. For the Federal Register notice and supporting documents, please visit: <http://www.epa.gov/superfund/sites/npl/current.htm>.

EPA's Ocean Survey Vessel Bold 2010 Annual Report Released

The U. S. EPA has released the Ocean Survey Vessel Bold 2010 Annual Report, a report summarizing the surveys completed by OSV Bold, EPA's coastal and oceans monitoring and assessment vessel. The surveys provide scientific information and data to support EPA's mission to protect and enhance ocean and coastal waters through a variety of programs including partnerships and regulatory activities. In 2010, the OSV Bold supported scientific surveys over a wide variety of geographic areas (Atlantic Coast, Gulf of Mexico, Florida Keys, Caribbean Sea), providing state-of-the-art oceanographic support to EPA scientists and their federal, state, territorial, and academic partners. The annual report highlights the Bold's scientific survey capabilities, survey accomplishments, and the unique role the vessel plays in supporting EPA's monitoring and assessment programs that address requirements of federal statutes such as the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act. For more information about EPA's OSV Bold, visit http://water.epa.gov/type/oceb/assessment/monitor/osvbold_index.cfm.

Alternative Landfill Cover Project Profiles

The U.S. EPA has developed a Web site to summarize timely information about demonstrations and full-scale applications of alternative landfill covers. The alternative landfill covers described involve design concepts that primarily minimize percolation of water into the waste. Projects for this Web site are collected using information from technical journals, conference proceedings,

information obtained from technology vendors and site managers, and state Web sites that provide permit information. Where available, the site profiles contain information about relevant site background (hydrogeology); materials disposed of at the site; climate; location; monitoring system used; cover type, size and design; performance results; points of contact and references. This Web site can be used as a tool to identify past solutions and lessons learned that would apply to new sites with similar contaminants and climate.

As of March 2011, the [Web site](#) included information on approximately 222 full-scale alternative landfill cover sites and about 45 demonstration projects. Four types of alternative landfill covers are included in this Web site: monolithic evapotranspiration (ET) covers, capillary barrier ET covers, asphalt covers, and bioengineering management

covers. These ET alternative cover designs are increasingly being considered for use at waste disposal sites, including municipal solid waste and hazardous waste landfills and radioactive waste sites. Many of these new ET sites are being proposed and built in the arid and semiarid regions of California, Arizona, New Mexico, Texas, and parts of the Great Plains. As further information is obtained, EPA will update and expand this Web site as EPA continues its efforts to examine trends in the use of alternative landfill covers.

Kelly Manheimer is an Environmental Engineer at the U.S. Environmental Protection Agency, Region 9. She works in the Superfund Division and oversees cleanup activities at several Superfund sites in CA. For information on any of the above topics, please contact Kelly at 415-972-3290 or manheimer.kelly@epa.gov.

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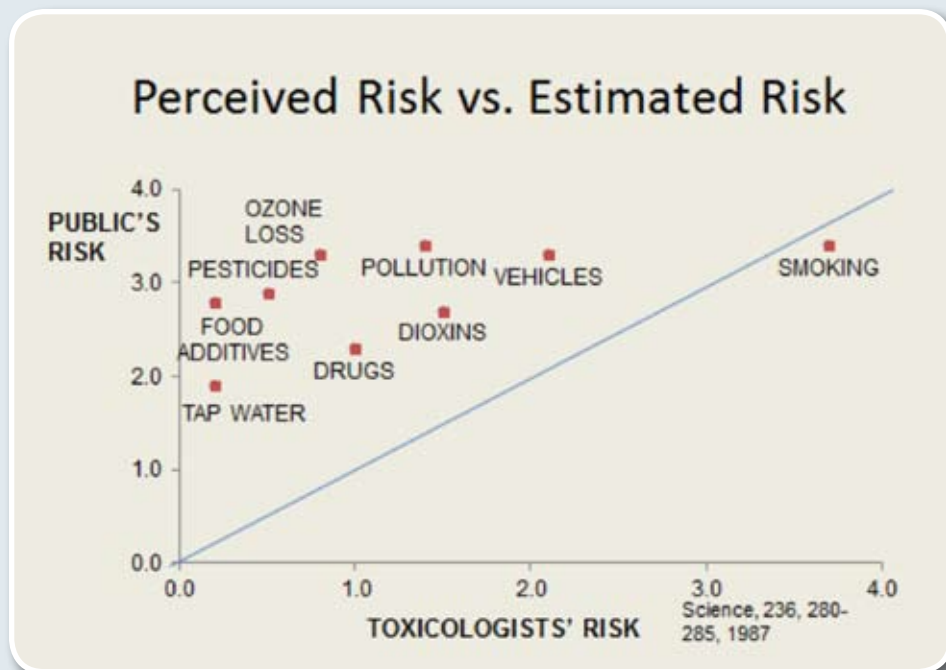
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Chemistry and Perception

By Bart Simmons

For decades, there has been evidence that the public views chemical risks differently than toxicologists or other professionals. The figure shows typical results from surveys of the public compared with experts. Compared with expert estimates, the public scores higher risks for pesticides, general pollution, and even tap water. In contrast, the public and experts have similar estimates of the risk of smoking, though the public underestimates the annual mortality from strokes and heart disease. Some have called this phenomenon “chemophobia,” but that does nothing to explain what is happening. One difference is the principle of dose. Paracelsus (1493-1541) has been credited with writing “the dose makes the poison.” Apparently he never wrote that, but he did write: “All things are poison and nothing is without poison, only the dose permits something not to be poisonous.” The public and the media confuse the toxicity of pure chemicals with the risk of measurable, but highly dilute solutions. Another issue is the perception that a “chemical” is toxic, but naturally-occurring substances inherently pose lower risk. In the 1980s,



One could blame the analytical chemists, of course, for developing ever more sensitive techniques for measuring chemicals in environmental samples, such as “Chemicals of Emerging Concern.” James Lovelock, the author of *The Gaia Hypothesis*, also invented the electron-capture detector, which allowed

and worry about Chemicals of Emerging Concern in drinking water, wastewater, and recycled water.

The concern about chemicals has helped stimulate the Green Chemistry movement. In a previous column, we discussed the practical difficulties of using Green Chemistry. Since much of the concern about “chemicals” is based on perceived risk, how does that affect the acceptance of alternative green products and technologies? When consumers and industry are asked to use greener but less effective products, e.g., phosphate-free detergents, resistance has been encountered.

Sustainability, including Green Chemistry, is rapidly becoming part of school curricula. Hopefully, this will include some basic chemistry and toxicology to provide a perspective on relative risks.

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

“All things are poison and nothing is without poison, only the dose permits something not to be poisonous.”

Bruce Ames published papers showing that the toxicity of naturally-occurring chemicals, e.g., aflatoxin in nuts, hydrazines in mushrooms, and ethyl alcohol in beer, overwhelm the risk from pesticide residues in food or chloroform in drinking water, for example.

the measurement of part per billion concentrations of halogenated compounds. High-resolution mass spectroscopy has pushed the level of detection to the part-per-trillion level and below. Liquid Chromatography-mass spectroscopy has widened the realm of measurable chemicals. As a result, we can measure

Water Resources Center Archives in Transition

By Linda Vida, WRCA Director



The transition of the Water Resources Center Archives from UC Berkeley to the UC Riverside campus, under joint management with California State University San Bernardino (CSUSB), is still in process, but significant progress has been made.

WRCA has a new name: Water Resources Collections and Archives. This name is more descriptive of the collection and allows the WRCA acronym to remain. Access to the unique materials of WRCA and those of the CSUSB Water Resources Institute (WRI) will be expanded due to the unique collaboration between UCR and CSUSB. UCR and CSUSB continue to work on developing policies and procedures to establish a statewide presence and digital network that will broadly share these important technical materials with a broad constituency.

A Joint Management Team (JMT) composed of key representatives from the UCR and CSUSB libraries meets twice monthly and is responsible for reviewing recommendations from various committees and making decisions about policies and procedures for circulation, interlibrary loan, and document delivery services. There is a Joint Cataloging and Technology Committee (JCTC) handling the transition of WRCA's records from UCB Oskicat Catalog to the UCR Scotty Catalog and to the CSUSB library catalog. This committee is responsible for moving "most" of the existing WRCA web content and has created a beta website (<http://library.ucr.edu/?view=wrca>). There's definitely a lot more to do and the previous website will not be disabled until the JMT is confident that the new web site has sufficient content and depth. The JMT continues to work on a new mission statement and

description of the statewide network, including an updated history that will soon be finalized and available on the new website.

Because many decisions remain to be made and implemented, the original April 25th re-opening date for WRCA has been changed. There is no alternate re-opening date established by the JMT to date, but they anticipate it will be sometime in summer 2011.

As always, please do not hesitate to contact me at lvida@ucr.edu or 951-827-2934. Thank you so much for your ongoing interest in WRCA. 💧

Recognition Events Keep Groundwater in the Spotlight

By Cliff Treyens, Public Awareness Director, National Ground Water Association

For the first time, more than 300 Web sites this year promoted [National Ground Water Awareness Week](#) worldwide, marking the event's broadest exposure in its 12-year history.



The 2011 edition, March 6-12, was noteworthy in a number of ways, said Cliff Treyens, NGWA's public awareness director. "More than ever before, Ground Water Awareness Week perpetuated itself among organizations and individuals this year. It's firmly established as a premier national event for promoting groundwater and water well stewardship to the public," he said. Treyens added that NGWA is living up to its vision statement, "to be the leading groundwater association that advocates the responsible development, management, and use of water."

"In National Ground Water Awareness Week, NGWA provides a focus and information for hundreds of organizations to educate the public about groundwater and water well stewardship," Treyens said. "This is a true partnership because so many people are involved in helping spread the word, but NGWA is clearly taking the lead."

The visibility of Ground Water Awareness Week has been on a steady increase as measured by hits on Web sites and social media platforms such

as Facebook, Twitter and blogs. In 2009, more than 200 Web sites promoted the awareness week; last year, it topped 250. In addition to cresting 300 Websites this year, Treyens said

there appeared to be more social media pickup than ever.

Other 2011 Highlights Include:

- Prominent Web page content on Websites for federal agencies, including the [U.S. Geological Survey](#), [U.S. EPA](#), and the [Centers for Disease Control and Prevention](#)
- Promotion of groundwater stewardship messages by state agencies, including those in Arizona, Hawaii, Kentucky, Louisiana, Massachusetts, Nebraska, New Hampshire, Ohio, Texas, and Wisconsin
- Scores of local governments at the village, township, city and county levels were involved
- There were many national promotional sponsors, including the American Farm Bureau Federation, Automotive Oil Change Association, Groundwater Foundation, Ground Water Protection Council, Irrigation Association, National Association of Conservation Districts, National Association of Local Boards of Health, National Environmental Services

Center, National Onsite Wastewater Recycling Association, American Geological Institute, International Bottled Water Association, National Rural Health Association, and American Public Health Association.

Almost six months from the day of the 2011 National Ground Water Awareness Week is NGWA's 2nd Annual [Protect Your Groundwater Day](#)



to be held on September 13. NGWA encourages groundwater professionals everywhere to promote this event, which is designed to give citizens actionable steps to protect groundwater—whether they own a private water well or not.

"We strongly encourage groundwater professionals and the community of people involved in water resources to embrace and promote Protect Your Groundwater Day to the public," Treyens said. "Share the link to the Protect Your Groundwater Day Web page and use the logo. Many people doing little things can make a big difference in protecting groundwater." 💧

GRA Welcomes the Following New Members

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 Britch, Stefanie
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 Burnell, Shawn
 Busby, John
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Campbell, Tina
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 Clossin, Gary
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 Donovan, Michael
 Duignan, Rory
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 Fong, Ryan
 Glotfelty, Marvin
 Gultinan, Eric
 Gustafson, Howard

Hatamyar, Grace
 House, Jackie
 Hull, Allon
 Jeffrey, Alan
 Johnson, Kristin
 Key, Wendy
 Korthamar, Daphne
 Li, David
 Longley, Karl
 McIlvrde, William
 Middleton, Greg
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 Olsen, Alex
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GRA Launches New Contemporary Groundwater Issues Council

By Vicki Kretsinger Grabert

Concurrent with GRA's commemoration of its 20th Anniversary in 2011, GRA has formed the new Contemporary Groundwater Issues Council. The overarching vision of the Council is to help GRA identify the state's most pressing information, education, and networking needs pertaining to groundwater, thereby allowing GRA and other stakeholder organizations to effectively address integrated water resources and environmental stewardship issues. The goal for this vision is to meet the needs of the state's water stakeholders by providing opportunities, e.g., water forums, workshops and conferences for sharing experiences with and potential solutions to the state's most pressing groundwater issues.

GRA has assembled a distinguished group to identify and discuss key groundwater issues while also providing critical advice and feedback to GRA on its wide array of educational, extension, and legislative outreach programs. The Council's input is also being considered during the planning and formulation of the program for the Biennial Groundwater Conference and GRA Annual Meetings. The new Council complements the roles of GRA's Board of Directors and GRA's Committees by providing external input on key ongoing or future groundwater-related issues, challenges, and opportunities.

The 31 Council members include a select group of executives and leaders from a range of disciplines and backgrounds at the local, state, and national level representing regulatory agencies, research and educational institutions, NGOs, water users, the public at large, and consultants sharing a common interest in the management, protection, and use of groundwater resources in California (<http://www.grac.org/cgic.asp>).



During the first Council workshop, held on April 26, GRA sought Council members' input and varied perspectives on key ongoing or future groundwater-related issues, challenges, and opportunities. Twenty-three Council members (including Professor Jay Lund of the University of California, Davis calling in from the Netherlands) attended the workshop along with five GRA Board members. The workshop was facilitated by Dorian Fougères of the Center for Collaborative Policy, and two students (Reid Bryson and Simon Cook) in the University of California, Davis Hydrology Program assisted with note-taking.

Following the lunch break, Mr. Tim Quinn, Executive Director of the Association of California Water Agencies and also a Council member, provided a keynote presentation on "Sustainability from the Ground Up: Groundwater Management in California, A Framework." The presentation provided an overview of ACWA's board-approved review of groundwater management in California. The Framework document identifies broad principles that

ACWA supports. The Framework also identifies goals, including sustainable management of surface water and groundwater resources statewide.

Six broad key issues, and potential planning and programming activities related to these issues, were identified through the voting and distinguished for consideration in the afternoon small group sessions at the workshop, including:

- Data management
- Conjunctive use/integrated regional water management
- Water quality impacts and disadvantaged communities
- Recycled water and managed aquifer recharge
- Economics, regulatory consistency, and sovereignty
- Contaminant cleanup and water resources management.

The workshop results will be considered by GRA's Board of Directors at its combined quarterly Board meeting and Annual Planning Meeting on May 14-15, 2011. Stay tuned for more news on how GRA's future programming will integrate input from the Council. 💧

One Mouse Click to Help A Groundwater Student!

By Paul Parmentier, Lisa Kullen, and Thomas Harter

For nearly a decade, GRA's Branches have been engaged in the Scholastic Fund Program that benefits local academic programs and their students through student academic scholarships, student travel scholarships to GRA conferences, and scholastic support to academic departments researching California groundwater. To encourage donations to this important program, GRA partnered with the Water Education Foundation (WEF) and, in 2010, created a fully tax-deductible [GRA-WEF Scholastic Fund Program](http://www.watereducation.org/secure/GRAScholastic.asp) under WEF's 501(c)(3) status. Now, members can make additional donations at any time using our new website, <http://www.watereducation.org/secure/GRAScholastic.asp>.

Financial support also occurs as a portion of GRA Branch meeting event sponsorship by local GRA members, companies, and vendors of groundwater-related products or services. In 2009-2010, the Southern California Branch raised \$2,525; the San Francisco Bay Branch raised \$2,250; the Sacramento Branch raised \$3,700; and the San Joaquin Valley Branch, which just joined the Scholastic Fund Program, raised \$500 for a combined \$8,975.

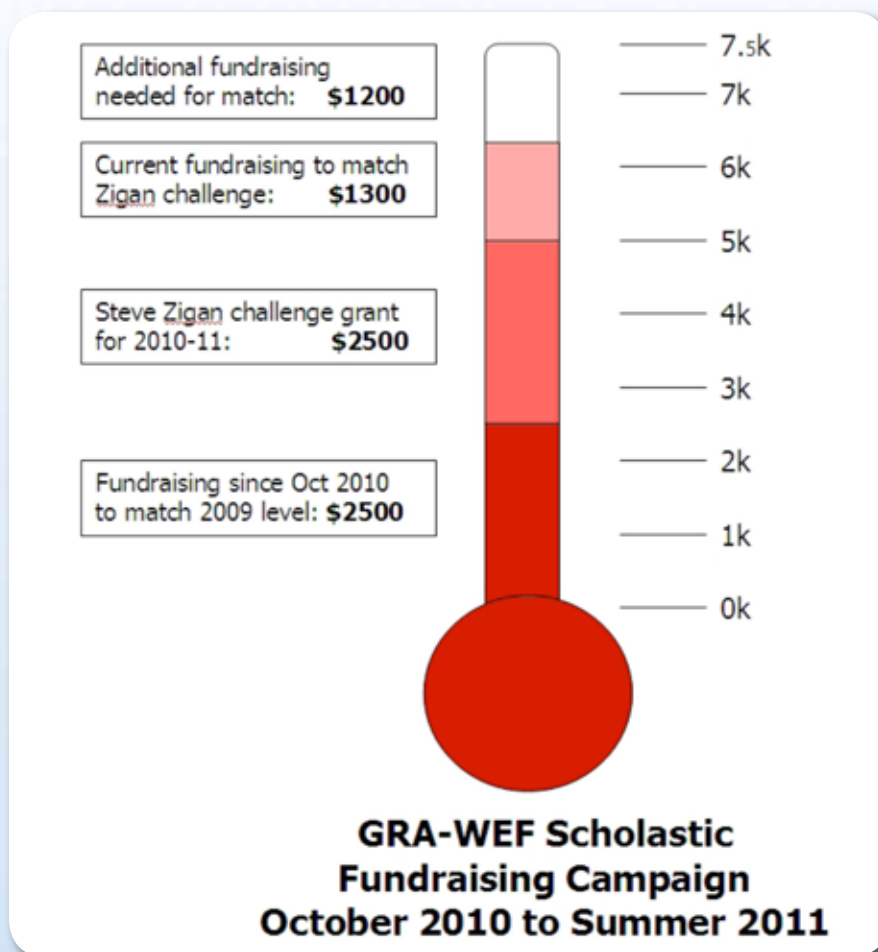
Individual member contributions collected through the GRA-WEF Scholastic Fund Program are used as incentive to match the Branches individual fundraising efforts. Participating Branches distribute the scholastic funds through their own programs, typically during the year following the fundraising effort. In 2009, GRA's Scholastic Fund Program awarded \$3,000 in scholarships to students. In 2010, the total award doubled to \$6,000. For 2011, scholastic support of over \$10,000 is anticipated to be available in response to the 2010

fundraising efforts at the Branch and statewide levels. This is an amazing achievement due to GRA's members and corporate donors!

The awards go directly to students and projects important to our groundwater resources. For example, in early 2011, GRA awarded funds to: Erik Cadaret of CSU Fullerton, who is studying hydrogeology and geochemical interactions in the Sheep Creek fan area to investigate the potential for artificial recharge; Tal Golan, who is pursuing a Masters Degree with focus on hydrogeology-related databases for several basins in the Mojave Desert; Katy O'Donnell, an undergraduate

student at CSU Sacramento, who is working with the USGS to research groundwater flow and heat flow near Mammoth Lakes for her senior thesis; Jennifer Kurashige of Cal Poly Pomona who will sample springs in the San Gabriel mountains; and Adam Hawkins, who is studying the use of fiber optic temperature measurements for understanding of geothermal systems. The scholarship fund has also sponsored student attendance at GRA conferences, dinner meetings and annual meetings for 18 students from four universities in northern California. GRA's contribution is pivotal in

Continued on the following page...



One Mouse Click to Help A Groundwater Student! – Continued

encouraging the students of today to study groundwater issues important to GRA's mission and to become the groundwater professionals and GRA members of tomorrow.

Inspired by the impact of this program, Southern California GRA member Steve Zigan generously offered a \$2,500 challenge donation to the GRA-WEF Scholastic Fund Program to promote contributions from other members (see our Winter 2010 edition of *HydroVisions*). Our goal was to raise \$7,500 between October 2010 and summer 2011, thereby meeting the \$2,500 (individual member) fund-raising level of the previous year plus matching Steve's challenge with an additional \$2,500 in donations from members. The response has been overwhelmingly positive; as of this writing, we are only \$1,200 from our goal. Your contribution to the GRA-WEF Scholastic Fund can help us achieve that goal – please consider making your contribution today or adding to your previous contribution. The GRA Home Page will lead you to the secure donation web site (<http://grac.org/scholasticfund.asp>) where you can make your contribution to the GRA-WEF Scholastic Fund Program. It's just one click to further groundwater education in California!

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Lists of individual donors have been included in previous editions of *HydroVisions*. 💧

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Renowned Promoter of the Importance of Groundwater Passes Away

T.N. Narasimhan (1935-2011)

Renowned professor, leader, international promoter of the importance of groundwater, and 2009 GRA Lifetime Achievement Award recipient, Dr. T.N. Narasimhan, passed away on April 29, 2011. His son, Dr. Ravi Narasimhan, wrote: “He battled lymphoma bravely and nobly for nearly ten months keeping his usual positive, upbeat spirit through a series of treatments, surgeries, and recoveries of increasing rigor. The combination of circumstances unfortunately affected his lungs and no recovery was possible. He was awake, alert, and conversing with family and friends up until a few minutes before the end, exhorting us to be and stay strong.”

Dr. Narasimhan was an Emeritus Professor in the Dept. of Materials Science and Engineering and the Dept. of Environmental Science, Policy, and Management at the University of California at Berkeley (UCB). He had more than 50 years of experience as a field practitioner, researcher, and professor in groundwater hydrology and water resources. His career was devoted to the study of water, including its scientific, engineering, cultural, human, and policy aspects.

Contributions to Environmental Engineering and Science

In 1956, he received his B.S. in Geology at the University of Madras, India, and began his career as a hydrogeologist in southern India as a member of the Indian Geological Survey between 1956 and 1969.

Dr. Mahdi Hantush provided a letter of recommendation that Narasimhan brought when he came with his family to the United States in 1970 to pursue graduate studies under Paul A. Witherspoon at UCB. He received his M.S. degree in Engineering Science from the UCB Dept. of Civil Engineering in 1971. Dr. Narasimhan studied under Prof. David Keith Todd, Ph.D. for his graduate work at UCB in Engineering Science. Dr. David Keith Todd was his advisor for his doctoral dissertation,



“A Unified Numerical Model for Saturated unsaturated Groundwater Flow” (1975). His research focused on the integration of concepts from porous media theory, soil mechanics, and soil physics to develop mathematical tools and computer codes for the study of transient fluid and soil behavior under saturated and unsaturated conditions in three-dimensional space for complex geological systems. His studies provided a foundation for later works.

One of his important contributions to groundwater science was the development, with Dr. Karsten Pruess of the Lawrence Berkeley National Laboratory, of a computer modeling concept to investigate the interaction between fluid phases in the porous blocks and fractures of rocks subjected to large temperature variations. In 1986, Dr. Narasimhan received GSA’s prestigious Oscar E. Meinzer Award.

Dr. Shlomo P. Neuman presented this award and discussed Dr. Narasimhan’s historical contributions (*Geology Bull.*, 1987).

International Promoter of Groundwater Awareness

He contributed substantially to international awareness of the importance of groundwater, having authored more than 110 technical publications and 36 reports, and made contributions to nine published textbooks in the field of hydrology and water resources.

In 1990, he received a joint appointment in the UCB College of Engineering and the College of Natural Resources to address scientific and engineering aspects of water and its human and policy implications. He considered this a high point in his career as he believed “the future of wise utilization of the world’s water is going to greatly depend upon the sciences and the humanities coming together in imaginative ways” (*UC Berkeley Engineering News*, September 19, 2005 Vol. 77, no. 4F).

Continued on the following page...

Renowned Promoter of the Importance of Groundwater Passes Away

– Continued

In 2000, the University of California Water Resources Center Archives began a program that assembled scholars of distinction to provide lectures as part of the *California Colloquium on Water*. From its outset, Dr. Narasimhan was the principal organizer of the series with lectures designed to increase the understanding and appreciation of water resources and contribute to informed decisions about water.

Throughout his more than 50 years of experience, Dr. Narasimhan displayed an extraordinary diversity of research, educational, and philosophical pursuits. He was passionate about the major challenges that lie ahead for our technological society to sustain water resources on local and global scales.

On October 7, 2009, Dr. T.N. Narasimhan was presented with the GRA Lifetime Achievement Award. Joined by his wife of 48 years, Vijaya, and his son, he accepted the award

with great appreciation. The full citation by Vicki Kretsinger Grabert is included in the Winter 2009 issue of *Hydro Visions* (<http://grac.org/hydrovisions.asp>).

Dr. Ravi Narasimhan (May 4, 2011) describes, “Ours is a Cal family. My father came to the U.S. to study here and stayed on. My mother has been on the staff for decades and I earned my undergraduate degree here in 1985. My father loved the University and LBL for the chance to pursue ideas for their own sake and without compromise. He spoke to me often about how he was only a short walk from an open, unfettered discussion with the best minds in any discipline. He was also immensely proud of the many students who worked with him and their independent accomplishments. These, to him, were the epitome of an institution of higher learning and he hoped Berkeley will always retain that commitment to the truth.” 💧



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By Tom Ballard,
Branch Secretary



The January meeting featured a talk by Steve Phillips with the USGS in Sacramento, California. The title of Steve's talk was *Groundwater and the San Joaquin River Restoration Program*. He summarized the present state of the ongoing effort to restore a large part of the San Joaquin River and the role that groundwater modeling plays in that effort. A primary goal of the SJRRP, a multi-agency effort led by the U.S. Bureau of Reclamation, is to restore salmon and other fish populations to the San Joaquin River from Friant Dam to the Merced River confluence. The increased river flows designed to accomplish this goal will result in increased seepage losses to the aquifer system, potentially exacerbating existing drainage problems in adjacent agricultural lands underlain by a shallow water table. Groundwater modeling will play a key role, coupled with monitoring, in estimating seepage losses and associated effects on the water table, establishing monitoring criteria to protect crops, and evaluating

management alternatives to reduce or avoid crop loss. The USGS Central Valley Hydrologic Model (CVHM), with its explicit representation of agricultural processes and routing of surface-water flow, is being used to support these and other aspects of the SJRRP. The regionally-scaled CVHM grid is being spatially refined near the river, and a detailed analysis of sediment texture in the region is being incorporated to better represent the natural heterogeneity of aquifer-system materials and their effects on groundwater conditions during restoration flows.

February's speaker was Mr. Jacob Gallagher, of WDC Exploration and Wells, who gave a presentation on *In-Situ Remediation Tips, Tools and Technology for Field-Level Implementation*. Mr. Gallagher, when faced with the possibility of spending his future in a windowless lab running protein assays, put his degree in Chemical Biology from UC Berkeley in a drawer and became a rig helper in the environmental drilling industry. The choice proved to be an invaluable opportunity to participate in real-world implementation of chemical oxidation/reduction and enhanced bioremediation technologies.

Mr. Gallagher's presentation focused on field-level strategies for delivering in-situ remediation reagents into the ground where they are designed to work. Whether it is peroxide, persulfate, permanganate, iron filings, rotten eggs, pancake syrup, salad dressing, macaroni & cheese sauce, or some proprietary blend of the above, it doesn't do any good sitting on a pallet in your 'staging area.' An environmental remediation project manager is faced with a number of hurdles from the conceptual to practical level. Should I use temporary injection points or permanent injection wells? How do I ensure that the product is cost-effectively batched according to the engineer's recommendations? How do I scale my budget from pilot-study to full-scale implementation? How can I stop remediation product from coming out of the cracks in the concrete of the neighboring middle-school parking lot? How can I maximize my radius of

influence? For the profit-margin-minded this also means 'return on investment,' these were all discussed at length. Bar charts, graphs and distribution plots were kept to a minimum, and practical, field-level tips and experience-based suggestions, combined with multimedia illustrations, made the presentation both engaging and insightful.

Rodney Fricke, GRA Sacramento Branch Treasurer also gave an update on Branch finances for the 2010 year.

The March meeting featured Mr. John Russell, P.G., of the California Underground Storage Tank Cleanup Fund. Mr. Russell's topic was *Update on Revisions to the Underground Storage Tank (UST) Cleanup Fund*. Mr. Russell is the Underground Storage Tank Cleanup Fund Manager with the California State Water Resources Control Board and has worked for the Regional and State Water Boards for the last 16 years.

Mr. Russell's presentation provided an update on UST Cleanup Fund activities, particularly the implementation of a new business model that the Fund has adopted in response to an external audit. This audit was prompted by recent revenue and cash flow problems, and identified areas of program administration where improvements could be made. These changes are critical to the future of the UST Cleanup Fund as the Fund expects to have annual reimbursement amounts for claims on the order of \$115 million, whereas past reimbursements have been running in the vicinity of \$250 million. The new business model, which includes annual budgets and classification and prioritization of UST Cleanup Fund reimbursements by project stage, is a major step in handling the reduced funding that will be available. The presentation also included updates on the new School District Account, Orphan Site Cleanup Fund, and the federal American Recovery & Reinvestment Act ("ARRA") funds used for petroleum UST brownfields. 💧

Southern California

By Paul Parmentier,
Branch Secretary

The 2010 Southern Branch officers retained their positions for 2011, and the year started with a presentation on January 19th of the Southern California GRA David Keith Todd Distinguished Lecturer, Dr. Prem Saint, Professor Emeritus, Cal State Fullerton. Dr Saint's presentation, "Groundwater: A Historical and Global Perspective," was based on his 40 years of field work in East Africa, India, Britain and Southern California. He captivated the audi-



The Chand Bouri in Central India

ence by describing groundwater usage in various part of the world, tracing the history of concepts dealing with groundwater development, and recent developments in Southern California. Dr Saint presented striking maps of water uses in South Asia and the Middle East, while reminding the audience of the significance of the water well in rural communities in India, noting personal memories of his upbringing in India, with photos of hand pumps and animal-powered well pumps. Dr.

Saint also discussed foreign terms that hydrogeologists should know: *bouris*, which are built as tiled vertical pools designed with ramps of stairs that allow access to water during seasons of high and low groundwater; and *qanats*, underground tunnels built over long distances to channel groundwater. Dr. Saint noted the archeological significance of previous river systems, and their connection with ancient civilizations.

To illustrate the historical growth in our technical understanding of groundwater, Dr. Saint started with the ancient Greek philosophers' notions of large groundwater reserves in the earth, like sponges. In the 1660s, Kircher described how sea water flowed deep at the bottom of seas and somehow recharged through underground connections to areas high up in the mountains. This era of speculation was followed in the 1400-1700s by Pierre Perrault's and others detailed measurements of rates of flow of the Seine, estimates of rainfall

and evaporation in the oceans. This was followed by the more modern science and engineering understanding of water, particularly in the U.S. The 1950s saw the emergence of computer models and planet-wide groundwater considerations, including recent climate change concerns. Dr. Saint identified numerous reports and included graphs and maps to demonstrate the loss of glacial ice in the Himalayas.

Dr. Saint then illustrated more local groundwater concerns in Southern California, including water imports, seawater intrusion into aquifers, recharge of treated surface water to replenish groundwater, the effectiveness of wetlands at Prado Dam, and the threat of precipitation from potential super storms to the Delta.

Dr. Saint's interesting and sobering view of groundwater resources brought into perspective the significance of groundwater and challenges for the future. 💧



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The Channel Islands

The Channel Islands are called the “North American Galapagos” because they are home to over 150 endemic or unique species. Anacapa and Santa Barbara Islands were designated as a national monument in 1938. In 1980, Congress included San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara as Channel Islands National Park.

Anacapa Island is the most popular destination because it is closest to the mainland. A 1.5-mile trail system allows visitors to experience the island’s vegetation, wildlife, and cultural history. Anacapa Island also has a rich human history. Shell midden sites indicate where Chumash people camped on the islands thousands of years ago. Visitors can also view the 1937 light station whose Mission Revival style buildings include the lighthouse, fog signal building, a water tank building, and other structures.

Anacapa Island has no streams or surface water. During the light station era, a large concrete catchment basin was constructed on the island to collect rainwater into two 50,000-gallon, redwood storage tanks located up the hill from the dwellings. The eight inches of annual rainfall typical for this arid setting was inadequate to supply the inhabitants. Additional fresh water had to be periodically shipped to Anacapa Island and pumped up to the tanks. A two-story concrete building, known as the “church,” was later built to protect the precious water supply.

A visit to Channel Islands National Park requires special planning. For additional information refer to: <http://www.nps.gov/chis/index.htm>

Photograph by John Karachewski, PhD (DTSC)