

HYDRO VISIONS

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Hydraulic Fracturing and Water Resources A California Perspective

Frederick T. Stanin, ARCADIS U.S., Inc.

On July 24, 2012, GRA held the first symposium in its Series on Groundwater and Energy, titled *Hydraulic Fracturing and Water Resources – A California Perspective*. Held in Long Beach, the symposium featured 15 speakers in four sessions, a panel session, a keynote speaker, five exhibitors, and over 100 attendees. GRA's Organizing Committee for the symposium consisted of Murray Einarson of Haley and Aldrich, Tim Parker of Parker Groundwater, Ted Johnson of the Water Replenishment District of Southern California, Chris Peterson of West Yost Associates, Brian Lewis of the DTSC, and Fred Stanin of ARCADIS U.S., Inc.

The four sessions presented: (1) an overview of hydraulic fracturing; (2) fracking in California; (3) potential impacts to groundwater resources; and (4) regulatory, legal and environmental issues. The keynote speaker, California Assemblyman Robert Wieckowski, is the author of AB 591, a bill aimed to require disclosure of chemicals used by oil and gas producers engaged in hydraulic fracturing.

Why a symposium on hydraulic fracturing? Stated simply, hydraulic fracturing as applied in the current revolution of natural gas exploration was the environmental story of 2011. Although hydraulic fracturing has been conducted in the oil and gas industry since the late 1940s, more recent advancements in the technologies of horizontal drilling and hydraulic fracturing led to targeting organic-rich shale formations (e.g., “shale gas” plays) previously viewed almost exclusively as source rocks from which petroleum hydrocarbons migrated into more permeable reservoirs.

California is a relative latecomer to this revolution and was the focus of the symposium. Following the first large-scale development of shale gas reserves in north-central Texas, and the recent exploration for gas in the Marcellus Shale in



Shonnie Cline of Water Research Foundation speaks in the first session along with Rob Habel of DOGGR and moderator Murray Einarson to provide an overview of hydraulic fracturing.

the Eastern U.S., it has now come to California—mainly the Monterey Shale—but the target is oil instead of gas.

With this increase in exploration and associated hydraulic fracturing come a number of concerns. There is the potential for hydrofracturing fluids and produced fluids (including oil and gas) to migrate into freshwater aquifers. Other concerns are more conventional. Recovered fluids must be properly managed at the surface, as they contain constituents (e.g., metals, salts, NORM) not present during initial injection. Because completions of shale gas/oil wells use hundreds of thousands to millions of gallons of water per well, there are concerns with depletion of water resources. Noise and other nuisances from drilling and completion activities, impacts

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California's Worst Pollutants Include Salt and Nitrate

By Sarah Raker

I've been working on sites with polluted groundwater for 25 years. My work has focused on delineating and remediating groundwater contamination, primarily chlorinated solvents and petroleum, derived from legacy industrial and military operations. Although these point-source pollutants can be challenging to characterize and can be very expensive to effectively remediate, the responsible parties tend to be former property owners or operators at the site and can be readily identified. The regulatory requirements for assessing and cleaning up contaminated soil and groundwater from point sources have been in place since 1969 when the Porter Cologne Water Quality Act was passed. Basin Plans outline beneficial uses and water quality objectives that help guide the process.

But some of California's worst pollutants are salt and nitrate, which are pervasive, chronic, and derived from multiple sources, often non-point. California's Central Valley has been accumulating salt and nitrate since the 1800s by way of irrigated agriculture (fertilizer), dairies (animal waste), septic systems, industrial manufacturers, municipal wastewater, oil field brines, and food processors. The rate of accumulation increased substantially in the San Joaquin Valley with the development of the federal Central Valley Project in the 1950s and the State Water Project in the 1960s. Sources of salt in water from these Projects include natural sources and the anthropogenic sources listed above. Receptors include industry, agriculture and local communities. Disadvantaged communities are particularly at risk because they cannot afford

the cost for water treatment, and it is difficult to assign financial responsibility to a wide range of potential parties. Although Basin Plans currently provide a regulatory framework for protecting water quality through total maximum daily loads (TMDLs), waste discharge requirements (WDRs) and NPDES, they are sorely out of date with respect to salt and nitrate. The current regulations do not fit the diverse sources and impacts that result from salt and nitrate contamination in groundwater.

I had the pleasure of attending GRA's recent symposium on salt and nitrate in groundwater held in Fresno this June (please see the summary article in this edition of *HydroVisions*). GRA held two previous symposia on nitrate contamination in 2002 and 2006. For those of you who work outside the Central Valley or who work on typical point-source projects like me, it's time for CV-SALTS to become a household word.

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a strategic initiative to address salinity, including nitrates. CV-SALTS was developed as a cooperative effort between the Central Valley Regional Water Quality Control Board, the State Water Resources Control Board, and the Central Valley Salinity Coalition, composed of Central Valley water users – cities, sanitation districts, and industry organizations. Their mission is to “develop a comprehensive regional salinity and nutrient management plan that is robust enough to support Basin Plan amendments.” Ultimately, they plan to work with stakeholders to update beneficial uses, water quality objectives, and policies through Basin Plan amendments.



CV-SALTS is focusing on the Central Valley Salt and Nutrient Management Master Plan, and will soon create area-specific plans. They will focus on the Sacramento River, San Joaquin River and the Tulare Lake Basins, and the Delta Plan for salinity management.

These plans must also comply with the recycled water policy requirements for both regulated discharges and unregulated sources. For example, in some cases, increased salt loading may be required to allow for water recycling. As noted at the symposium, the Basin Plan amendment process has improved recently, but CEQA has been an added burden. The updated plans also need to include monitoring and reporting requirements. But most importantly, the plans need to require management practices to minimize loading. Several examples were provided at the symposium.

Please learn more about this important issue at www.cvsalinity.org/. 💧

Cheers – Sarah Raker,
GRA President

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Hydraulic Fracturing and Water Resources – A California Perspective

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Lunchtime speaker Assemblyman Robert Wieckowski informed the crowd of the status of his bill AB591, which would require disclosure of chemicals used in hydraulic fracturing.

to the landscape due to surface disturbance, and potential impacts to air quality from wellsite operations and associated vehicular traffic are additional concerns. Finally, the burgeoning development of shale gas/oil is seen by some as an impediment to development of alternative sources of energy.

All of these issues were examined during the symposium. The Keynote Address by **Robert Wieckowski**, California Assemblyman and author of AB 591, emphasized that the bill is about requiring operators to disclose the chemical components of their hydrofracturing fluids. One of the biggest challenges is fashioning language that promotes disclosure but also protects trade secrets.

The first session, an *Overview of Hydraulic Fracturing*, featured three speakers: **Murray Einarson** of Haley and Aldrich, who also served as moderator; **Rob Habel** of the California Division of Oil, Gas, and Geothermal Resources (DOGGR), and **Shonnie Cline** of the Water Research Foundation. Murray Einarson opened the symposium by remarking about how

hydraulic fracturing in California may be different from other areas in the U.S., particularly with respect to the target hydrocarbon (oil instead of gas), and also about how oil and gas operators are looking at the limits of the definition of Underground Sources of Drinking Water (USDW) as contained in the Code of Federal Regulations. Rob Habel said that current hydrofracturing activity in California is related to oil production from the Monterey Shale. He emphasized that California has a rather fragmented state government, impacting the regulation of hydraulic fracturing. The relevant role of DOGGR is to prevent damage to hydrocarbon reservoirs by promoting efficient recovery of oil and gas. DOGGR does not oversee hydrofracturing operations at present and is developing well construction regulations to be released in 2013. Shonnie Cline identified the primary research needs of the water community as: the prediction of chemicals in flowback and produced waters, and improved analytical methods; water supply monitoring protocols; and the identification of subsurface risks (including casing issues).

The second session, *Fracking in California*, was moderated by **Tim Parker** of Parker Groundwater and featured three speakers: **Tupper Hull** of the Western States Petroleum Association (WSPA); **James Melrose** of Halliburton, and **Ed Pinero** of Veolia Water North America. Tupper Hull emphasized that because of California's long oil and gas history, the state has extensive experience regulating oil and gas exploration and production, and thus the industry is already sufficiently regulated. He reported that in 2011, there were 628 wells in the state that were hydraulically fractured by operators which are members of WSPA. James Melrose indicated that the primary areas of interest in California are the Santa Maria/Ventura/Los Angeles Basins (onshore and offshore) and the San Joaquin Basin (mainly Kern County), all involving the Monterey Shale. Because the targeted oil is viscous, hydrofracturing operations require more proppant than in other areas and a very viscous hydrofracturing fluid to carry the proppant. The result likely will be less hydrofracturing fluid used per well, and thus lower water demand than in other areas of the country. Mr. Melrose also indicated that vertical wells may prove to be economically viable, relieving the need for more expensive and water-intensive horizontal wells for hydrofracturing operations. Thus, the per-well volume of hydrofracturing fluid may be significantly less in California than in other areas. Ed Pinero shared his knowledge and experience with control and treatment of flowback and produced waters from hydrofracturing. He emphasized that many such operations are modular, and have a relatively low environmental footprint compared to centralized facilities. With treatment, the salts and solids in the recovered waters are the biggest issues, but are manageable.

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The symposium ended with a lively Q&A session with the audience and panel members covering a broad spectrum of viewpoints, including (from left to right); Rob Habel (DOGGR), Shonnie Cline (WRF), David Albright (USEPA), Earl Hagstrom (Sedgwick Law), Damon Nagami (NRDC), Ted Johnson (WRD), John Connor (GSI Environmental), and moderator Murray Einarson (Haley & Aldrich).

The third session, *Potential Impacts to Groundwater Resources*, featured four speakers: **Mike Nickolaus** (Groundwater Protection Council); **John Connor** (GSI Environmental, Inc.); **Ted Johnson** (Water Replenishment District of Southern California), who also served as moderator; and **Mark Zeko** (Environmental Engineering and Contracting, Inc.). Mike Nickolas presented an overview of his Groundwater Protection Council, an association of state regulatory agencies, who have developed an on-line chemical disclosure registry called FracFocus, where the public can access posted information on the chemical compositions of hydrofracturing fluids on a per-well basis. John Connor presented his experience with groundwater contamination issues related to oil and gas activity and hydrofracturing operations. He indicated that methane is usually the main issue, and the challenging is determining the source(s) of that methane which is often naturally occurring as opposed to being from drilling and well completion operations. Ted Johnson gave a summary of his water district's experience with managing groundwater resources within a basin having a

long oil and gas production history. He indicated that with 9,700 oil and gas wells and over 400 fresh water wells, there are no fresh water contamination issues stemming from the oil and gas activity. Mark Zeko summarized the experience of his firm in Pennsylvania and West Virginia related to hydrofracturing operations. They have found that most of the concerns, sometimes initially disguised as health issues, are really complaints about nuisance – annoyance with noise, traffic, and other inconveniences.

The fourth session, giving an overview of *Regulatory, Legal and Environmental Issues*, was moderated by **Fred Stanin** of ARCADIS U.S., Inc., and featured four speakers: **James Pierce** of DOGGR; **David Albright** of USEPA; **Damon Nagami** of the Natural Resources Defense Council (NRDC); and **Earl Hagström** of Sedgwick Law. James Pierce examined the possibilities of DOGGR to regulate hydrofracturing operations with existing regulations. David Albright discussed the roles of the federal government, which are mainly associated with the deep injection of oil and gas field waters. He

indicated that unless diesel is involved as a component of hydrofracturing fluids, the USEPA has no authority over such operations under the Safe Drinking Water Act. Damon Nagami indicated that the NRDC's position is not to ban hydrofracturing altogether, but instead to support a moratorium on the technique until adequate safeguards are put in place, because there is a general lack of information about hydrofracturing and no California-specific studies of the potential environmental impacts. Earl Hagström added the perspective of a defense attorney. He presented hydrofracturing issues as being about risk and reward, but that there is the possibility of transferring the risk to other parties by means of contract or insurance. He predicted that there will be a lot of litigation over insurance claims.

The fifth session was a panel discussion, moderated by Murray Einarson, comprising the following panelists: David Albright, Shonnie Cline, John Connor, Rob Habel, Earl Hagström, Ted Johnson, and Damon Nagami. The panel took questions from the moderator and from those in attendance. The most memorable moment was when **Dr. John Cherry**, the renowned hydrogeologist from the University of Guelph, characterized the activities in the U.S. as a grand experiment with no proper scientific research on the effects of hydrofracturing on the environment. He challenged the funding mechanisms for such research in the U.S. because of the ties between universities and industry (or other parties), and indicated that the U.S. would be better off with a funding system similar to that in Canada, where the funding is not similarly tied and thus scientific research can proceed relatively unencumbered.

If you have any questions regarding the symposium, please contact the author at fred.stanin@arcadis-us.com. 💧

Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem

By Michael Steiger, Erler & Kalinowski, Inc.; Thomas Harter, University of California, Davis; Vicki Kretsinger, Luhdorff & Scalmanini, Consulting Engineers; Jean Moran, California State University East Bay; Daniel Cozad, Integrated Planning and Management; Jim Strandberg, Erler & Kalinowski, Inc.; Sarah Raker, AMEC Environment and Infrastructure, Inc.; and Penny Carlo, Carollo Engineers

GRA, in collaboration with the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) Initiative and the Central Valley Regional Water Quality Control Board, held the 26th Symposium in GRA's Series on Groundwater Contaminants, entitled "Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem," on June 13–14, 2012 in Fresno. The 171 participants included scientists, practitioners, governmental agencies, nongovernmental organizations, and private business interests, particularly the agricultural, dairy, and food processing industries.

The United Nations' visit to Tulare County in 2011 and subsequent report on safe drinking water and sanitation for low-income communities in the San Joaquin Valley highlighted growing concerns about the decades-old problems of salt and nitrate in California's groundwater. Nitrate concentrations in groundwater exceeding the drinking water standard pose a difficult challenge for disadvantaged communities (DACs) and in private water supply wells that serve rural residences. Salt accumulating in the soil and groundwater in the San Joaquin Valley threatens agricultural viability and the sustainability of California's water systems.

Opening Session: Overview of Drinking Water and Source Control Policy, Regulation, Funding, and Training/Education

Laurel Firestone, Director of the Community Water Center, described the impact of elevated groundwater nitrate levels on drinking water supplies in DACs. These communities carry a disproportionate burden of the impact and face a host of institutional, infrastructure and community challenges. Ms. Firestone outlined four dimensions to address this issue (see Figure 1). Regulatory agencies, in response to a 2002 sunset on general waivers for agriculture and other diffuse sources of nitrate and salt, are developing new regulatory programs. **Pamela Creedon**, Executive Officer for the Central Valley Regional Water Quality Control Board (CVR-WQCB), oversees the largest of these programs. Her Board regulates 80% of irrigated land, 40% of waste discharges, 30% of NPDES facilities, and more than 50% of DACs in the state. Two years ago, the Board adopted a "groundwater protection strategy." The first comprehensive regulatory program for nitrate and salt pollution of groundwater was the 2007 dairy program. Currently, the Board is developing regulations for agriculture under the Irrigated Lands Regulatory Program (ILRP). An even broader group of dischargers are engaged in CV-SALTS, a stakeholder driven process for managing discharges of salt and nitrate to groundwater and surface water. Ms. Creedon highlighted some

of the most challenging dilemmas: tackling the issue of legacy vs. current nitrate and salt contributions; interdependency of DACs and agriculture; integration of regulatory and non-regulatory solutions; and diversity and complexity of salt and nitrate sources, which prevent a one-size-fits-all approach. **Angela Schroeter** of the Central Coast Board outlined their approach, which focuses on Central Coast basins from the Salinas Valley southward. Nitrate affects nearly 25% of community wells in these areas. The Board is implementing stricter source control, monitoring, and assessment. In March, the Board introduced a tiered farm regulatory program whereby prescribed management practices, monitoring and reporting levels vary by tiers.

Session 2: Nitrate in Groundwater – Quantifying Fluxes, Identifying Sources, and Following Their Fate and Transport

Sonja Brodt of UC Davis discussed the mass balance approach used in the California Nitrogen Assessment (CNA) to quantify sources of reactive nitrogen statewide (Figure 2). **Jean Moran** of CSU East Bay discussed the fate and transport of nitrate in the Salinas Valley. Denitrification was found to affect nitrate transport along the Salinas River despite local differences in the recharge rate and dominant water source. Examination of isotopes and other tracers in a deep supply well revealed complex flow and mixing of nitrate-laden irrigation recharge water with young and old groundwater in the well's capture zone. **Gary Eppich** of Lawrence Livermore

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Figure 1: The four dimensions for a successful strategy to find long-term safe drinking solutions for disadvantaged communities (Laurel Firestone, Community Water Center)

Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem – Continued

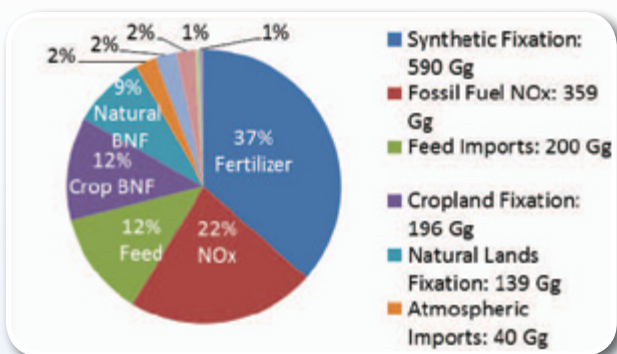


Figure 2. Statewide nitrogen input in gigagrams (Gg) of nitrogen per year. BNF = biological nitrogen fixation. Flows of biologically available nitrogen in terrestrial ecosystems has doubled since 1960 (Sonja Brodt, University of California, Davis).

National Laboratory, discussed a case study of nitrate source determination in San Diego County using multiple isotopic tracers, including nitrogen, oxygen, and boron. Nitrogen and oxygen isotopes can be used to rule out nitrate fertilizer, but cannot distinguish between other sources. The addition of boron isotopes may allow a more definitive assessment.

Session 3: Fate and Transport of Nitrate

Matthew Landon of the U.S. Geological Survey (USGS) described the results of nitrate synthesis analysis from the statewide Groundwater Ambient Monitoring and Assessment (GAMA) priority basin project. Statistical and spatial analysis of GAMA and California Department of Public Health (CDPH) data lead to the following conclusions: 1) nitrate is higher than the MCL in 3% of aquifers used for public supply, 2) most groundwater is oxic and denitrification is not expected to occur, and 3) increasing nitrate concentration trends are observed in select basins where land use is agricultural; decreasing trends are observed in areas where land use has changed from agricultural to urban. Ate Visser of Lawrence Livermore National Laboratory used the same GAMA data to examine nitrate in “tritium-dead” supply wells. He explained the rationale for using wells with < 1 pCi/L tritium and oxic conditions to assess background nitrate concentrations. Although significant spatial variability exists in background nitrate

concentrations, no tritium-dead wells exhibit concentrations above the MCL (Figure 3). These results can be used to assess recent impacts on groundwater quality and to calibrate and test models of aquifer vulnerability.

Christopher Green of the USGS discussed the role of heterogeneity in the transport of nitrogen in groundwater. Future nitrate concentrations for the central eastern San Joaquin Valley have been modeled using multiple geological realizations and mixed samples typical of heterogeneous systems. Modeling shows nitrate concentrations are likely to increase unless conditions change substantially. Andrew Fisher of UC Santa Cruz discussed the fate and transport of nitrate in Harkins Slough, an area of the Pajaro Valley Groundwater Basin with active managed aquifer recharge (MAR). Detailed chemical and isotopic analyses

show denitrification significantly reduces nitrate concentrations during infiltration. Nitrate concentrations also are reduced by dilution during recharge and transport (Figure 4). Further research is needed to assess how complex and dynamic infiltration and biogeochemical processes can be used to reduce nitrate concentrations in groundwater.

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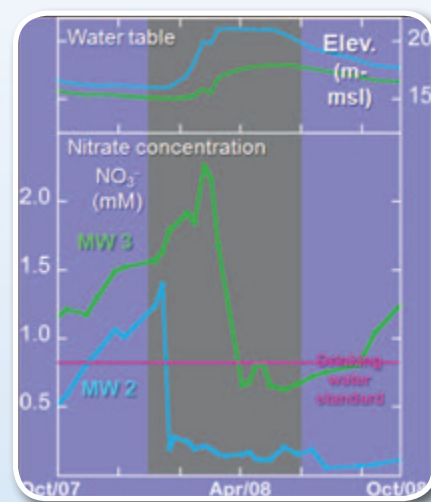


Figure 4. Results from monitoring wells in the Harkins Slough area of the Pajaro Valley Groundwater Basin, showing a sharp decrease in nitrate concentration corresponding to a rise in the water table caused by artificial recharge (Andy Fisher, University of California, Santa Cruz).

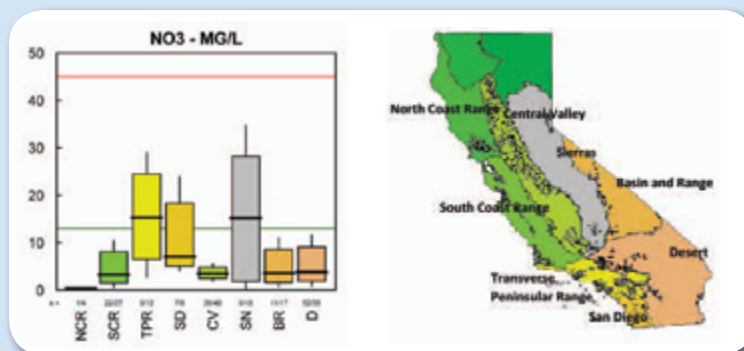


Figure 3. Box-and-whisker plots (a) of nitrate concentration distributions for eight provinces defined under the GAMA priority basin project. Shown are the median value (black line), 25th and 75th percentiles (boxes), and 1.5x the interquartile range (whiskers). Locations (b) for GAMA priority basin project provinces, as abbreviated on figure 3a (Ate Visser, Lawrence Livermore National Laboratory).

Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem – *Continued*

Session 4: Managing Nitrate Sources and Contaminated Groundwater

Kristin Dzurella of UC Davis discussed how improved agricultural practices, particularly those associated with field fertigation, can reduce the contribution of nitrate to groundwater. Economic and logistical barriers hinder widespread adoption of improved practices (e.g., drip irrigation and soil nitrate testing). Education and outreach are critical to facilitate adoption of improved practices. David Orth of the Kings River Conservation District discussed how the California Legislature has consistently found that groundwater management best occurs at the local level. Management efforts such as SB 1938 plans, Integrated Regional Water Management Plans, and the evolving ILRP will play important roles in addressing nitrate contamination in community drinking water supplies. J.P. Cativiela of Dairy CARES discussed regulations adopted by the CVRWQCB that require dairies to demonstrate that their manure management practices are protective of water quality. Dairy operators are required to monitor first-encountered groundwater, traditionally conducted on a dairy-by-dairy basis. The Board is now allowing monitoring to occur through a representative monitoring program (RMP) in which dairies gather data to document the relative effectiveness of various management practices. The RMP has been implemented as a non-profit fee-based membership association, which presently comprises approximately 1,300 individually owned and operated dairy farms. Adam Zacheis of Carollo Engineers presented results of pilot studies using fixed-bed biological treatment, which can provide an alternative to the add-on unit process approach by eliminating multiple organic and inorganic contaminants in a single reactor, thereby potentially minimizing costs

and plant footprint. Biological treatment also allows for the treatment of water sources without brine disposal.

Session 5: Drinking Water: Treatment/Alternative Supply Options

Vivian Jensen of UC Davis discussed treatment technology options for removal of nitrate from potable supply wells. She summarized recent advances in nitrate treatment and provided a detailed cost comparison of the two most common technologies, ion exchange and reverse osmosis. Small systems will benefit from continued research and development of new and emerging technologies, waste management and minimization, and improved efficiency to reduce costs. Jay Lund of UC Davis reported his evaluation of alternative supply options, regionalization, and costs for small water systems in the Tulare Lake and Salinas basins. Dr. Lund's key take-home messages were that 1) safe drinking water is the most pressing issue, yet there are significant challenges related to organization and funding; 2) nitrate loading can be reduced, long-term, with training, research, investment, compliance, and funding; and 3) the state needs to collect and organize data to allow for better assessment. Mike Waite of Ionix SG Ltd. described a means for the removal of nitrate for brine disposal. An existing single-use, throwaway method was converted to a closed-loop, multiple re-use method by combining advanced ion exchange regeneration methods with an electrocatalytic nitrate reduction cell. In the cell, nitrates are efficiently reduced to nitrogen and oxygen gases, with the brine recovered and reused onsite, in North Davis Meadows, CA. Robert Borch, an independent consultant, presented progress in a decade-long development of robust, low-cost denitrifying bioreactors for groundwater and surface water bioremediation of nitrate, perchlorate, selenium, and

metals. The objective of his research has been to combine simple construction and operation with well-defined microbial mechanisms for biological removal of the pollutants.

Dinner and Panel Discussion: What are Appropriate State and Local Activities for Managing Nitrate Problems in California

Paul Sousa of Western United Dairymen emphasized achievements of dairies in collecting data on their manure and nutrient management practices intended to reduce nitrate impacts to groundwater. Danny Merkley of the California Farm Bureau Federation suggested existing water bond funding should be more flexibly spent to address nitrate drinking water issues. Undersecretary of Food and Agriculture Sandy Schubert informed the audience the governor's mandate is to get state agencies out of their "silos" and have them collaborate on streamlining and avoiding duplication of regulations. She emphasized the need to address nitrate drinking water issues through a cooperative approach and promulgation of regulations that are practical and offer incentives to comply. Dave Spath of the CDPH pointed out nitrate was the hot-button water-quality topic in 1972; his agency has since collected extensive water quality data and is working to coordinate state efforts to support affected communities. He pointed out that—unlike other contaminants—no safety margin is built into the nitrate MCL, and that acute toxic effects are seen in infants at the MCL. State Water Resources Control Board member Francis Spivy-Weber underscored the need for a collaborative approach. Although her agency provides guidelines and funding for pilot projects, she believes much of the initiative has to come from affected communities and associated stakeholder groups. Debbie

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Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem – Continued

Davis of the Governor’s Office affirmed this position. **Maria Herrera** of the Community Water Center, speaking on behalf of DACs, pointed out that individual households in DACs are shouldering a very large burden of nitrate impacts, often paying 10% of household income for clean water.

Session 6: The Recycled Water Policy and Salt and Nutrient Management Planning

Tim Moore of Risk Sciences, and the current Policy Facilitator for CV-SALTS, provided an overview of CV-SALTS challenges and other programs addressing salt and nitrate in the Central Valley. The salt and nitrate challenges facing stakeholders in the valley are interconnected and will require creative and collaborative solutions. **Bobbie Larson**, an attorney with Somach Simmons & Dunn, discussed the 2009 Recycled Water Policy and stakeholder involvement in developing the policy. The regulated community was seeking a consistent approach to minimize project delays, increased costs, and uncertainty. NGOs were seeking a comprehensive manner to address salinity in groundwater. The

policy recognized the need for a basin-wide approach, and requires submittal of Salt and Nutrient Management Plans (SNMPs) by May 2014, with up to a 2 year extension. **Robert Beggs** of Brown and Caldwell discussed Camp Pendleton’s SNMP and its impact on the Camp’s use of recycled water. 99% of Camp Pendleton’s water is groundwater, which is largely dependent on recharge from upstream areas (Figure 5) with a long history of litigation and negotiation. A SNMP was developed to understand sources and sinks of TDS, sodium, chloride, and nitrate. A groundwater model used to evaluate potential management strategies indicated that advanced water treatment with recycled water injection as a saltwater intrusion barrier provided several benefits with no significant constraints.

Session 7: Part I - Salinity Source Control and Treatment

Parry Klassen, current Chair of the CV-SALTS Executive Committee and representing the East San Joaquin Water Quality (ILRP) Coalition, presented an overview of the Management Practice Committee and the Salt and Nitrate Practice Tool Box. This set of tools for review, validation and archival of management practices accommodates agricultural and other practices. **Burt Fleisher**, representing Hilmar Cheese, the largest cheese manufacturer in California, summarized its history in salt control. The company has tested many different treatment technologies and process changes to reduce salinity in discharged water. He reviewed the effectiveness, cost and compliance they have achieved. **Bob Croback** and **Gary Carlton** of Kennedy Jenks Consultants discussed the Management Practice Manuals from the Wine Institute and California League of Food processors. They discussed the purpose, history and development of the manuals, which are now being used to implement controls and practices in many facilities in these industries.

Session 8: Part II – Salinity Source Control and Treatment

Matt Zucca of Erler & Kalinowski, Inc. presented salinity impacts due to water conservation by the City of Woodland, and the City’s long-term salinity reduction program. A water conservation model was used to estimate water savings and the resulting salinization of inflow to the WWTP. The City has developed a salinity reduction program and is working with the City of Davis to construct a 300 MGD WWTP to improve its source water quality. The City also banned the use of new self-generating water softeners to reduce influent salinity. **Joe McGahan** of Summers Engineering discussed the Grasslands Bypass Project and its success in reducing selenium discharges to the San Joaquin River (SJR) and improving water quality in area wetlands. The Project consolidates regional drainage flows and uses the San Luis Drain to convey the flow around habitat areas. Innovative efforts by farmers, including water conservation and reuse of drainage water on salt tolerant crops, have significantly reduced salt loads to the SJR (see Figure 6). **Nigel Quinn** of the Lawrence Berkeley National Laboratory and the U.S. Bureau of Reclamation discussed real-time

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Figure 5. Conceptual model of sources and sinks for the Camp Pendleton Salt and Nutrient Management Plan (Robert, Beggs, Brown and Caldwell).

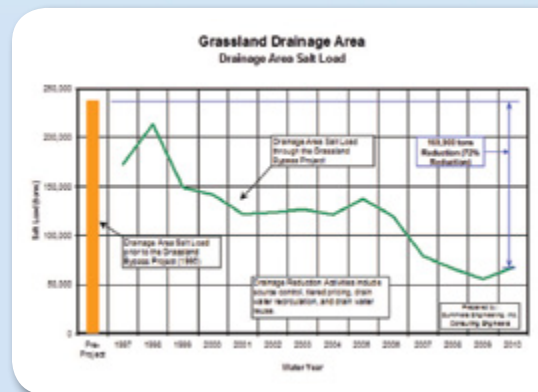


Figure 6. Grassland Drainage Area salt load reductions (Joseph McGahan, Summers Engineering).

Salt and Nitrate in Groundwater: Finding Solutions for a Widespread Problem – Continued

salinity management in the Grassland water District in the SJR Basin. A real-time water-quality monitoring network provides data to develop and calibrate a daily salinity mass balance model. Conclusions include (a) real-time management can be an integrator of existing monitoring, modeling, and river flow forecasting efforts; (b) data management and real-time data QA are key to successful implementation; and (c) full cooperation of stakeholders is required to successfully implement a Basin-wide program.

Session 9: Salt Consolidation and Treatment Technologies

Vashek Cervinka, retired from the Department of Water Resources, discussed the Integrated On-Farm Drainage Management (IFDM) system at AndrewsAg Farm in Kern County. The 1200-acre farm historically disposed of drainage water into a 100-acre evaporation pond with high selenium and salinity. The IFDM system allows for pond closure without taking the farm out production; this has proven successful economically and ecologically and produces high value crops. **Dr. Karl Longley**, board member with the CVRWQCB, discussed the key aspects of salinity mitigation in the Central Valley. He described the role of the CVRWQCB and CV-SALTs, presented how other countries have coped with the salinity dilemma, and discussed in-valley and out-of-valley salinity management solutions. Salt concentration technologies include desalination and brine disposal, IFDM with brine shrimp and biofuel production, salinity gradient solar ponds (Figure 7), and salt extraction and mining. **Frank Schubert** of Combined Solar Technologies discussed a desalinization system designed for the City of Tracy for removal of salt from wastewater to comply with Delta salinity standards. The evaporative process is powered by dried almond shells, and the system generates electricity used to power the WWTP. The project faces



Figure 7. Photograph of a salinity gradient solar pond (Karl Longley, California Regional Water Quality Control Board).

many challenges, including complying with air quality standards, political opposition, and large up-front cost, but is moving toward construction within a few years.

Session 10: Panel Discussion: Perspectives on Salt and Nutrient Management and the Recycled Water Policy

The closing panel discussion provided five perspectives on California's salt and nitrate management in practice, led by Karl Longley, Chair, CVRWQCB. Kurt Berchtold, Executive Officer of the Santa Ana RWQCB, emphasized the need to include compounds of emerging concern along with salt and nitrate in future monitoring programs. Although Santa Ana successfully amended its Basin Plan to allow flexibility in managing salt, ongoing updates of the SNMP will be needed in response to changes in water quality and various agency projects. Pamela Creedon, Executive Officer for the CVRWQCB, noted that salinity mass has doubled in the Central Valley since 1940s. She stressed the importance of awareness of the issue in California and crafting effective solutions. David

Cory, representing farmers, indicated that they are concerned that using recycled water will create a public relations problem. Tracy Egoscue, former Executive Officer of the LARWQCB discussed how the recycled water policy was started in the LA basin when golf courses began to use recycled water. Although salt and nitrate were the initial concerns, compounds of emerging concern, VOCs, and other pollutants were also considered. Toby Roy of the San Diego County Water Authority emphasized that Regional Boards need to work with stakeholders to incorporate implementation plans into their basin plans that provide flexibility and focus on the most effective approaches for managing salts. 💧

LETTER TO THE EDITOR

Dear Editor,

We were disappointed to read Bart Simmons's article in the Winter 2011 edition of *Hydro Visions*, primarily because Mr. Simmons presents no substantiation of his claim "that organic food production has detrimental effects on groundwater, as well as other potential environmental effects."

Without citing data, Simmons states, "... nitrate leaching ... [is] greater for organic farming because of the lower yield and the need for cover crops between cash crops."

Unfortunately, little research has been conducted in the U.S. substantiating the positive impact of organic farming on water quality. What little data does exist consistently indicates that organic farms have significantly less herbicide, pesticide, and nutrient losses to the environment than non-organic farming.

Specifically, long-term organic management has been found in numerous studies to decrease nitrate leaching from soils (Snapp et al. 2010; Burger and Jackson 2004; Kramer et al. 2006; Poudel et al. 2002; McIsaac 2001).

One example: data from a recently published 12-year study show that fields under organic management had half the annual nitrate leaching losses than fields under conventional management (Snapp et al. 2010).

Mr. Simmons's suggestion that organic farming is bad for global climate change because it has greater nitrous oxide emissions is misleading. Nitrous oxide is produced through natural bacterial processes in soil that can be stimulated by a wide range of agricultural practices including growing nitrogen-fixing legumes, a common practice in organic farming.

Contrary to the study by the Manchester Business School, Agricultural Research Service, scientists in the U.S. have documented that, after 9 years, organically managed plots had a global warming potential of $-1069 \text{ kg CO}_2 \text{ ha}^{-1} \text{ y}^{-1}$ equivalents compared to a GWP of $1110 \text{ kg CO}_2 \text{ ha}^{-1} \text{ y}^{-1}$ equivalents found in the no-till system (Cavigelli et al. 2009). This is because, despite increases in N_2O flux in the organic system, these were more than counter-balanced by the levels of carbon sequestered under organic management.

We are always open to receiving new data on the performance of agricultural management systems; however, Mr. Simmons's article offers no new information and is inaccurate and misleading. In fact, organic farming is playing a significant role in helping mitigate global climate change and reducing nitrate leaching into ground and surface waters. The potential of organic farming to provide such environmental services deserves much greater scientific scrutiny.

Sincerely,

Jane Sooby
Organic Farming Research
Foundation

Citations

Burger, M. and L.E. Jackson, "Plant and microbial nitrogen use and turnover: rapid conversion of nitrate to ammonium in soil with roots," *Plant and Soil*, 266 (2004): 289-301.

Cavigelli, M., M. Djurickovic, C. Rasmann, J. Spargo, S. Mirsky, and J. Maul, "Global warming potential of organic and conventional grain cropping systems in the mid-Atlantic region of the U.S.," *Proceedings of the Farming Systems Design Conference, Monterey, California* (2009), 51-52.

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Poudel, D., W. Horwath, W. Lanini, S. Temple, and A. Van Bruggen, "Comparison of soil N availability and leaching potential, crop yields and weeds in organic, low-input and conventional farming systems in northern California," *Agriculture, Ecosystems & Environment* 90 (2002): 125-137.

Snapp, S.S., L.E. Gentry, and R. Harwood. 2010. "Management intensity – not biodiversity – the driver of ecosystem services in a long-term row crop experiment." *Agriculture, Ecosystems, & the Environment*. 15 August 2010, Pages 242-248

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LETTER TO THE EDITOR

Response

by Bart Simmons,

author of *Chemist's Corner*

I agree with Ms. Sooby that a limited number of studies have been completed which compare the water quality effects of organic vs. conventional farming. In addition, it is sometimes difficult to compare studies due to differences in design and metrics. Given the disparate results of the studies, it is not possible to reach a blanket conclusion regarding comparative environmental impacts of organic vs. conventional food. The results clearly depend on crop type and management technique. Results of my research indicate organic food production may have some environmental impact on groundwater.


Snapp¹ reports nitrate-N leachate losses in kg ha⁻¹ for one crop: maize (corn). They found that organic farming produced approximately 50% of the nitrate leaching of conventional, integrated management. Note that Snapp reports nitrate leaching per hectare, whereas Williams² and the DEFRA report phosphate equivalents per ton of crop.

The referenced publication by Burger and Jackson³ (2004) did not compare organic with conventional farming, but rather compared soil without roots to soil with roots. However, in an earlier study, Burger and Jackson⁴ (2003) studied immobilization of nitrate and ammonia, and concluded: "The challenge in managing high [organic matter] input systems [e.g., organic farming] may well be in balancing C and N inputs to prevent a build-up of large standing NO₃ pools, yet avoiding high rates of microbial N immobilization during peak periods of crop N demand."

Kramer et al⁵ found that nitrate leaching from conventionally farmed apple orchards was much higher than

organically-farmed apples, with integrated management (some organic and some conventional fertilizers) having intermediate results. They attributed lower nitrate leaching to denitrification, leading to increased N₂ emissions.

Poudel et al⁶ studied corn and tomato farming using organic, limited input, and conventional management. They concluded: "Soil N availability and N leaching potential during a cropping season varied by crop, farming system, and the amount and source of N application." They calculated nitrate leaching potential from mineralizable N and average soil mineral N. Potentially mineralizable N, measured as NH₃-N kg⁻¹, was consistently higher in organically-farmed vs. conventionally-farmed soils. Average soil mineral N (NO₃-N plus NH₄-N) was lower for organic than conventional in tomatoes, but higher for corn.

The data presented in my column from the DEFRA report were that eutrophication potential, primarily due to nitrate leaching, was generally greater for organic farming compared with conventional farming. Using Lifecycle Analysis (LCA), Williams found that the eutrophication potential of organic farming was greater than conventional farming for milk, rapeseed, lamb, and beef. For wheat and potatoes, there were similar levels. 

¹ Snapp, *Agriculture, Ecosystems, and Environ.*, 138(2010) 242-248

² Williams, Main Report. Defra Research Project IS0205. Bedford: Cranfield University and DEFRA

³ Burger and Jackson, *Plant and Soil* 266: 289-301, 2004.

⁴ Burger and Jackson, *Soil Biology & Biochemistry* 35 (2003) 29-36

⁵ Kramer et al, *PNAS* (2006) 103, 12, 4522-4527

⁶ Poudel et al, *Agriculture, Ecosystems and Environment* 90 (2002) 125-137

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GUEST EDITORIAL

The Cadiz Water Project: Mining Groundwater in the Mojave Desert

By John Bredehoeft, the Hydrodynamics Group

Introduction

This guest editorial discusses the proposed Cadiz Water Project relative to the established precepts of sustainable groundwater development that was initially proposed a hundred years ago; concepts that have been continuously applied both technically and legally ever since. It responds to the invitation of the *HydroVisions* Editor to offer comments from a different perspective than those advocated by Scott Slater in his guest editorial on the same Cadiz Water Project in the summer, 2012 Edition of *HydroVisions*.

Cadiz Incorporated, a publicly traded company, which purports to endorse renewable and sustainable resource development, proposes to pump groundwater, at an average rate of 50,000 acre-feet annually (ac-ft/yr) for a period of 50 years, from property it owns in Cadiz Valley. All the water will be removed from the groundwater basin via a pipeline, and ultimately discharged into the Colorado River Aqueduct. Based on studies prepared for Cadiz, the natural recharge to the aquifer system is approximately 32,000 ac-ft/yr; numerous other estimates have concluded that the recharge is much smaller. In any case, for a desert aquifer system like Cadiz, where the ultimate source of water is recharge from precipitation, a safe or sustainable yield cannot exceed the rate of natural recharge, when all the water pumped is exported from the basin. The Cadiz aquifer system is no exception; as a result, the proposed Cadiz project will result in the depletion of groundwater (overdraft). The project represents an unsustainable use of groundwater.

Before discussing the Cadiz Project further, let's review basic principles of groundwater hydrology, so that we are not talking past one another.

The Hydrology of Valleys in the Basin and Range Province

Under natural conditions, the alluvial aquifers that underlie the valleys of the Basin and Range are full of groundwater. These systems have existed for geologic time. Under natural (undisturbed) conditions, before any development, the recharge to the aquifers is balanced by the discharge from the aquifers, or:

Recharge = Discharge
(under undisturbed conditions)

The discharge from the aquifers occurs in many of the closed valleys in the Basin and Range as evaporation from the playa and/or by transpiration from plants in the lower parts of the valleys (phreatophytes) that draw their water from the water table. Very few of these plants are present in Cadiz project area; groundwater in this area is thought to discharge, before development, primarily as evaporation from the local playas.

Principles of Sustainable Groundwater Development

The groundwater profession is on the eve of the 100th anniversary of the introduction of the concept of *safe yield*, which defines a rate of pumping that will not deplete the groundwater resource. Although the concept was described in technical reports earlier, Charles Lee in 1914 first defined safe yield to be the *net annual supply which may be developed by pumping*

and artesian flow without persistent lowering of the ground-water plane (Lee, 1914, The determination of safe yield of underground reservoirs of the closed-basin type; American Society of Civil Engineers). A few years later, Oscar Meinzer, often called the father of modern hydrology, expanded the description by noting that *the practical question with which we have to deal is not as to the quantity of ground-water that lies below an area, but as to the rate of replenishment, for conservative developments must be based on the rate at which the ground-water can be withdrawn year after year, for generations to come, without depleting the supply* (Meinzer, 1920, Quantitative methods of estimating ground-water supplies; Geologic Society of America).

The court system embraced both the concept and the term *safe yield* when the first groundwater basin adjudication occurred in the 1940s. Some twenty groundwater basins have now been adjudicated in California, all to correct groundwater overdraft or to prevent its occurrence by mandating that pumping be maintained within the concept of safe yield. Further, over the last twenty years, numerous local groundwater management plans have been prepared on the same fundamental basis—pumping at sustainable rates that will not deplete the groundwater supply.

Consistent with the concept of capture introduced by Theis (1940) and expanded by Lohman (1979), pumping groundwater in a previously undeveloped basin constitutes a new withdrawal from a system that was in a natural state of balance. In order for such a groundwater system to reach a new equilibrium (a state that can be

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The Cadiz Water Project: Mining Groundwater in the Mojave Desert – Continued

maintained indefinitely) one of two things must occur: 1) the pumping must be balanced by an increase in the recharge, and/or 2) the pumping must be balanced by a decrease in the discharge. In the Cadiz setting, groundwater pumping will not increase recharge; recharge is determined by climatic conditions—precipitation, etc. On the other hand, pumping will decrease the discharge by capturing groundwater that would otherwise discharge at the Bristol Lake and Cadiz Lake playas.

How large can the capture be in a groundwater system like Cadiz Valley? Pumping from the valley can ultimately capture all of the natural discharge; this places a limit on how large a groundwater development could be and still reach a new equilibrium in which water levels in the pumped system stabilize over time—as noted above, we commonly refer to this limit as the *safe yield*, a pumping rate that is sustainable long-term. This leads us to a state that, in a groundwater system like that underlying Cadiz/Fenner Valley, is characterized as:

Safe Yield = potential capture = recharge – required residual discharge

In this instance the *safe yield* is equal in magnitude to the recharge less any residual discharge required to preserve the basin, e.g. to resist saline intrusion—a statement that is consistent with 100 years of what is considered good groundwater management.

Can one pump more than the safe yield?—of course. If the pumping exceeds the quantity of groundwater that can be captured, then water will be continually drawn from storage, and water levels within the system will continue to decline. In this situation the water drawn from storage is *mined* from the system, a condition long known as *overdraft*. As discussed above, avoiding overdraft (or correcting overdraft situations) was the objective of all

groundwater basin adjudications—maintaining long-term sustainability is the primary objective of every modern groundwater management plan.

The Cadiz Project—How Much Water Will Be Mined?

Cadiz proposes to pump, and export from the basin, an average of 50,000 acre-feet annually, for 50 years, from the aquifer system beneath property it owns in Cadiz Valley.

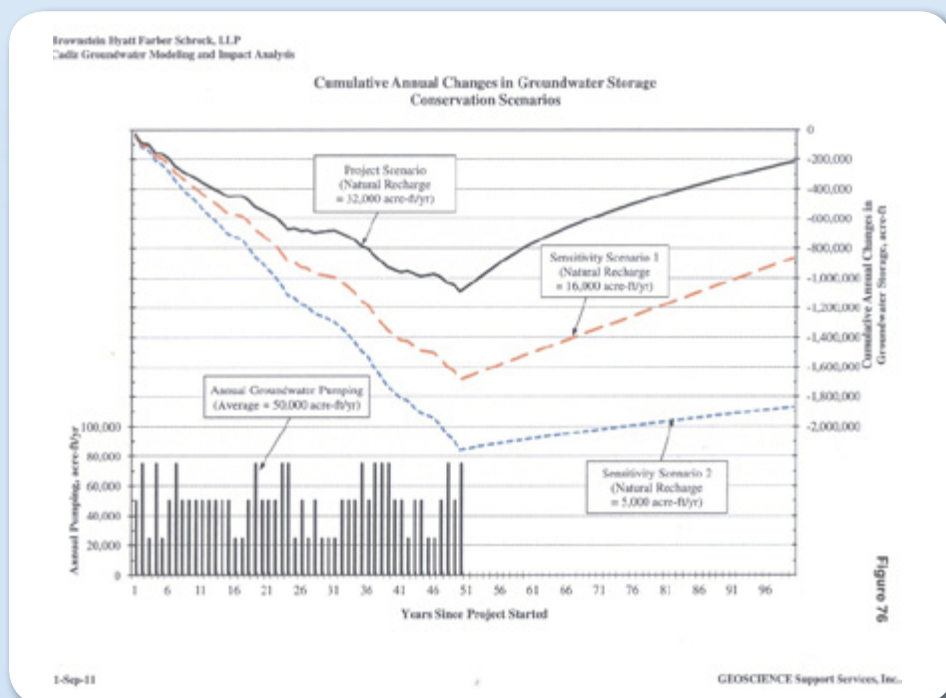
CH2M HILL, on behalf of Cadiz, estimated groundwater recharge to Cadiz/Fenner Valley to be 32,000 ac-ft/yr. Geoscience, on behalf of Cadiz, constructed a groundwater model for Cadiz Valley in which they simulated the effects of pumping 50,000 ac-ft/yr for 50 years, assuming 32,000 ac-ft/yr of recharge. I previously suggested that a recharge rate of 32,000 ac-ft/yr was much too high—8 of 10 earlier independent estimates of recharge suggested that the recharge is less than 12,000 ac-ft/yr.

The Geoscience modeling results, used in the Draft EIR, included a graph of groundwater projected to be removed from storage (see figure).

The cumulative change in storage is a graph of the groundwater removed from storage by the pumping. As the recharge rate decreases, the amount of water removed from storage must be larger to balance the pumping. This water removed from storage is groundwater that is removed from the system—storage continues to decline as long as the pumping continues. In fairness, the Cadiz Project makes no pretense that it will not remove a large quantity from groundwater storage—i.e., *mine groundwater*. The proposed project is fundamentally a groundwater mining, or overdraft, project.

If recharge is really as high as 32,000 ac-ft/yr, the project will mine about 1,100,000 ac-ft over its 50 year life. My analysis suggests that the red or the blue curve (recharge of 16,000 or 5,000 ac-ft/yr) is probably more likely. This indicates that after 50 years

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The Cadiz Water Project: Mining Groundwater in the Mojave Desert – Continued

of pumping, between 1,600,000 and 2,200,000 ac-ft of groundwater will have been mined by the Cadiz project. Not included in the graph are another 175,000 to more than 200,000 ac-ft of freshwater storage that would be lost to saline water intrusion as a result of project pumping.

If pumping stops completely after 50 years, the basin will eventually recover as shown by Geoscience in the above graph. However, there are no provisions proposed by Cadiz, or included in the Draft EIR, to ensure that pumping will stop as shown. Even with recharge of 32,000 ac-ft/yr, the basin remains depleted by 200,000 ac-ft after 50 years of recovery. With a recharge rate of 16,000 ac-ft/yr, the basin is still depleted by 800,000 ac-ft 50 years after the pumping ceases; at a recharge rate of 5,000 ac-ft/yr the basin is depleted by 1,800,000 ac-ft 50 years after the pumping ceases. Geoscience estimated full recovery at the lower recharge rate to take nearly four centuries. *The Geoscience analysis illustrates that the proposed pumping mines groundwater and leaves the basin with residual depletion impacts that persist long after the pumping ceases—if it ceases after 50 years.*

Concluding Remarks

Clearly, the Cadiz Project is designed to mine groundwater in the Cadiz Valley; Cadiz does not claim otherwise, but it avoids acknowledging overdraft and uses words like conservation scenarios, reliable, and sustainable to describe the project. As proposed, the project will mine (deplete) groundwater storage by 1.1 to 2.2 million ac-ft during its proposed 50 years of pumping. The basin could recover if pumping completely ceases, but even the most optimistic scenarios indicate a substantial groundwater storage deficit will remain 50 years after pumping ceases.

If the recharge is low, as I believe it is, the storage in the system will take several hundred years to fully recover after pumping ceases. However, there is nothing in the permit being sought, or in the Draft EIR, that limits the pumping to 50 years.

Any permitting agency, by approving the Cadiz Project, would be: 1) turning its back on the precepts of safe yield that has guided prudent and progressive groundwater management for 100 years, and 2) setting a precedent that it is now open season for private firms to mine (overdraft) groundwater from the basins in the Mojave Desert.

John Bredehoeft, PhD, retired in 1995 as a senior research geologist after 32 years with the USGS, and established the consulting firm The Hydrodynamics Group. During his years at the USGS, working with George Pinder, John Bredehoeft 1) published the first widely utilized numerical groundwater flow model (for which they received the Horton Award of the AGU in 1968), and 2) the first widely used contaminant transport model (for which they received the Meinzer Award of the GSA in 1973). During his career in research, Bredehoeft worked on a variety of other topics, was a consulting professor at Stanford for 8 years, and served on numerous national advisory committees for the NRC, NSF, and DOE. He published more than 100 articles in refereed scientific journals. Highlights of his numerous awards include AGU's Horton Medal (the highest award given to a hydrologist), GSA's Penrose Medal (the highest award given to a geologist), NGWA's life-member award (their highest award), and GRA's Lifetime Achievement Award.

John Bredehoeft can be reached at: the Hydrodynamics Group, Sausalito, CA 94965; jdbrede@aol.com.

Note from the Editor: GRA welcomes editorials from all perspectives, and will consider contributions with a different point of view on the Cadiz project. Please submit short comments on the subject, or express interest in a full editorial, to Steven Phillips at editor@grac.org.

The views expressed in this article are those of the author and do not necessarily reflect the position or policy of the Groundwater Resources Association of California, its Directors, Officers, or Membership. 💧

GUEST EDITORIAL

Senate Bill to Make Well Logs Publicly Available was Defeated

By Tim Parker, Parker Groundwater

At a time when electronic information on groundwater, including well logs, is readily available and served online in other western states, and a national groundwater network is growing, California still has an antiquated law that makes well completion reports confidential. For the second time in as many years, a bill to make well logs publicly available (SB1146, authored by Senator Fran Pavley, Senate Natural Resources and Water Committee Chairwoman) was defeated by the Legislature. This editorial contains some historical background on well confidentiality and pertinent water code sections, discusses the defeated bill to make well logs publicly available, and presents arguments on both sides to making well logs publicly available. At the end of this article is a list of the opponents, and a link to the legislation.

In 1948, Assembly Bill 21 was introduced in the California Legislature in response to the 1947 drought, and not only included the requirement to file well completion reports (well logs) and specified confidentiality, but also would have established appropriative rights to groundwater – the bill died. The Dickey Water Pollution Control Act followed as AB 1934 and, without groundwater rights as part of the bill, was passed in 1949 as part of the well statutes. The 1949 law did not contain any restrictions on well completion report availability; that came later in statutes added in 1951. Although the record is not completely clear, what is generally accepted as accurate is the following quote by C.H. Purcell, Director of Public Works, May 21, 1951: “The information required to be filed is regarded by some drillers as part of their stock in trade, and such drillers

are reluctant to submit such information if it is made available to the public. It is believed that if such information is not open to public inspection, more complete and accurate information will be received.”

The Dickey Water Pollution Control Act and subsequent amendments are incorporated in the California Water Code, Division 7 – Water Quality, Chapter 10: Water Wells, Catholic Protection Wells, Monitoring Wells, and Geothermal Heat Exchange Wells. Water Code sections pertinent to well logs include 13751, which requires that all wells be installed by a state licensed C-57 Water Well Contractor, and lays out the requirements for reporting the well completion information to the California Department of Water Resources (DWR). Water Code Section 13752 requires that well logs be maintained confidentially by DWR and not open for public inspection except for government agencies doing studies or for contaminant studies being completed under a regulatory agency order.

If you are in private industry or academia doing a water resource study, geotechnical study for construction, or a liquefaction study; or are a citizen buying a piece of real estate on property that will require a well assessment (just to name a few ways well log information is needed for non-government agency purposes), only with written authorization from the well owner may you obtain a well log. Imagine trying to obtain 10,000 well logs for a basin study, or even 100 well logs for a small-scale study.

The defeated bill SB 1146 would have required the DWR to, upon request, make the well logs available to the public. DWR would have been

required to provide specified disclaimers, and was authorized to charge a fee for the provision of a report to recover reasonable costs. The bill would have required those who request well logs to provide their name, address, an identification number from a government-issued source, and their reason for making the request. Finally, the bill would have required the release of a well log to comply with the Information Practices Act of 1977, including a provision for DWR to redact from the report specified information pertaining to the well owner.

Arguments in Support

All other western states make well logs publicly available; most states publish them on their websites.

The need for access to well completion reports for private studies is continuous, resource intensive and expensive, whether it is for a new private well, a real property transaction, liquefaction potential study, EIR review, constructing a new building, landslide mitigation, soil erosion, or academic studies involving geology or hydrogeology. This information currently must be sought through tedious field reconnaissance without assurance of completeness since the logs for all wells, current and destroyed, are unobtainable for non-governmental entities without permission from the well owner, the identification of whom is itself often a difficult challenge.

Additional potential benefits to making well logs publicly available include: (1) overall improvement in the quality of information; (2) more opportunities for collaborative groundwater studies between academia, public agencies and

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Senate Bill to Make Well Logs Publicly Available was Defeated – *Continued*

private industry; and (3) the possibility to iteratively build on the valuable well log information of multiple open sources. An aside is the need to actually be able to publish the well log information in the studies being generated, including in reports by public agencies.

Arguments in Opposition – 5/25/12 Senate Floor Analyses

San Gabriel Valley Water Association (SGVWA) states in opposition, “Since September 11, 2001, public water systems have been seeking ways to better protect their water supplies from terrorist or malicious acts. In fact, the federal government requires water systems to conduct vulnerability assessments and implement homeland security measures to better protect water supplies and facilities from sabotage. In support of these efforts, the California Department of Public Health, which oversees state-level homeland security initiatives for water systems, no longer releases physical well location information to the public. SB 1146 weakens those security efforts, and is in direct conflict with local, state and federal efforts to protect public water supplies.

“Furthermore, well data for public water wells is generally available to government agencies and qualified professionals upon request to the well owner. Full public access to this information would increase vulnerability without adding meaningful benefit to groundwater studies. Therefore, SGVWA must oppose this bill.”

Rebuttal to the Argument in Opposition

Considering public access to well completion reports an increase to water supply vulnerability because of physical well location information really does not pass the giggle test. First, analysis and historical evidence suggest

that massive casualties from attacking water systems are difficult to produce; there may be significant exceptions, but these exceptions are not related to wells. Simply put, there are many easier, higher risk areas in water supply systems for terrorism than wells.

Second, if you want to obtain a physical well location, well logs generally contain poor location information, as those of us who work with them regularly know; we spend copious time and resources trying to accurately locate the wells associated with well logs. To be candid, most wells are fairly easily recognized from the street or on Google Earth; many have signage in urban areas, and we simply follow the power lines in agricultural areas. Perhaps most importantly, as indicated below in the research by Legislative

staff, there are far more accurate sources of well location information already publicly available on the Web; for example:

- A review of urban water management plans and capital improvement plans showed that over 160 water agencies have published the locations of their wells, usually on maps, but sometimes the actual addresses. This represents locations of over 2,200 water system wells, of which Legislative staff has located 96% using online maps.
- Adjudicated groundwater basins have court-appointed watermasters, a number of whom have published maps showing locations of production wells within their

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Senate Bill to Make Well Logs Publicly Available was Defeated – *Continued*

jurisdiction. For example, the Main San Gabriel Basin Watermaster published a fairly detailed 2008 map showing the location of 99 active production wells.

- The drilling of a new water system well is usually a project subject to the California Environmental Quality Act (CEQA). CEQA, among other things, requires the disclosure of the location of the project. A review of CEQA Clearinghouse's online database shows the location of over 70 wells.

To suggest making well logs publicly available would not add meaningful benefit to groundwater studies is just plain wrong, as described above in the supporting arguments.

As a reminder, a lot of effort has gone into source water assessment and protection (wellhead protection) during the last decade to identify potential sources of contaminants that could impact groundwater near public supply wells. A key to successful Source Water Assessment & Protection Program (SWAPP) implementation is collaboration and sharing of information in order to fully protect our drinking water sources. How do we protect source water around public supply wells, working with planning agencies and the public, if our well locations and associated geologic and construction data are secret?

Finally, it is worth observing that the other western states have made their well logs available to the public without incident.

What's Next

After two years and two recent attempts to support making well logs publicly available (in 2011 it was SB 263, also by Senator Pavley), GRA currently is considering whether to pursue this effort again during the next

Legislative session. GRA will continue to implement its overall legislative and policy objectives:

- To help formulate statewide policy on the development, management, and protection of the state's groundwater resources, soil and groundwater remediation, and environmental assessments; and
- To disseminate scientific and technical information among GRA members and those who influence policy development concerning groundwater resources.

Support & Opposition on Record with the California State Legislature

Support: California Rural Legal Assistance Foundation, City of Lakewood, Clean Water Action, Community Water Center, East Bay Municipal Utility District, Groundwater Resources Association, Karuk Tribe, Northern California Water Association, Planning and Conservation League, Sierra Club California, Sonoma County Water Agency, and The Nature Conservancy.

Opposition: California Groundwater Association, California Police Chiefs Association, City of Torrance, County of Tehama Department of Public Works, Desert Water Agency, East Valley Water District, Friant Water Authority, Kings River Conservation District, Kings River Water Association, Newhall County Water District, Orchard, Dale Water District, Rowland Water District, Valley Ag Water Coalition, and San Gabriel Valley Water Association, which lists 67 cities, public water suppliers & utilities, private water suppliers, private and industrial groundwater producers, consultants, and others; see www.sgvwa.org for the full listing.

The text of Senate Bill SB 1146 is available at <http://leginfo.legislature.ca.gov/>.

Note from the Editor: GRA welcomes editorials from all perspectives, and will consider contributions with a different point of view on making well logs publicly available. Please submit short comments on the subject, or express interest in a full editorial, to Steven Phillips at editor@grac.org.

The views expressed in this article are those of the author and do not necessarily reflect the position or policy of the Groundwater Resources Association of California, its Directors, Officers, or Membership. 💧

Groundwater Resources Association 21st Annual Conference & Meeting

“California Groundwater: Data, Planning and Opportunities”

OCTOBER 3-5, 2012
OCTOBER 4-5, CONFERENCE AND MEETING
OCTOBER 3, OPTIONAL FIELD TRIP AND DINNER
ROHNERT PARK, CA

Cooperating Organizations: University of California Water Institute, California Department of Water Resources, Cal/EPA Department of Toxic Substances Control, Water Education Foundation, U.S. Geological Survey, Association of California Water Agencies, National Ground Water Association, International Association of Hydrogeologists

Co-Sponsors: AMEC Environment & Infrastructure, Brownstein Hyatt Farber Schreck, Kennedy/Jenks Consultants, Sonoma County Water Agency

Conference Focus

California’s groundwater resources are receiving an unprecedented attention with a “watershed” of new information, programs, and regulations. This year’s two-day conference will provide the latest information on recent and developing policies and regulations and technical and legal challenges affecting groundwater use and management in California. Conference attendees will receive information on a number of statewide activities and new regulations, including the California Department of Water Resources’ (DWR’s) groundwater content enhancement for the California Water Plan Update 2013 and the results of its statewide survey of groundwater management plans and conjunctive use, groundwater recharge and banking projects; DWR’s California Statewide Groundwater Elevation Monitoring (CASGEM) program; State Water Board programs and initiatives; and the Association of California Water Agency’s (ACWA’s) Groundwater Management Framework Action Plan Implementation.

Topics for Conference Sessions Include:

- The Association of California Water Agency’s (ACWA’s) Implementation of the Sustainable Groundwater Management Framework;
- Groundwater data collection and management: national, state, and local programs and plans;
- DWR’s California Statewide Groundwater Elevation Monitoring (CASGEM) program and local agencies’ development of Alternative Monitoring Plans;
- Policy and institutional change recommendations developed by the Water in the West Program to ensure effective groundwater management;
- Development of innovative urban water management practices by the engineering research center “ReNUWIt” (Re-inventing the Nation’s Urban Water Infrastructure);
- Surface water/groundwater interaction and climate change;
- Groundwater quality and remediation;
- Groundwater recharge areas and land use planning;

Dates & Details

GRA EVENTS & KEY DATES

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

GRA Web Conference

What Makes for a Successful Recharge Project?
Sep. 25, 2012

GRA 21st Annual Conference & Meeting

Oct. 4-5, 2012 | Rohnert Park, CA

GRA Web Conference

Case Studies of Successful Surface Recharge Projects
Oct. 17, 2012

GRA Board of Directors Meeting

Nov. 2, 2012 | Sacramento, CA

GRA Symposium

Investigation and Remediation of Dry Cleaner Release Sites
November 7, 2012 | Concord, CA

GRA Web Conference

Case Studies of Successful Injection Projects
Nov. 14, 2012

GRA Web Conference

Recycled Water Recharge
Dec. 12, 2012

- Advances in groundwater modeling; and
- Panel discussion: Integrated Groundwater Management: Local, Regional and Statewide Roles and Perspectives.

Continued on the following page...

California Groundwater: Data, Planning and Opportunities – *Continued*

Special Features – October 3rd

- **Field Trip:** Sonoma County Water Agency will lead an optional field trip with stops and informative presentations at several of its facilities instrumental to local groundwater, including SCWA's Ranney Collector Wells along the Russian River. Lunch and wine tasting will be provided.
- **Dinner:** On October 3rd, conference attendees may attend a separate, optional dinner that will feature discussions of the local geology, vineyard water conservation practices, water and wine from a winemaker's perspective.

2012 David Keith Todd Lecturers

- William Alley, Ph.D., US Geological Survey, Emeritus
- John Cherry, Ph.D. Director of the University Consortium for Field-Focused Groundwater Contamination Research and Adjunct Professor, University of Guelph

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. 💧

SAVE THE DATE

For the 26th Symposium in GRA's
Series on Groundwater Contaminants

"Investigation and Remediation of Dry Cleaner Release Sites"

NOVEMBER 7, 2012 – CONCORD, CA

Symposium Focus

GRA will be hosting a one-day technical and policy Symposium focusing on Dry Cleaner release sites and the impacts to soil, soil gas, groundwater and indoor air. The Symposium will focus on the technical mechanisms of Perchloroethylene (PCE) and its daughter products in affected media, technologies for subsurface characterization, corrective action remedies and the regulatory considerations to achieve site closure. This will include new and innovative tools and techniques for more effective site characterization and remedial techniques such as in situ source zone remediation by vapor extraction, reductive dechlorination and ISCO bioremediation of CVOCs, and permeable reactive barriers. Other possible topics, such as: monitored natural attenuation; passive subslab depressurization; institutional control closure strategies; legal and policy issues, such as the phase out of PCE by 2023 and the new "green" dry cleaner chemicals; and the potential for a dry cleaner "cleanup fund" for remediation at orphan sites, may also be covered. Case studies of legacy sites from California as well as examples of other dry cleaner release sites throughout the U.S. will also be examined, focusing on the challenges and accomplishments from both the consulting and regulatory arenas. The Symposium will also include a panel discussion featuring leading legal, regulatory, real estate and insurance representatives, who will discuss the policy, insurance, and legal issues regarding dry cleaner sites including cleanup, liability and the future of PCE.

Preliminary Topics for Symposium Sessions Include:

- High Resolution Site Characterization Techniques
- In-Situ Remediation Technologies
- Physical (vapor extraction/soil removal) Source Area Remediation
- Regulatory Oversight, Risk Assessment and Site Closure Criteria for Dry Cleaner sites
- Alternative points of compliance for cleanup of PCE and other Dry Cleaner solvents
- Vapor Intrusion and Mitigation Issues
- Case studies of legacy Dry Cleaner sites and other similar sites across the U.S.
- Legal, Insurance, and Related Issues for Funding Dry Cleaner Cleanups.

Student Poster Session

GRA seeks to increase participation by university and college faculty and students in its programming. The **Student Poster Session** allows students who are conducting highly relevant research in the general area of the conference theme. The Student Poster Session provides students with an excellent opportunity to showcase their research and provide attendees an opportunity to learn from the frontier of groundwater science. 💧

Wells and Words

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

Direct-Circulation Rotary Drilling – An exceptional and valuable tool for exploration of subsurface geology

All direct- and reverse-circulation (circ) rotary drilling methods use similar mechanical and hydraulic systems to rotate the drill string and bit, as opposed to percussion (i.e., Cable Tool drilling). That said, rotary drilling tools also include an air-percussion bit used in bedrock drilling that operates like a pneumatic “jack hammer.” This article focuses on direct-circ rotary drilling; subsequent articles will discuss reverse-circ rotary drilling and other important aspects of rotary drilling technology. Hand-operated rotary drilling tools have been used for centuries to quarry stone for building material, but it wasn’t until the 1900s that the method evolved to what is encountered in modern-day drilling practices; interestingly, early applications of modern-day rotary drilling were developed for the water well industry¹.

Direct-circ rotary drilling is a method by which the sediments and rock at the bottom of the hole are broken up using a rotating, hardened-tooth drill bit at the bottom of a rotating drill pipe². Most direct-circ rotary drilling rigs are truck mounted and designed to use either top-head or rotary-table drive to generate a rotational motion. Lubrication and cooling of the bit are provided by continuous circulation of a drilling fluid, which also serves to bring the cuttings to the surface. In direct-circ methods, drilling fluids are pumped down the drill string and returned to the surface between the drill string and the borehole wall (annulus); reverse-circ methods pump the fluids down the annulus and the cuttings are returned through the drill string.



Figure 1: Dresser Model T70W direct-circulation rotary drilling rig using air and equipped with hydraulic accentuated casing hammer. Photo was taken in May 1999 during the installation of two 6-inch diameter 250-ft deep monitoring wells by Beylik Drilling, Inc. (now Layne-Christensen) along the foothills of the Pine Nut Range near Minden, Douglas County, NV. Background – Carson Range east of Lake Tahoe and the Sierra Nevada.

The basic drill string for direct-circ rotary drilling includes (from bottom to top) bit, stabilizers or collars, drill pipe and substitute joints (subs), kelly, and swivel. Different types of drill bits (drag, fish tail, blade, and roller-type bits, including tri-cone bits, with carbide or diamond tips), with ports or nozzles to convey the drilling fluid, are used to drill the hole; the type of bit used is based on the application and geology. Stabilizers provide additional weight to the drill string and encourage plumb borings. Thick-walled, threaded, and hollow drill pipe (or rods) are typically 20 feet long and allow drilling fluids to reach the drill bit. A kelly is a piece of drill pipe or square pipe in cross section that is either attached to the top-head drive or is mated to the rotary-table drive to transfer the rotational motion to the drill string. Subs are short pieces of drill pipe that

are used to reduce wear on the threads of the kelly and other parts of the drill string. The non-rotating swivel maintains circulation through the drill string and must be able to lift the entire drill string. Supporting equipment includes: (1) mud pumps for liquids and compressors for air to circulate the drilling fluids; (2) portable or constructed mud pits to store fluids, settle-out solids, and allow recirculation of the drilling fluids; (3) shale-shaker, cyclone, or baffled troughs to remove cuttings from the drilling fluid, allowing for sampling of cuttings; (4) pull-down chain to apply downward pressure (if needed) to the drill string and bit; (5) optional casing advancement systems during some drilling methods (e.g., pneumatically driven casing hammer); (6) support service vehicles, including a flat bed truck or trailer for drill pipe and a water truck; (7) casing line

Continued on the following page...

Wells and Words – Continued

with block and tackle to move casing joints and equipment; and (8) a rope hoist windlass (“cat head”) to move lighter loads. The typical drilling crew for small-sized rotary rigs includes the driller and two helpers. Figure 1 shows a direct-circ rotary drilling rig using air as the fluid.

Controlling the properties of drilling fluids (e.g., bentonite, organic polymers, air, water, and foam) is critical to the successful completion of the boring. Essential tools that measure basic properties of the mud (density and viscosity) include the mud balance (lbs/gallon) and the marsh funnel (seconds/~quart). The drilling fluid serves several functions, including cooling and lubricating the bit and drill string, returning cuttings to the surface, and balancing the lithostatic and hydraulic pressures at the borehole walls so that the boring will not collapse. Stabilizing the borehole walls allows the boring to be drilled without advancing casing – an exception is direct-circ air rotary in unconsolidated sediments, which requires casing advancement. The volume of drilling fluid is about three times the volume of the borehole; hence, direct-circ rotary drilling requires a significant amount of clean and potable water for mixing drilling fluids, and the drilling fluids must be disposed of using appropriate methods.

Direct-circ rotary drilling using bentonite or polymer muds is ideal for exploration of unconsolidated sediments because the method is rapid for installation of 4-inch to 12-inch diameter borings. The practical maximum diameter for direct-circ rotary drilling is about 18 inches. Drilling rates can exceed 200 feet/day (10 hour shift), but note that these drilling rates do not include casing installation and collecting reliable formation and water samples; large-diameter wells require slower, multiple-pass drilling methods. Bit size and tool weight limit the borehole diameter (increments of 12 inches) on a single pass, therefore, multiple passes (or reaming) are needed for large-

diameter borings for production well completions and yields greater than 500 gpm³.

Initially, for exploration drilling, a 6- to 8-inch diameter bore is drilled to evaluate the subsurface sediments. Cuttings from most rotary drilling methods are of poor quality, making it difficult to reconstruct sediment textures because of the grinding action of the rotating drill bit and subsequent mixing of the cuttings in the returning drilling fluids; therefore, down-hole geophysical tools (e.g., electric, natural gamma, and caliper logs) are used to help in this evaluation. The borehole is then reamed to the desired depth to a larger diameter to accept steel or PVC casing, screen, louvers, or perforations, and filter pack. Most wells constructed with direct-circ rotary methods in uncased borings are designed with filter packs because of the uncertainty of the sediment textures.

Because drilling fluids are used in direct-circ rotary drilling, aggressive well development programs are recommended to remove residual drilling fluids to increase well efficiency. Direct-circ rotary drilling methods are an ideal tool for exploration drilling and small diameter test wells and low-yield production wells – the right tool for the right project. 💧

¹Campbell, Michael D. and Jay H. Lehr, 1973, *Water Well Technology*, McGraw-Hill Book Company, New York, 681pages.

²American Geological Institute, 1987, *Glossary of Geology* (third edition), Editors R.A. Bates and J.A. Jackson, American Geological Institute, Alexandria, Virginia.

³Gordon, R.W., 1958, *Water Well Drilling with Cable Tools*, Bucyrus-Erie Co., S. Milwaukee, WI, 230 pp.

⁴UOP Johnson, 1966, *Groundwater and Wells* (first edition), Edward E. Johnson, Inc., Saint Paul MN.



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Legislative Update

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

While the summer weather in Sacramento has been pleasant and mild for the most part, the political atmosphere in the State Capitol promises to heat up as the Legislature reconvenes from its month-long summer recess. Although the Legislature passed and the Governor signed an on-time budget for the second consecutive year, state policy makers face enormous challenges in the face of tough economic times.

2012 GRA Supported and Monitored Legislation

SB 1146 (Pavley) – Legislation to make well logs public information similar to other western states. The bill requires the Department of Water Resources to make the well reports public subject to specified disclaimers. *Status: SB 1146 failed to pass off the Senate floor due to vigorous opposition from the agriculture community.*

AB 591 (Wieckowski) – AB 591 requires operators of oil and natural gas wells to provide information on hydraulic fracturing to the Division of Oil, Gas, and Geothermal Resources (DOGGR), for publication on the Division's website. *Status: AB 591 is currently in the Senate Rules Committee awaiting referral to the Senate Appropriations Committee. The GRA Legislative Committee has recommended a support position with suggested amendments.*

SB 1054 (Pavley) – SB 1054 would require a well owner or operator to notify surface property owners of commencement of drilling operations and hydraulic fracturing operations that are about to occur near or below

their property. This bill would also require notification to be given to the supervisor of DOGGR, the appropriate regional water quality control board, water supplier, and municipal government. *Status: SB 1054 failed to pass off the Senate Floor.*

Water Bond

The \$11 billion water bond intended to pay for what lawmakers in 2009 said was a crucial upgrade of California's water infrastructure has been pulled from the November ballot and delayed until 2014. This is the second time lawmakers have removed the proposition from the state ballot. It was a key component of the 2009 water bill package, and remains part of the proposed Bay Delta Conservation Plan (BDCP) financing package.

The Governor supported delaying the bond measure because he did not want it to compete with his own tax measure on the ballot. Lawmakers backed the move for a variety of reasons; some wanted to avoid what many saw as certain defeat while others want an opportunity to reduce the size of the bond to remove elements that critics see as wasteful spending. Senate President Pro Tem Darrell Steinberg, instrumental in getting the bond proposal and other elements of the bill package passed in 2009, defends the current size and components of the bond measure but recognizes that it needs to be reduced in order for a bond measure to pass in the current economic environment. Having said that, there was little agreement earlier in the year about how the bond measure could be reduced without losing key support.

Bay Delta Conservation Plan

On July 25, Governor Brown and Secretary of the Interior Ken Salazar outlined key updates and revisions to California's Bay Delta Conservation Plan. Both officials expressed their commitment to completing the plan by June 2013. The cornerstone of the updated proposal is the construction of a water intake and conveyance facility that will have a total capacity of 9,000 cubic feet per second – significantly smaller than what was outlined in earlier proposals. The conveyance facility will be paid for by user fees for state and federal water contractors. Other alternatives, including larger and smaller capacities, or no facility at all, will be considered as the plan undergoes the environmental review process.

Governance and operations also play a key role in the revised plan. Rather than setting fixed regulations and long-term guarantees, the BDCP will use an independent science-based review process, or "decision tree," to inform management and regulatory decisions. While most interest groups and stakeholders have applauded the efforts of Governor Brown, Secretary Salazar, and various state and federal agencies in bringing the BDCP to this point, many have expressed doubt that potential participants will be able to assess the feasibility or "cost-benefit" ratio of the project based on the available information. Governor Brown and Secretary Salazar have expressed openness to further input, and additional information is expected to become available in the coming months. For more information and for updates and revisions to the BDCP, visit: http://baydeltaconservationplan.com/news/news/12-07-25/Governor_Brown_and_Obama_Administration_Outline_Path_Forward_for_BDCP.aspx.

Continued on the following page...

Legislative Update – Continued

Fracking

Hydraulic fracturing of oil and gas wells, or ‘fracking,’ has taken on a life of its own in the Capitol since it was featured at GRA’s Legislative Symposium and Lobby Day last April and more recently at GRA’s Symposium on fracking. Over the last 12-18 months, a large number of public inquiries were received by DOGGR and it became evident that it does not collect or possess information on fracking in California. In fact, there is no requirement to even notify the Division of proposed hydraulic fracturing activities.

Assembly Member Bob Wieckowski has been working with DOGGR, the oil and gas industry and environmental groups to reach consensus on AB 591 to address the fracking data gap. He attended GRA’s recent fracking Symposium and told GRA’s audience that the bill may be close to agreement. One sticking point has been the proprietary nature of the fracking fluids. Each oil industry service company has proprietary blends of fluids, largely composed of water, and a small percentage of chemicals and solids called proppants, which help keep the fractures open. DOGGR is considering how the proprietary and confidential nature of trademark and patent information may be determined and protected by DOGGR. Assembly Member Wieckowski said that another challenge has been the large number of environmental organizations involved in the discussion and how to address their issues and concerns. In closing, Assembly Member Wieckowski mentioned Senator Pavley’s bill (SB 1054), which failed passage, and would have required local notification of fracking operations. He said that notification requirements could be part of any final agreement on AB 591.

In the meantime, DOGGR has completed a series of public hearings throughout the state in oil and gas reservoir areas to provide information on fracking, the pending process to develop fracking regulations, and to receive input from the public. DOGGR’s pending regulatory process is intended to close the data gap about hydraulic fracturing operations and identify steps necessary to protect environmental resources, including groundwater. For more information, visit: http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx.

PPIC Report on Water and the California Economy

A new publication by the Public Policy Institute of California (PPIC), *Water and the California Economy*, highlights the importance of water management in California in the context of our current economic climate. The PPIC found that significant improvements and innovations have been made in the last several decades, but that California is still vulnerable to the sudden interruption of water supply. Although only 2 percent of the state’s gross domestic product relies on water (via agriculture and related manufacturing), the potential for catastrophic events such as earthquakes and flooding and their impacts raise fear throughout California.

The PPIC report presents a number of key changes that could mitigate the impacts of catastrophic events, including modernizing water measurement and pricing, reducing vulnerability to water supply interruptions, strengthening water markets, improving local groundwater management, reducing exposure to catastrophic flood risk, improving environmental management, and developing more reliable funding. The report can be found on PPIC’s website: www.ppic.org.

Looking Ahead

The 2011-2012 Legislative Session is quickly coming to an end. The Legislature adjourns for the year on August 31st and the November elections are just around the corner. When the 2012-2013 Legislative Session begins in December, there will be a 40 percent turnover and number of new legislators. With such a large group of new members, GRA will have to redouble its efforts to educate legislators on the importance of groundwater to California’s water supply and economy. We look forward to providing GRA members a final legislative briefing at the annual meeting in Sonoma, and to keeping GRA at the forefront of groundwater in the State’s Capitol. 💧

The Federal Corner

By Kelly Manheimer, U.S. EPA

US, Mexico Sign Agreement Addressing High Priority Border Environmental Issues

Last week, EPA Administrator Lisa P. Jackson joined Mexico's Secretary for the Environment and Natural Resources, Juan Elvira Quesada, to sign the Border 2020 U.S.–Mexico Environmental program agreement. The Border 2020 agreement will work to address high priority environmental and public health problems in the border region, and follows the expiring Border 2012 agreement. The Border 2020 program works to reduce pollution in water, air, and on land, reduce exposure to chemicals from accidental releases or terrorism, and improve environmental stewardship. [Click here for more information.](#)



New Information About Harmful Algal Blooms Online

EPA has published a new web page on harmful algal blooms to help inform other agencies and the public about key issues regarding cyanobacteria, or blue-green algae, blooms in recreational waters and drinking water. Harmful algal blooms cause fouling of beaches and shorelines, economic and aesthetic losses, taste and odor problems in drinking water, and direct risks to human, fish and animal health. The web page includes information on the causes of bloom occurrence, preven-

tion and mitigation measures, adverse human health effects from exposure to cyanotoxins, ecological effects, sampling and detection methods, policies and guidelines, past and ongoing research, and links to related sites. [Click here to visit the web page.](#)

New Tool Helps Estimate Affordability of Water Pollution Control Requirements

EPA has released a new web-based tool to help a variety of stakeholders evaluate the economic and social impacts of pollution controls needed to meet water quality standards set for specific uses for a waterbody, such as swimming or fishing. The tool will help stakeholders identify and organize the necessary information, and perform calculations to evaluate the costs of pollution control requirements necessary to meet specific water quality standards. [Click here for more information.](#)

Virtual Academy Webinar: Water Quality Standards 101

EPA is hosting the first Water Quality Standards Virtual Academy webinar: “Water Quality Standards 101.” Water quality standards are the foundation of the water pollution control program mandated by the Clean Water Act. Water quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions such as antidegradation policies. This webinar is aimed at a wide range of interested parties. The webinar will be held on Thursday, October 4, 2012 from 1:00 to 3:00 p.m. EST. [Click here to register.](#) For more information, visit <http://water.epa.gov/learn/training/standardsacademy/index.cfm>.

U.S. Water Partnership Launched to Address Global Water Challenges

U.S. public and private sectors recently announced that they are dedicating over half a billion dollars to address key water challenges around the world through the newly-formed U.S. Water Partnership. EPA General Counsel Scott Fulton and former EPA Administrator William K. Reilly keynoted the global launch of the partnership, one of six signature initiatives announced by the U.S. government at the United Nations Conference on Sustainable Development. A joint effort of public and private sectors in the U.S., the Partnership is supported by 41 members including government agencies, academic organizations, water coalitions, non-governmental organizations and the private sector. For more information on the U.S. Water Partnership, please visit <http://uswaterpartnership.org/>.

EPA Releases Green Infrastructure Permitting and Enforcement Fact Sheets

EPA has released a series of six fact sheets on incorporating green infrastructure measures into National Pollutant Discharge Elimination System wet weather programs. These fact sheets and four supplements address stormwater permits, total maximum daily loads, combined sewer overflow long-term control plans, and enforcement actions. The series is available at: http://water.epa.gov/infrastructure/greeninfrastructure/gi_regulatory.cfm#permittingseries.

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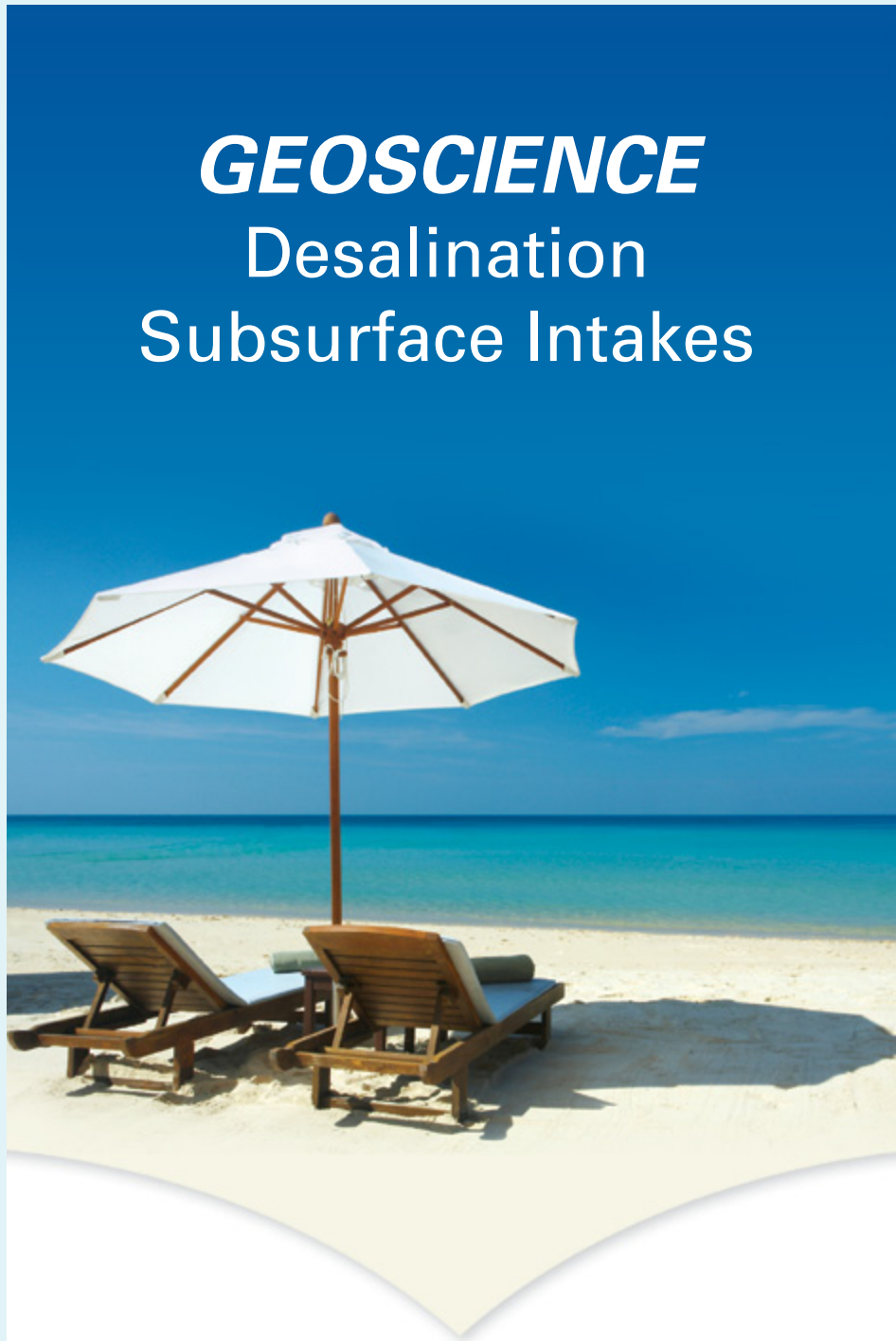
The Federal Corner –

Continued

Simulation of Climate Change in San Francisco Bay Basins, California: Case Studies in the Russian River Valley and Santa Cruz Mountains

As a result of ongoing changes in climate, hydrologic and ecologic effects are being seen across the western United States. A regional USGS study of how climate change affects water resources and habitats in the San Francisco Bay area relied on historical climate data and future projections of climate, which were downscaled to fine spatial scales for application to a regional water-balance model. Changes in climate, potential evapotranspiration, recharge, runoff, and climatic water deficit were modeled for the Bay Area. In addition, detailed studies in the Russian River Valley and Santa Cruz Mountains, which are on the northern and southern extremes of the Bay Area, respectively, were carried out in collaboration with local water agencies. The full Report can be found here: <http://pubs.usgs.gov/sir/2012/5132/pdf/sir20125132.pdf>.

Kelly McCarty Manheimer is Chief of the CA Sites Superfund Section at the U.S. Environmental Protection Agency, Region 9. She works in the Superfund Division and oversees cleanup activities at many 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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Brochure Gives Guidance on Water Testing Near Oil and Gas Activities


By Cliff Treyens, NGWA

The National Ground Water Association (NGWA) and the Ground Water Protection Council (GWPC) are making available a water-testing brochure for household water well owners living near oil or gas development and completion activities, including hydraulic fracturing. The brochure is timely with hydraulic fracturing [emerging as an issue in California](#), and walks water well owners through how to go about getting their water tested prior to oil and gas activi-

ties to establish baseline water quality. It then provides guidelines for retesting the water after oil and gas development and completion activities.

Addressed in the brochure are issues such as “chain-of-custody” testing to ensure unbiased, accurate sampling and test results; what constituents to test; what to do if one’s water quality changes; and where to get more information. The brochure, which is an abbreviated version of the previously published NGWA

Information Brief on Water Wells in Proximity to Natural Gas or Oil Development, is available as a downloadable PDF from <http://wellowner.org/water-quality/hydraulic-fracturing-brochure-for-water-well-owners/>.

For more information, contact Cliff Treyens at 614-898-7791, ext. 554, or ctreyens@ngwa.org. 



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GRA Welcomes the Following New Members

JUNE 1 - SEPTEMBER 7, 2012

| | | | |
|---------------------|---|---------------------|-------------------------------------|
| Anderson, Glen | Schaaf & Wheeler | Russell, Todd | Stanford University |
| Angell, Matt | Madera Pumps, Inc. | Snyder, Scott | Snyder Geological |
| Barros, Jessica | TRC | Su, Grace | Johnson Wright, Inc. |
| Barry, Jeff | GSI Water Solutions Inc. | Tang, Philip | Conestoga-Rovers & Associates |
| Berends, Michael | Conestoga-Rovers & Associates | Thrupp, Bruce | The Source Group, Inc. |
| Boehm, Leslie | Geoscience Support Services, Inc. | Towbin, Jeff | University of California |
| Bostick, Sara | ERM-West, Inc. | Turner, Melissa | MLJ-LLC |
| Bruno, Jeanne-Marie | Park Water Company | Turner, Roger | Roger Turner & Associates, Inc. |
| Carol, Penny | Carollo Engineers | Wanek, Mark | OTIE |
| Cato, Kerry | Cato Geoscience, Inc. | Watkins, Jessica | ENVIRON International Corp. |
| Cherry, John | University of Guelph | Watterson, Nicholas | Luhdorff & Scalmanini C.E. |
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| Draper, Steven | Engineering/Remediation Resources Group, Inc. | Williams, Tom | Dubai Isles Development |
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| Janes, M Katy | Sacramento State University | | |
| Kahl, Brian | Groundswell Technologies | | |
| Katon, Andrew | Baker Hughes | | |
| Kennedy, Thomas | SoundEarth Strategies | | |
| Kraft, Richard | Geosyntec Consultants | | |
| Lechler, Benjamin | CH2M HILL | | |
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| Peterson, Austin | California American Water | | |
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**GRA Extends Sincere
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Resources - A California
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Call for Nominations for Director Seats Open in 2013

The Association is now soliciting nominations for GRA Board of Director candidates to run for five (5) seats that commence service January 1, 2013. The Nominating Committee has established the following criteria for nominating and selecting candidates for the final ballot that will be presented to the GRA membership for voting.

Minimum Qualifications for Director Nominees

- Active Regular Member of GRA at the time of nomination.
- Recognized leader in a groundwater-related field, which may include regulation, evaluation, development, remediation or investigation of groundwater, groundwater supplies or related technology; science education; and groundwater law or planning.
- Significant contributor to the field of groundwater resources in California.
- Prior contributions and leadership role in a GRA Branch, GRA committees or GRA program activities, or like experience with a similar organization.

Nominating Guidelines and Procedures

1. Directors and members of GRA may nominate themselves or another member as prospective candidates to run for the Board as described below.
2. Nominations must be submitted in writing to GRA and accompanied by:
 - A statement from the nominee addressing the following questions:

Why are you interested in serving on the GRA Board of Directors?

What qualifications and experience do you have for serving as a Board member?

What specific skills or expertise do you bring to GRA and the GRA Board (e.g., leadership skills, fund-raising, financial management, etc)?

What experience do you have serving on similar boards of directors?

What level of time commitment can you make to GRA?
 - Current curriculum vitae.
 - A letter of recommendation from a current Director or Regular Member.

3. The Nominating Committee will review all nominations and evaluate the nominees based upon on their response to the above questions and their qualifications. The Committee will conduct interviews, if deemed necessary.
4. The Nominating Committee shall recommend a slate of nominees for presentation to the GRA Board of Directors for approval. The recommended slate of nominees shall correspond to the number of available Director openings each year.
5. The approved slate of nominees shall be presented to the GRA membership in ballot form in accordance with the GRA bylaws.

To declare your desire to be nominated or to nominate someone other than yourself, please follow the guidelines in section number two above and forward the material to Kathy Snelson, GRA Executive Director, via email (executive_director@grac.org), fax (916-442-0382) or mail (621 Capitol Mall, 25th Floor, Sacramento, CA 95814) no later than October 9, 2012.

Should you have any questions or need additional information about the GRA Director Call for Nominations, please contact Kathy Snelson at (916) 446-3626. 💧

GRA Extends Sincere Appreciation to the Co-Chairs and Sponsor for its August 2012 Symposium *Managing Wells In California – Protecting Groundwater Resources*

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Central Coast

By Jeff Kubran
Branch Secretary



Since the last edition of *HydroVisions* our Branch had two meetings, in May and July. During the May meeting, Dr. Arturo Keller from the UC Center for Environmental Implications of Nanotechnology (UC CEIN) at UC Santa Barbara presented “Emerging Patterns and the Environmental Implications of Nanotechnology.” Dr. Keller is studying the fate and transport of commercial nanoparticles, including five metals and five metal oxides. Nanoparticles are used for various applications, such as solar panels, medicine, defense, cosmetic, fabrics, sunscreen, and car paint. Nano is measured from 1–100 nanometers and can be in the form of nanospheres or nanotubes. Patterns are emerging regarding nanoparticles in natural media, including their sedimentation rates, attachment to sand and clay, dissolution, and photo activity. Low ionic strength and minimal organic material can keep nanoparticles suspended; however, hard water, such as most well water, can cause the nanoparticles to settle out.

In July, Dr. Bill Alley, USGS Emeritus and GRA’s 2012 David Keith Todd Distinguished Lecturer for southern California, discussed the communication of groundwater science from real time to millions of years. Dr. Alley contrasted humans versus hydrologic time scales; humans typically think in 20-50 year time frames, but we should be thinking in terms of multiple generations. On the other extreme,

groundwater levels can change due to earthquakes or other phenomenon in days or less. Moving to months to years, Dr. Alley gave an example of a program in Pennsylvania where monitoring wells are used as an indicator of drought conditions. Once we move to tens to hundreds of years, humans have a greater effect due to long-term pumping that lowers groundwater levels substantially. These lower water levels can affect the vegetation and cause aquifer materials to compact, resulting in a loss of water holding (storage) capacity. At the scale of tens of thousands of years, analysis of packrat midden has shown the change from woodland areas to desert vegetation. Finally, on the scale of millions of years, Dr. Alley discussed the numerous studies done in the Yucca Mountain area, which found that opal can be dated to show the steady state of groundwater within the mountain.

The Central Coast Branch would like to thank BC2, the scholastic sponsor of the July meeting. 💧

Sacramento

By Troy Turpen,
Branch Secretary

April’s meeting featured a lively discussion of Sacramento County’s Abandoned Well Program, with David Von Aspern of the Sacramento County Environmental Management Department. Mr. Von Aspern has extensive experience in this field, and has supported GRA in many officer positions since 1992. Over 500 abandoned wells have been identified and cataloged in Sacramento County; emphasis on proper abandonment has focused on those wells that pose an immediate threat to health and safety. The County developed an outreach program to increase awareness of the existence and potential problems associated with abandoned wells. Many photographs were shown of abandoned wells in every size and construction type imaginable, and in different states of repair; this illustrated how finding the wells in the first place can try a detective’s



skills. Many attendees chimed in with their own abandoned well experiences.

The May meeting featured Mr. Barry Marcus, P.G. from the Sacramento County Environmental Management Department with an update of the Low-Threat Underground Storage Tank Case Closure Policy. The Policy, which is now in effect, is intended to provide state-wide guidance to close petroleum UST sites that have lingered and do not pose a threat to environmental health, but have tied up limited resources. The Policy has raised many concerns regarding blanket closure of sites versus site-by-site assessments.

The June meeting featured Mr. Charlie Ridenour, P.E., Ms. Dot Lofstrom, P.G., and Ms. Evelia Rodriguez, P.E., from the California Department of Toxic Substances Control, with the eighth Annual DTSC Regulatory Update. Mr. Ridenour discussed DTSC news, including management changes, program changes and cuts, and toxicity criteria changes (especially TCE and PCE). Ms. Lofstrom discussed guidance updates, including for Vapor Intrusion, Site Characterization and Geophysics, and the Preliminary Endangerment Assessment Manual (PEA). Ms. Rodriguez discussed safer consumer product regulations, including chemicals of concern and product prioritization, the determination of alternate products, the Priority Product List and regulatory responses.

The Sacramento Branch thanks our Scholastic Sponsors: for April, Enviro-Tech Services company; for May, Woodward Drilling Co., Inc.; and for June, Blaine Tech Services Inc.! 💧

Southern California

By Emily Vavricka,
Branch Secretary

In July, the Branch hosted GRA's 2012 David Keith Todd (DKT) Distinguished Lecturer for northern California, Dr. John Cherry; his presentation was titled "Aquitards...Why They Matter." Dr. Cherry, a world renowned hydrogeologist, researcher, and lecturer, proved an exhilarating presentation on why aquitards are often under-researched when they can be considered at least as important in hydrogeology as aquifers. The talk provided an overview of aquitards, contaminant hydrogeology of some Holocene aquitards in Louisiana and China, Pleistocene aquitards in Ontario and Manitoba, and the nature of some older sedimentary rock aquitards in the United States and Canada. Dr. Cherry described the nature of aquitards, the potential for fractures, and their connectivity to the groundwater flow system. He emphasized the importance of aquitard research given the world's reliance on them for isolating hazardous and high-level nuclear waste. Dr. Cherry also provided interesting and



humorous facts regarding his research endeavors and projects across the world. The DKT Lecture provided an excellent opportunity for GRA members to learn from one of the prominent leaders in the groundwater field.

The Branch would like to thank Geosyntec Consultants and Regenesis, who sponsored GRA's DKT Lecture

Series, and also Roux Associates, Inc. for sponsoring the Branch scholastic fund for the July meeting. The Branch also proudly sponsored the registration fees for three students to attend GRA's symposium on "Hydraulic Fracturing and Water Resources – A California Perspective" in Long Beach. The three students from USC, Britt Card, Michelle Stewart and Meredith Vivian (and Ahee Han, who was unable to attend) conducted research for their senior thesis project on hydraulic fracturing in California. The Branch was privileged to have had the opportunity to help these students to attend presentations about their thesis topic and to meet a variety of professionals engaged in their areas of interest. 💧

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- And
- Dissolution from a field-scale non-aqueous phase liquid and the implications with respect to the evolution and longevity of dissolved phase plumes



For booking information, universities can learn more at:

<http://grac.org/dkt.asp>

Sponsorship opportunities are also available.

For donation information, visit website above or email:

executive_director@grac.org

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Call for Submissions

HydroVisions is looking for submissions from students engaged in groundwater research, to highlight in our Student Corner.

Do you know of a student with something to share?

- Articles
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For further information, please contact:

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The Sacramento River

The Sacramento River has eroded scenic Iron Canyon in the western foothills of the Cascade Range northeast of Red Bluff. The largest river in California, the Sacramento has a length of 327 miles and an average annual runoff of 22,000,000 acre-feet. This is approximately one third of the total runoff in the state. The river is vital to the state's economy and is a major source of drinking water for residents of northern and southern California. The Sacramento River is also a principal source of irrigation water for Sacramento and San Joaquin Valley farmers and fresh-water flow into the Delta and San Francisco Bay (USGS, http://ca.water.usgs.gov/sac_nawqa/study_description.html).

The Pliocene-aged Tuscan Formation forms the foreground and canyon outcrops. This formation covers an area of over 2,000 square miles and consists of conglomerates, breccias and sandstones that are interpreted as debris flows and lahars derived from volcanoes of the Ancient Cascade Range south of Lassen Peak. A better understanding of the stratigraphy and depositional history of the Tuscan Formation is important because it is a potential regional aquifer in the northern Sacramento Valley.

This photograph was taken in the U.S. Bureau of Land Management (BLM) Sacramento River Bend Outstanding Natural Area, which is a valuable historic and natural resource that presents many recreational and educational opportunities. From the lush riparian habitat surrounding the Sacramento River and its tributaries to the expanse of the rolling hills of blue oak savannah, this scenic area offers diverse habitat for bald eagles, osprey, migratory and song birds, deer, and salmon. The area also offers numerous recreation opportunities for wildlife viewing, hiking, boating, camping, and hunting. Additional information about the BLM Sacramento River Bend Outstanding Natural Area is available at: <http://www.blm.gov/ca/st/en/fo/redding/recreationmain/reddingrecreationtehama.html>.

*Photograph by John Karachewski, PhD (DTSC), www.geoscapesphotography.com
GPS coordinates of photograph: 40.255491N, 122.168336W*