GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA

HYDROVISIONS

VOLUME 22, NO. 2 SUMMER 2013

Diverse Group of Groundwater Leaders Meet to Discuss and Develop Recommendations on Groundwater Recharge, Storage, and Quality Issues

By Reid Bryson, Luhdorff & Scalmanini, Consulting Engineers

The third annual workshop of GRA's Contemporary Groundwater Issues Council (CGIC) was held on April 16, 2013. Twenty-eight persons, including CGIC members and/or their representatives, others, and five GRA Board members attended the workshop. The workshop was facilitated by **Dorian Fougeres** of the Center for Collaborative Policy. Mr. Fougeres provided guidance to CGIC Co-Chairs **Vicki Kretsinger Grabert**, **Tim Parker** and **Thomas Harter** during many pre-planning sessions for the workshop.

As in previous years, the workshop focused on identifying recommendations to address California's groundwater-related management, regulatory, and research needs. The workshop featured presentations on groundwater banking by **Ellen Hanak** (Public Policy Institute of California, Co-Director of Research and Senior Fellow), results from the Groundwater Ambient Monitoring and Assessment (GAMA) Priority Basin Project by **Miranda Fram** (US Geological Survey, Program Chief USGS-GAMA), and recommendations for addressing nitrate in groundwater by **John Borkovich** (State Water Resources Control Board, GAMA Program Manager). Council members and invited attendees also worked in topic-specific small groups to discuss ideas and propose specific recommendations addressing (1) groundwater recharge and storage, and (2) groundwater quality and contamination. These recommendations were later reviewed and revised by the full group of attendees. An open discussion period followed, during which Council members and invited attendees discussed future funding for the GAMA Program and the potential role of the California Department of Water Resources (DWR) Water Plan Update 2013 to serve as a strategic guidance document for statewide groundwater conditions and a comprehensive reference for water resources managers. Council members concluded the workshop by voting in a straw poll on the recommendations developed earlier in the day.

The 2013 Contemporary Groundwater Issues Council in action.

Elena Hanak provided an overview of the current groundwater recharge and banking projects in California. Dr. Hanak described a three-tiered classification scheme for groundwater banking projects to distinguish projects by their degree of accounting and extent of participation. She noted that efforts to gather data on current banking and recharge projects indicate that the majority of projects are not collecting key data that

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

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HYDROVISIONS is the official publication of the Groundwater Resources Association of California (GRA). GRA's mailing address is 621 Capitol Mall, 25th Floor, Sacramento, CA 95814. Any questions or comments concerning this publication should be directed to the newsletter editor at editor@grac.org or faxed to (916) 442-0382.

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With Gratitude to Dr. David Huntley

By Sarah Raker

As a kid growing up in Arizona, I became fascinated with geology. My family made frequent outings to the Mogollon Rim on the southwestern edge of the Colorado Plateau and to the Sonora Desert of southern Arizona. We explored canyons and creeks, deserts and springs, and picked up a lot of rocks along the way. During one of our treks, I was perplexed when I discovered a mountain creek that disappeared into the stream bed. Later, my ninth grade earth science teacher, a former petroleum geologist, taught us about the earth's crust and continental drift. I was hooked. I majored in geology at San Diego State in the late 1970s when most students focused on classes to enhance their careers in the petroleum or mining industries. In 1978, Dave Huntley brought something new to the curriculum – groundwater and engineering geology. Then I was really hooked.

Dave opened my world to groundwater. With the help of Stan Davis and Patrick Domenico, we studied the basic principles of groundwater flow, aquifer characteristics, water budgets, and hydrogeologic phenomena, like losing streams. I finally understood how that stream had disappeared! In addition to Darcy's law, my favorite groundwater-related discovery from Dave was learning about Terzaghi's Principal of Effective Stress: the total stress on a soil is equal to the sum of effective stress and pore water pressure. Dave showed us numerous examples of slope failures throughout San Diego County where pore water pressure, enhanced by our need for green lawns and commercial development, had a powerful and devastating effect on the clay-rich formations. One of the highlights of Dave's engineering geology class was a field trip to the freshly altered landscape after the 1979 Imperial Valley earthquake. Although there was no loss of life, the 6.4 magnitude earthquake caused an estimated $30 million in property damage and affected the irrigation systems in Imperial Valley. We saw offset hay stacks, roads and ditches; sand boils with mounds of sand bubbling up from liquefaction; and the once six-story Imperial County Services building that was squashed to five.

The first gift Dave gave to me was during the summer of 1979 after he received a call from Dean Gregg of Fugro and was asked to manage the water resources investigation for the infamous MX missile project. Although I'm sure he would have preferred surfing or sailing, he spent the summer in the Nevada desert supervising groundwater projects. Fugro was under contract with the Department of Defense to perform an expedited study of the groundwater supply in the deep carbonate and alluvial aquifers of eastern Nevada and western Utah. Huge quantities of water were needed to build the underground "railroad tracks" in the Great Basin valleys that would have a lasting impact on the groundwater resource. Along with many other up-and-coming hydrogeologists, I was tasked with measuring water levels, conducting aquifer tests on irrigation wells, estimating discharge quantities, sampling springs and measuring pH in the field by titrating water samples with a phenolphthalein indicator. That was great stuff! I used the data to prepare my Senior Thesis under Dave and later used the same principals and similar hydrogeology to prepare my Master's Thesis titled *Water Chemistry as an Indication of Groundwater Flow Direction*.

Soon after I graduated in 1980, Dave received a call from a former SDSU student looking for field geologists; he was obviously the "go to" guy for well-trained students. Hydro Search had a contract with Fugro to continue the groundwater studies for the MX missile project. Thanks to Dave's generous reference, I quickly moved to Reno and launched my career. At Hydro Search, we installed numerous exploratory and water supply wells in the eastern Nevada valleys, collected water-quality data from local springs and ran 24-hour to week-long pumping and aquifer recovery tests. It was amazing work for a beginning hydrogeologist.

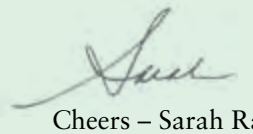
Fortunately for the environment, the MX missile project was cancelled in 1981; Reagan called it "a Rube Goldberg scheme." Unfortunately, the DoD contract ended and I was out of work. Fortunately, the University of Nevada, Reno and the Desert Research Institute picked me up, but that's another story.

Continued on the following page…

With Gratitude to Dr. David Huntley – *Continued*

Dave was an extremely important influence on me and my career, and I thank him with all my heart. And I know I am not alone with this gratitude. Through Dave's consulting and research funding and his untiring enthusiasm for teaching, Dave provided unique projects and supported many of his undergraduate and graduate students. I'd also like to thank Dave on behalf of some of his former students who became my friends and colleagues: Bob Hawk, Chris Ross, John McHugh, Matt Wiedlin, Michelle Dalrymple, Mike Marsden, Mike Palmer, Sam Williams, Steve Carlton, and Victor Harris.

Keep on sailing Dave! And many thanks!



Cheers – Sarah Raker,
GRA President

David Huntley is GRA's 2013 David Keith Todd Distinguished Lecturer for southern California; please visit www.grac.org for his lecture schedule.

Diverse Group of Groundwater Leaders Meet to Discuss and Develop Recommendations on Groundwater Recharge, Storage, and Quality Issues

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Benefits of better recharge management and policy pointed out by Dr. Ellen Hanak, Co-Director of the Public Policy Institute of California.

Dr. Miranda Fram, program chief of the USGS-GAMA program, provides an overview of the GAMA Priority Basin Project.

John Borkovich, GAMA program manager at the State Water Resources Control Board, explains groundwater quality data and monitoring efforts.

would allow for rigorous analysis. Using the Kern Water Bank as an example, Dr. Hanak showed the additional water-supply flexibility that such projects can provide by working with urban and agricultural water users. Such flexibility was evident during the 2007 to 2010 drought period when, according to her analysis, withdrawals from the Kern Water Bank and other Southern California groundwater banks provided 1.9 million acre-feet; this is about three times the amount available through the statewide water market during those dry years. More information about Dr. Hanak's research is available at www.ppic.org.

Miranda Fram summarized results from the GAMA Priority Basin Project, one of four GAMA projects, which was designed to provide spatially unbiased assessments of groundwater quality at statewide, regional and basin scales, with a focus on aquifers used for public water supply. From 2004–12, the USGS collected samples from over 2,300 wells in all 165 priority basins statewide, thus providing for assessments of approximately 95% of the used resource. Dr. Fram noted that results show untreated groundwater quality varies regionally and between basins based on natural and anthropogenic sources of trace elements and anthropogenic sources of nitrates and organic constituents. For uranium, the fourth most common trace element found to exceed water quality benchmarks, geochemical modeling and analyses show how agricultural land uses have increased downward groundwater flow and mobilized adsorbed uranium through increased production of dissolved bicarbonate. More information about the USGS GAMA Program is available at http://ca.water.usgs.gov/gama.

John Borkovich reviewed two recent widely-publicized reports, commissioned by state legislation, that have assessed groundwater quality and recommend actions in response to documented cases of regional contamination or degraded groundwater quality. The first report, commissioned by Assembly Bill 2222, documented 680 community water systems, serving nearly 21 million people, with at least one well having multiple detections from 2002–10 of a contaminant or water quality constituent above a drinking-water benchmark. Fifty-eight percent of those community water systems were affected by naturally-occurring constituents, 38 percent were affected anthropogenic constituents, and 11 percent were found to be impacted by both naturally-occurring constituents and anthropogenic contaminants. The second report, authored by UC-Davis researchers, characterized nitrate contamination in the Tulare Lake Basin and Salinas Valley, and proposed a comprehensive approach to addressing nitrate contamination of groundwater. Mr. Borkovich reviewed these recommendations with an emphasis on early implementation actions and proposed funding sources. More information about these reports and the SWRCB GAMA program is available at http://www.waterboards.ca.gov/gama.

Small Group: Groundwater Recharge and Storage

Participants discussed a variety of topics related to groundwater recharge projects and offered recommendations to address regulatory uncertainty, the availability and quality of recharge project data, and education deficits that collectively hinder more effective implementation of recharge projects. Lack of regulatory clarity was identified as a problem that leads to confusion among local entities and the public regarding the acceptable beneficial uses of recharged water. Examples noted by group members included recharge projects in the Kaweah River watershed and Pajaro Valley where local entities are concerned that state regulations regarding acceptable sources of water for recharge projects may change in ways that would limit or prohibit the use of some source waters, and that limitations on beneficial uses assigned to recharged water inhibit the development of additional recharge projects. Several recommendations developed by the group addressed concerns of this nature, including a call for the development of a statewide recharge policy that explicitly defines recharge to be a beneficial use in addition to those beneficial uses originally assigned to the

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Diverse Group of Groundwater Leaders Meet to Discuss and Develop Recommendations on Groundwater Recharge, Storage, and Quality Issues

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source water. Another recommendation called for expanded opportunities for recharging surface water from large flow events. The group also recommended that recharge project managers be more transparent regarding their operations in order to encourage more efficient resource management. Other recommendations focused on the need for education efforts tailored to policymakers, regulators, recharge project managers, and the public to provide an appropriate level of understanding of groundwater recharge.

Small Group: Groundwater Quality and Contamination

The group addressed a variety of topics regarding gaps in public understanding of groundwater quality and contamination, opportunities for improved efficiency among groundwater quality monitoring programs, and the need for improved groundwater quality data management. Recommendations included efforts to better educate the public on the need for water quality testing and the development of basin-specific recommended constituents for monitoring by private well owners. Participants also discussed the need to improve monitoring of shallow aquifers to complement the work of the GAMA programs and improve the statewide understanding of anthropogenic and naturally occurring constituents impacting shallow wells now and possibly impacting deeper wells in the future. Opportunities for improved efficiency across monitoring programs were also identified. These included the need for more consistent and thorough consideration of groundwater resources in Integrated Regional Water Management Plans and the possible inclusion of groundwater in efforts underway through the California Water Quality Monitoring Council, established by Senate Bill 1070.

Funding the GAMA Program

Despite its contributions to groundwater management in California, GAMA Program funding is scheduled to expire in 2014. Participants familiar with GAMA noted that USGS staff is working with SWRCB staff to develop a funding plan. Participants also noted that shallow groundwater monitoring is a part of the future plan for GAMA. Trends monitoring based on previously monitored sites is also under consideration as a future GAMA activity.

Participants discussed whether future GAMA shallow groundwater monitoring should include an assessment of risks that shallow groundwater poses to deeper groundwater (i.e., public drinking water supplies), and whether some areas of contamination could be deemed a lower priority and left in place in lieu of required contributions to a fund that would compensate affected users and provide for research and outreach. Views on this concept varied. The discussion included acknowledgement of the precedent for leaving contaminants in place through other regulatory programs, although the requirements for analysis and assurance of the lack of future risk are considerable. Other participants noted that availability of accurate land use data and changes in land use or land ownership following contamination would be very important and could affect liability for any contaminants left in place.

DWR California Water Plan Update 2013

Participants considered the efforts underway by DWR to incorporate groundwater content into the Water Plan Update 2013 and whether the state should merge Bulletin 118 with the Water Plan in order to improve groundwater management efforts. The discussion that followed focused on the risks associated with merging the documents, particularly the history associated with Bulletin 118.

The discussion broadened to include concerns among participants that state agencies are limited in their ability to engage in statewide water resources management by the partitioning of responsibilities within and among state agencies. Participants noted that the partitioning is attributable, in part, to legislative mandates developed over many years.

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Kamyar Guivetchi of Dept. of Water Resources (left), Jim Strandberg of GRA, and Karl Longley of Central Valley Regional Water Board (right) at the Contemporary Groundwater Issues Council.

Diverse Group of Groundwater Leaders Meet to Discuss and Develop Recommendations on Groundwater Recharge, Storage, and Quality Issues

– Continued

Straw Poll

The workshop concluded with a straw poll whereby CGIC members evaluated the recommendations developed over the course of the day. Members voted to indicate their level of support for each recommendation. The straw poll results and recommendations will be presented to the GRA Board of Directors in June; the Board will review the recommendations and consider actions to address them.

Contemporary Groundwater Issues Council

GRA formed the Contemporary Groundwater Issues Council in 2011. The overarching vision of the Council is to help GRA identify the state's most pressing information, education, and networking needs which pertain to groundwater, thereby allowing GRA and other stakeholder organizations to effectively address integrated water resources and environmental stewardship issues. The goal for this vision is to meet the needs of the state's water stakeholders in providing opportunities, e.g., water forums, workshops and conferences, to share experiences with, and potential solutions to, the state's most pressing groundwater issues. The Council members include a select group of executives and leaders from a range of disciplines and backgrounds at the local, state, and national level representing regulatory agencies, research and educational institutions, NGOs, water users, the public at large, and consultants sharing a common interest in the management, protection, and use of groundwater resources in California. More information is available at http://www.grac.org/cgic.asp.

Picture Your Research Featured in HydroVisions

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
- Research Papers
- Summary Blurbs

For further information, please contact:
editor@grac.org, subject "Student Corner"

Dates & Details

GRA EVENTS & KEY DATES

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

GRA Symposium
High Resolution Tools and Techniques for Optimizing Groundwater Extraction for Water Supply
Jun. 19, 2013 | Garden Grove, CA

GRA Board Meeting
Aug. 16, 2013 | Berkeley, CA

29th Biennial Groundwater Conference and GRA 22nd Annual Meeting
Oct. 8-9, 2013 | Sacramento, CA

GRA Workshop
Collaborative Leadership: Negotiating Relationships to Improve Water Resources Planning
Nov. 4, 2013 | Sacramento, CA

7th Symposium in GRA's
Series on Tools and Technologies

High Resolution Tools and Techniques for Optimizing Groundwater Extraction for Water Supply

COOPERATORS
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JUNE 19, 2013
HYATT REGENCY ORANGE COUNTY – GARDEN GROVE, CA
7 CEU HOURS AVAILABLE

The June 20, 2013 Demonstration that was previously announced in conjunction with the Symposium is not being offered.

Groundwater research, developments in drinking water regulations and experience operating water supply wells have resulted in a growing awareness of and appreciation for the importance of variations in geology, geochemistry and well condition in the vertical dimension. High costs for, among other factors, replacing wells, pipeline relocation, various forms of treatment, and operations and maintenance in perpetuity, have led to new applications of existing technologies as well as development of new technologies for well diagnosis. Much has been learned in recent years, and there have been marked increases in efficiency and cost effectiveness. The goal of this symposium is to present information regarding recent advances in collecting and using high resolution data with respect to groundwater wells (municipal, remediation, agricultural, industrial and monitor).

Symposium Focus

The Symposium will feature invited speakers from consulting, contracting, industry, government, and academia. Topics addressed will include:

- Tools and techniques to identify the scale of geologic and water quality variability and well screen condition under pumping and non-pumping conditions
- Differences in water quality between test holes and constructed wells
- Contaminant delineation in pumping wells
- Modifying wells to improve water quality relative to undesirable constituents
- Effects of nearby pumping on idle wells
- Screen rehabilitation
- Vertical conduit evaluation and management
- Modeling well modification results
- Age dating and vulnerability assessment
- Optimizing groundwater production wells to reduce cost and maximize benefit.

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29th Biennial Groundwater Conference & GRA 22nd Annual Meeting

California's Groundwater Future in the Balance: Intergrating Quantity & Quality in a Changing Climate

CALL FOR ABSTRACTS

OCTOBER 8-9, 2013
RED LION/WOODLAKE CONFERENCE CENTER HOTEL – SACRAMENTO, CA

CO-SPONSORS
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CONFERENCE ORGANIZING ENTITIES:
California Department of Water Resources | Water Education Foundation | UC Water Institute
Association of California Water Agencies | State Water Resources Control Board | Regional Water Quality Control Boards
US Geological Survey | California Department of Toxic Substances Control | US Bureau of Reclamation
California Department of Public Health | California State University East Bay

About the Conference:

For more than 50 years, the Biennial Groundwater Conference has provided policy-makers, practitioners, researchers, and educators the opportunity to learn about the current policies, regulations, and technical challenges affecting the use and management of groundwater in California. This year's conference will focus on the challenges that California faces in integrating various aspects of water quantity and quality in a changing regulatory, political, and environmental climate. Collaborative efforts have initiated integration of groundwater into the framework for *California Water Plan Update 2013*, and with many basins in decline and Delta through-flows constrained, groundwater policy and regulatory discussions in the coming years are expected to increase significantly in fervor and frequency.

The two-day Conference features a plenary session, concurrent sessions with policy and technical presentation, and a final general assembly. The concurrent session topics include (those in blue are open to abstract submissions):

- Groundwater Quality: Coordinating Programs
- DWR's Role in California's Groundwater
- Groundwater Quality Challenges & Advancements Toward Improved Supply Reliability
- Chronic Groundwater Level Declines: Options for Improved Management for Protection of Water Supply and Quality
- Recent Innovation in Groundwater Quality Remediation to Improve Supply Reliability
- Surface Water/Groundwater Interaction
- Strategies to Sustainably Manage Groundwater Quality and Quantity in an Uncertain Climate Future
- Emerging Groundwater Trends
- Managed Aquifer Recharge: Water Quantity and Quality Considerations

Call for Abstracts – Due June 30, 2013

Abstracts are being solicited for the October 8-9, 2013 Biennial Groundwater Conference in areas related to the topics listed above in blue. Guidelines for submitting an abstract for a Paper or Poster resentation: http://www.grac.org/abstractguidlines.asp.

Please submit your abstract by email to: Mary Megarry of GRA, mmegarry@grac.org no later than June 30, 2013.

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. For more information, please contact Dr. Jean Moran at jean.moran@csueastbay.edu.

Sponsor and Exhibitor Opportunities

If you are interested in exhibiting your organization's services or products, or being an event co-sponsor, please contact Mary Megarry at mmegarry@grac.org or 916-446-3626.

Additional information: contact Jim Strandberg (jstrandberg@ekiconsult.com; 510-452-1308) or Chris Petersen (cpetersen@westyost.com; 530-792-3239).

Collaborative Leadership: Negotiating Relationships to Improve Water Resources Planning

NOVEMBER 4, 2013 | 9:00-4:30
SHERATON GRAND – SACRAMENTO, CA

Nearly all water resource planning and program implementation activities involve public meetings and stakeholder involvement due to the public nature of water and environmental policy and laws. Many water issues and projects are complex and thorny, causing uncertainty and angst among local stakeholders with a whole set of different perspectives and opinions. Collaborative leadership and policymaking are critical skill sets for public employees, particularly executives, and mid-level managers. Attendees will have an opportunity to learn from several key water industry leaders and the Sacramento State University's Center for Collaborative Policy – a nationally recognized consensus-building organization working statewide on the California's thorniest conflicts. Attendees will learn how to develop collaborative leadership competencies, and how to apply them by following a collaborative policy making method. You will also learn how to build networks and manage collaborative groups. This event will serve to educate water, groundwater, and planning professionals and elected officials on some of the key tenets of stakeholder involvement, collaborative leadership through a mix of presentations, work groups, and interactive exercises in a one-day event.

Trainers

Center for Collaborative Policy, California State University, Sacramento

Gina Bartlett, Director, Bay Area Office, and Managing Senior Mediator

Dave Ceppos, Associate Director and Managing Senior Mediator

Keynotes

Dave Orth, General Manager, Kings River Conservation District

Grant Davis, General Manager, Sonoma County Water Agency

Celeste Cantú, General Manager, Santa Ana Watershed Project Authority (invited)

Who Should Attend

People who have a role and interest in managing water resources and groundwater: Agency Staff, Land Use Planners, Technical Consultant, Elected Officials, Boards of Directors and Boards of Supervisors.

For More Info: www.grac.org or contact Kathy Snelson ksnelson@nossaman.com (916) 446-3626.

High Resolution Tools and Techniques for Optimizing Groundwater Extraction for Water Supply – Continued

Sessions

- Higher Resolution Data Collection Technology and Data Analysis Techniques
- Water Supply Case Studies – Potable Supply
- Water Supply Case Studies – Well Operations and Maintenance
- Water Supply Studies – New Insights.

Program Agenda

http://www.grac.org/hiresagenda.pdf

In addition to the oral presentations, a poster session will be held at the conclusion of the Symposium. The poster session will provide an excellent forum for the authors to present their work in an informal and interactive setting.

Who Should Attend: groundwater supply managers and engineers, hydrogeologists, regulators and students.

Additional information: Contact Rob Gailey, rmgailey@thesourcegroup.net or 415-407-8407, or Noah Heller, nheller@besstinc.com or 866-298-8701.

Wells and Words

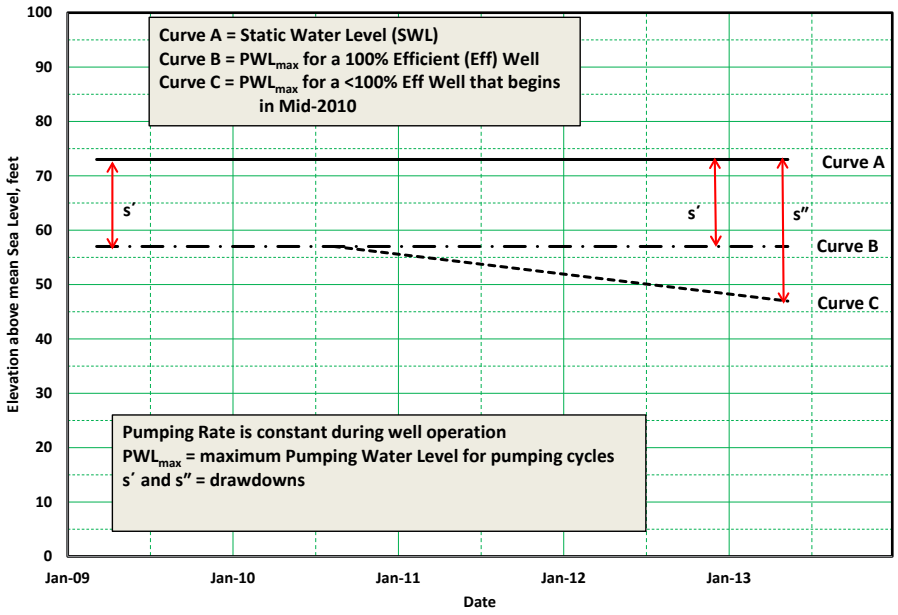
By David W. Abbott P.G., C.Hg., Senior Hydrogeologist, Daniel B. Stephens & Associates, Inc.

Regularly Scheduled Checkups for Water Supply Wells—A Key to Extending Well Longevity and Reducing Operational Costs

The planning, installation, and construction of water supply wells can represent a significant capital investment, especially for deep, large-diameter, and high-yield wells. In many cases, scheduled and frequently performed measurements and maintenance can increase the longevity of a well by at least a factor of four,[1] and also increase its operational reliability. This article focuses on two simple measurements—water-level and pump discharge—that are vital to tracking the performance of a well. These parameters should be collected consistently during normal well operations in order to predict the need for, and timing of, a well-rehabilitation (well-rehab) program. All wells surrender to some degree to deterioration caused by the aging process.[2]

These basic measurements as part of a well maintenance program can result in economic savings in well operations, the design of more effective and lower-cost well-rehab programs, and prevent premature well replacement. Regular maintenance should be conducted on all wells. The frequency of measurements and well maintenance depends on the purpose of the well, original construction and design of the well, operational logistics, hydraulic responses, and the hydrogeology. Water levels and pumped volumes should be collected methodically and systematically. The recommended frequency of these measurements is at least monthly; however, more frequent measurements (weekly or daily) are better predictors of well reliability and may reveal well problems sooner than a monthly program. The sooner a well *problem* is identified, the more likely well-rehab will be successful.[3]

Figure 1: Generalized Hydrograph of Well 61



Water Levels should be measured to the nearest 0.01 feet (ft). Airline (bubbler) measurements have an accuracy of about 0.5 psi or 1.15 ft with standard pressure gages; the use of an airline should be discouraged for collecting water levels. The pump chamber diameter of the well should be designed to accommodate at least a ¾-inch diameter sounding-tube (s-tube) strapped to the pump column and set to a depth of about 5 ft above the pump intake or bowls. If an airline is used then an s-tube must still be installed in order to calibrate the pressure gage. The s-tube should allow clear and unobstructed access to both the static (non-pumping) water level (SWL) and pumping water level (PWL). Water levels should be measured using a calibrated electric sounder (e-sounder) through the s-tube; data loggers (also calibrated using an e-sounder) are ideal and provide a high-frequency record of water level fluctuations. Data loggers can be linked to a supervisory control and data acquisition (SCADA) system, giving high-quality real-time data that can be digitally transmitted, analyzed, and stored.

The SWL should be collected after the pump has been turned off for several hours (hrs); the appropriate interval is well-dependent. The PWL should be collected after the pump has been running for about 60 minutes (or more). The elapsed time (ET) interval that is used should be consistent for all subsequent measurements during the monitoring program. The ET intervals for specific wells may vary depending upon well and aquifer hydraulics. This information should be recorded in a logbook noting the following: date, time, pump on or off, ET since pump was on or off, SWL, and PWL. The reference point for all water level measurements should be conveniently located, permanent, and used for all measurements. The data should be plotted as hydrographs (time versus depth to water [or elevation]) in the field to compare with the historical record.

These water level measurements can provide a powerful basis for evaluation of the hydraulic performance of a well.[4] For example, Figure 1 is a hypothetical set of curves for Well 61 that pumps at

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Wells and Words – *Continued*

215 gpm for 18 hrs/day followed by 6 hrs of recovery. Curve A is the SWL (measured 30 minutes prior to turning the pump on), which remains unchanged through this 4-year record. Curve B is the PWL (measured about 60 minutes after the pump is turned on); it is parallel to Curve A, and indicates that the well efficiency (Eff) in 2009 is about the same as the Eff in 2013 – it is likely that no well-rehab is needed with this type of response. Curve C is an alternate PWL (measured 60 minutes after the pump is turned on) that starts to diverge from Curve A in mid-2010; it suggests that the Eff has decreased significantly by 2013 and that the well may soon require well-rehab.

Discharge Data is the second most important variable to measure: both the cumulative volume (Vol_{cum}) of water and instantaneous discharge (Q_{ins}) are relevant. An in-line totalizing flow meter with a sweep second hand should be installed in a horizontal section of the discharge line about 4 ft from any pipe-bends or other appurtenances.[5] The Vol_{cum}, or totalizer, should be recorded in the logbook with a corresponding date and time; if the well is pumping, then a Q_{ins} can be estimated using the sweep second hand. It is vital to record the units of the flow meter, i.e., gallons or ft3, and also to record when flow meters have been replaced. A totalizing hour meter should be installed on the pump so that the number of hours the pump is operating can be estimated. Both totalizing meters should be recorded at least weekly, if not daily. This information is used in combination with the SWL and PWL to interpret the hydrographs and to evaluate pump and well performance.

Other Data that may be collected on a regular basis includes the following:

1. Specific capacity (SC) testing using a variable-speed pump at least every five years;[2] the test should include at least three different discharges for at least 60 minutes each.
2. General water quality data at least every two years, including the following: major cations (Ca, Mg, Na, K); major anions (HCO_3, Cl, SO_4); minor ions (Fe, Mn, F, N-species); and physical parameters (Hardness, Alkalinity, Total Dissolved Solids, Electrical Conductivity, pH, Color, Odor, Turbidity).
3. Down-hole video logs to inspect the interior of the well casing at least every five years; the video logs are important for evaluating the structural integrity of the casing and well screen.
4. A permanent file should be maintained for each well and include the following information: correctly completed Water Well Completion Report (a.k.a. Well Drillers Report); geophysical logs; construction details; pumping test data; water quality data; SWL, PWL, and discharge/volume logs; any historical records related to well maintenance activities, dates of pump installations and replacements; and any site-specific and well-head observations by operation employees.

Notice the absence of a constant-discharge pumping test. It is important that a formal SC test (step-drawdown) and constant-discharge pumping test be conducted on the well immediately after well installation, construction, and development.[3] The aquifer coefficients estimated from a constant-discharge test, which generally will not change, are related to the SC and provide an optimum goal for the PWL and discharge relationships. This specific information is used as baseline operating conditions for evaluating the frequency of scheduled SWL and PWL measurements and maintenance intervals.

[1] Gass, Tyler E., T.W. Bennett, J. Miller, and R. Miller, date unknown, *Manual of Water Well Maintenance and Rehabilitation Technology*, reprinted by the National Water Well Association from the Robert S. Kerr Environmental Research Center, USPA, Ada, Oklahoma, 247 pages.

[2] Clark, Lewis, 1988, *The Field Guide to Water Wells and Boreholes*, Geological Society of London Professional Handbook Series, John Wiley & Sons, New York, 155 pages.

[3] US Department of Interior, 1981, Ground Water Manual, John Wiley & Sons, New York, 480 pages.

[4] Brassington, R., 1988, *Field Hydrogeology*, Geological Society of London Professional Handbook Series, John Wiley & Sons, New York, 175 pages.

[5] Anderson, Keith E., 1984, *Water Well Handbook*, Missouri Water Well and Pump Contractors Association, Belle, MO, 281 pages.

Legislative Update

By Tim Parker, GRA Legislative Committee Chairman,
Chris Frahm and Rosanna Carvacho, GRA Legislative Advocates

Spring and early summer are always busy times in the Legislature as committees hear bills that were introduced in their house and then in June legislation is moved from one house to the other to begin the same committee process. Additionally, this spring GRA held its Annual Legislative Symposium and Lobby Day in Sacramento.

GRA's Annual Legislative Symposium and Lobby Day

On April 24th, GRA hosted its Annual Legislative Symposium and Lobby Day at the Citizen Hotel in Sacramento. The topic was: *Striking the Balance – Can we develop the water, gas and energy supplies we need and still protect California's groundwater and natural resources*? The Symposium was again hosted in cooperation with the California Groundwater Coalition.

The Symposium featured a diverse group of speakers, including both legislators and other state office holders, such as Natural Resources Secretary John Laird, Water Board Member Tam Doduc, and Assembly Majority Leader Toni Atkins. Each of these speakers provided GRA members with a candid look at "what's happening" in the state this year, perspectives on fracking, and predictions about the future of the water bond.

Several new members of the Legislature were also present to weigh in on water issues relevant to their districts: Assemblymembers Marc Levine, Rudy Salas, and Jimmy Gomez took the opportunity to introduce themselves to attendees and speak about why water is an important issue for them. Other speakers included Dan McManus of the Department of Water Resources (DWR), updating GRA on progress with the 2013 California Water Plan; Allan Highstreet, a consultant for DWR, who explained DWR's draft Finance Planning Framework; and Anton Favorini-Csorba with the Legislative Analyst's Office, who discussed the issues associated with moving drinking-water activities from the Department of Public Health to the Water Board.

Keynote Speaker Senator Hannah-Beth Jackson spoke about her bill, SB 395, and provided her perspective on why fracking has become such a hot topic in the Legislature this year – and why she believes fracking regulation is needed. Fracking was a hot topic throughout the day, culminating in a lively Roundtable Discussion in the afternoon featuring various consultants and industry experts. The Fracking Panel was followed by a talk from Miranda Fram of the USGS, who provided an overview of the GAMA program. A final diverse panel of lively speakers, which included Dennis O'Connor, Principal Consultant to the Senate Committee on Natural Resources and Water, gave their perspectives on regional self-sufficiency and how to finance the state's Water Plan.

The GRA Legislative Committee has already received accolades for delivering another outstanding program this year. Thank you, GRA members, for again supporting GRA's Annual Legislative Symposium and Lobby Day! Your continued support has made this event the "go to" groundwater event in the Capitol. GRA would also like to thank our partner for this event, the California Groundwater Coalition – with your help the Legislature is beginning to understand that there are millions of ratepayers across California who care about groundwater policy and legislation.

GRA Supported Legislation

SB 620 (Wright) – SB 620 removes the statutory limitation on the Water Replenishment District (WRD) of Southern California's annual reserve fund. The current limitation on the use of reserves, which requires that 80% of the reserves be spent on the purchase of imported water, is inconsistent with the goals and objectives of WRD and the state water plan. SB 620 is currently awaiting action on the Senate Floor where it is expected to pass and move on to the Assembly.

SB 658 (Correa) – SB 658 clarifies that the Orange County Water District can recover all clean-up costs for the Orange County groundwater basin. GRA supports timely remedial activities to enhance the long-term beneficial use of California's groundwater resources. SB 658 is critical to the remediation of pollutants to ensure a safe water supply for the residents of Orange County. This bill is currently in the Senate Environmental Quality Committee where it is expected to pass and move on for a full vote of the Senate by the end of May.

Hydraulic Fracturing, or "Fracking"

As seen at the Legislative Symposium, fracking is a big issue in the Legislature this year. GRA has formed a workgroup to examine the issue, both through the Legislative and Regulatory processes. The workgroup has reviewed the draft regulations put out by the Division of Oil, Gas and Geothermal Resources (DOGGR) and GRA has sent a letter providing comment on the draft regulations. The workgroup and Legislative Committee will continue to monitor the regulations and legislation on fracking.

Continued on the following page…

Legislative Update – *Continued*

Changes in the Legislature

The Legislature has seen a lot of changes in the last few months. In late February, Senator Michael Rubio (D–Shafter), Chair of the Senate Environmental Quality Committee, resigned from the Senate. Senator Jerry Hill (D–San Mateo) is now the Chair of the Senate Environmental Quality Committee. Rubio's resignation left the Senate with 3 vacancies; however, in March, Assemblymember Ben Hueso (D–San Diego) was elected to fill one of the vacancies.

Hueso's departure from the Assembly created a vacancy which will be filled by a Special Primary Election on May 21st and, if needed, a Special General Election on July 30th. Hueso is no longer Chair of Assembly Water, Parks and Wildlife Committee; the new Chair is Assemblymember Anthony Rendon (D-Lakewood).

There are still two vacancies in the Senate. A Special Election for the 32nd Senate District will be held on May 14th and the Special General Election for the 16th Senate District will be on July 23rd.

With all these changes in the Legislature, committee membership and chairs are continually changing; we will keep you informed of how the changes affect the committees most important to GRA.

Appointments

In March, Governor Brown appointed Tam Doduc and Frances Spivy-Weber to the State Water Resources Control Board. With the retirement of Board Chair Charles Hoppin in April, Felicia Marcus, a current Board member, was appointed Chair, and Dorene D'Adamo was appointed to fill the open Board seat vacated by Charles Hoppin. All five positions on the Board remain filled.

Dorene D'Adamo has served as a policy advisor and legal counsel for multiple members of Congress since 1994, most recently serving as senior policy advisor for Congressman Jim Costa. D'Adamo was a visiting instructor at California State University, Stanislaus from 1992–98 and an associate attorney at the Law Offices of Perry and Wildman from 1992–94. She was a policy consultant at Dee Dee D'Adamo Consulting from 1991–92 and legislative director for Congressman Gary Condit from 1990–91. D'Adamo was assistant legislative director at the California Youth Authority from 1988–90 and served in multiple positions in the California Assembly from 1985–88. D'Adamo has served on the California Air Resources Board since 1999 and the California Partnership for the San Joaquin Valley since 2007.

Looking Ahead

As the year and legislative session progresses, GRA's Legislative Committee and its Legislative Advocates will continue to monitor issues and legislation important to GRA. Please do not hesitate to contact us at any time if you have questions about pending legislation or GRA's Legislative Committee and program.

The Federal Corner

By Jamie Marincola, U.S. EPA

A note from Kelly Manheimer: I've enjoyed my stint as the EPA contributor to the Fed Corner, but now I'm moving on to an extended leave of absence from EPA to journey in Cambodia with my family. I'll be back, but leave the readers in the very capable hands of your new Fed Corner contributor. Adieux!

Success Spotlight: San Joaquin River

EPA's Clean Water Act Section 319 Program provides funding for restoration of nonpoint source-impaired water bodies. In California's San Joaquin Valley, widespread use of the pesticide diazinon resulted in elevated concentrations toxic to aquatic life; in 1992, several portions of San Joaquin River were placed on California's list of impaired waters. Watershed stakeholders implemented agricultural best management practices in orchards, such as biological methods to replace chemical farming practices, maintenance of natural areas, and hedgerows to provide habitat for beneficial insects to control pests. Partners also initiated discharge regulations and a total maximum daily load for diazinon. As a result of these management actions, pesticide concentrations decreased and 17 miles of the river were removed from the state's list of impaired waters for diazinon in 2010. To learn more, see: http://water.epa.gov/polwaste/nps/success319/ca_sanjoaquin.cfm.

EPA Survey Finds More Than Half of the Nation's River and Stream Miles in Poor Condition

EPA released results from the first comprehensive survey looking at the health of thousands of stream and river miles across the country, finding that more than half—55 percent—are in poor condition for aquatic life. The 2008–09 National Rivers and Stream Assessment reflects the most recent data available, and is part of EPA's expanded effort to monitor waterways in the U.S. and gather scientific data on the condition of the Nation's water resources. To access the report, visit: http://www.epa.gov/aquaticsurveys.

Pyrethroid pesticides increase in latest pollution trends monitoring study of California stream bed sediments

A popular form of insecticide is showing up in significantly higher levels in samples of California stream bed sediments, according to the latest Stream Pollution Trends monitoring program study. The Stream Pollution Trends (SPoT) monitoring program is an annual assessment of a sample of large watersheds across California conducted by the State Water Resources Control Board to determine how stream contaminant concentrations are affected by urban and agricultural land use. The pyrethroid pesticide residue was detected in 85 percent of the statewide samples taken in 2010, the latest samples analyzed. The pesticide was detected in 55 percent of the 2008 samples. Pyrethroids are a man-made pesticide used in many household insecticides and pest sprays, and in public mosquito control programs. The latest SPoT report is available at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/spot9rpt.pdf.

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The Federal Corner – *Continued*

EPA Releases Marine Beach Sanitary Survey Tools

EPA has made available a new sanitary survey to provide marine beach managers with a technically sound and consistent approach to identify pollution sources and share information. The survey helps marine beach managers synthesize data on water quality, pollutant source, and land use to aid them in improving beach water quality for swimming. Survey results also can be used to help set monitoring priorities, determine appropriate remediation, facilitate beach and watershed planning, and develop predictive models. The survey consists of routine on-site sanitary surveys designed to be filled out each time water quality samples are taken, and an annual sanitary survey that includes more comprehensive information about factors in the surrounding watershed that might affect water quality at the beach. EPA will present a webinar on the new survey in spring 2013. For more information, visit: http://water.epa.gov/type/oceb/beaches/sanitarysurvey_index.cfm.

Draft Final Vapor Intrusion Guidance Documents

EPA has prepared external drafts of two guidance documents about vapor intrusion: a general guidance for all compounds and one focused on petroleum hydrocarbons released from underground storage tanks. When final, these guidance documents will help ensure vapor intrusion exposure assessment and mitigation actions to protect human health are undertaken in a technically, scientifically and nationally consistent manner. For more information, see: http://www.epa.gov/oswer/vaporintrusion/.

EPA Honors Winners of First-Ever Campus RainWorks Challenge

EPA announced the winners of its Campus RainWorks Challenge, a new design competition created to inspire the next generation of landscape architects, planners, and engineers to develop innovative green infrastructure systems that mitigate the impacts of urban stormwater while supporting vibrant, sustainable communities. More than 200 student teams participated, and four winners were chosen: Illinois Institute of Technology (1st prize, small institution), University of Florida (1st prize, large institution), Missouri University of Science and Technology (2nd prize, small institution), and University of Arizona (2nd prize, large institution). Many of the winning designs proposed transformative additions to the campus landscape that would reduce stormwater impacts while educating students about the movement of water through the urban environment. To learn more, see: http://water.epa.gov/infrastructure/greeninfrastructure/crw_winners.cfm.

Jamie Marincola is an Environmental Engineer at the U.S. Environmental Protection Agency, Region 9. He works in the Water Division on Clean Water Act permitting and public affairs outreach. For information on any of the above topics, please contact Jamie at 415-972-3520 or marincola.jamespaul@epa.gov.

Basic pH

By Bart Simmons

What could be simpler than pH?

The popular belief that the range of pH values is from 0–14 is incorrect. Since pH is the log of hydrogen ion activity, there is no specific range. The pH of drainage from the Iron Mountain Mine near Redding has been measured as low as -3.6. Needless to say, this was measured with special equipment.

At very high pH, the measurement also becomes problematic. Because the concentration of the hydrogen ions is so low, other monovalent cations—particularly sodium and potassium—compete with the hydrogen ions, resulting in depressed pH values. This error is called alkaline or sodium error. Electrode manufacturers offer electrodes that are "low sodium error," and EPA methods for pH (e.g., 9040C and 9045D) state that a low sodium error electrode should be used for high pH range samples. Unfortunately, EPA does not define a low sodium error electrode. Instrument manufacturers and vendors offer various claims about the glass used in the electrode and low sodium errors of their electrodes. However, I have been unable to find comparable specifications from them. One instrument manufacturer, Thermo-Fisher Scientific (formerly Orion), offers electrodes that are "low sodium error," but also offers a table showing sodium error corrections as a function of pH and sodium concentration.

Particularly problematic is the pH measurement of samples containing lime. Limestone is primarily calcium carbonate, $CaCO_3$. When baked in a cement kiln, CO_2 is driven off, producing quicklime, CaO. When mixed with water, quicklime is hydrated and produces calcium hydroxide, $Ca(OH)_2$. The pH of a saturated $Ca(OH)_2$ solution is 12.45 at 25°C. California has a hazardous waste criterion of equal to or greater than 12.5.

Temperature can also affect pH readings. If the temperature of the solution being tested is greater than 25° C., the pH error is negative; if the temperature is less than 25° C., the error is positive. EPA methods specify that at high pH readings, the measurement should be done at 25 ± 1° C. However, if accuracy is a concern, I recommend that you request the lab to report the actual temperature of the sample during pH measurement.

The greater source of uncertainty in pH measurement is actual laboratory precision. EPA includes performance data in the pH methods 150.1 and 9040C for six reference samples with pH values ranging from 3.5 to 8.0. The solutions were tested by 44 chemists in 20 labs, and the results had an average standard deviation of 0.14. This provides a significant limit on pH precision.

Bottom line: Some labs are in the practice of reporting four significant figures, e.g., 10.15. This is a misleading result, and should be reported as 10.2.

The other consequence of this lab precision is that, as a practical matter, it is not feasible to determine whether the pH of a saturated Ca $(OH)_2$ solution is greater or less than 12.5 with a high level of confidence.

Real-world method performance must be considered when comparing data to regulatory limits, and those regulatory limits must consider the real laboratory performance.

Bart can be reached at bartonps@aol.com.

Understanding Shasta Valley Groundwater through Modeling

By Christina R. Buck for doctoral work in Hydrologic Sciences at University of California-Davis, currently Water Resources Scientist with Butte County Department of Water and Resource Conservation

Advised by Dr. Jay Lund, Dr. Thomas Harter and Dr. Graham Fogg, University of California-Davis

The Pluto's Cave basalt aquifer in the Shasta Valley shares many characteristics with other regions in the Cascade Range. This study integrated available information for the Shasta Valley with general understanding of Cascade hydrogeology from other studies to develop a rough quantitative understanding of groundwater in Shasta Valley.

Several approaches have been applied to represent aquifers with fractured rock and preferential flow paths in numerical models. Usually discrete fracture models or equivalent porous media models are used (Blessent et al. 2009). The equivalent porous media model is based on the groundwater flow equation (Shoemaker et al. 2008), yet the dual porosity nature of the aquifer, having distinct flow paths or fractures combined with less hydraulically conductive matrix material, is not explicitly represented. However, this approach has been used successfully (Gannett and Lite 2004; Scanlon et al. 2003). In accordance with Scanlon et al. (2003) and given that fracture systems in the Pluto's Cave basalt formation are numerous and well connected on a regional scale, this modeling effort used MODFLOW and an equivalent porous media modeling approach to organize water balance components and test our conceptual model of the Pluto's Cave basalt aquifer. The objective of this model development is to simulate long-term average regional groundwater flow, including recharge, spring flow, and pumping.

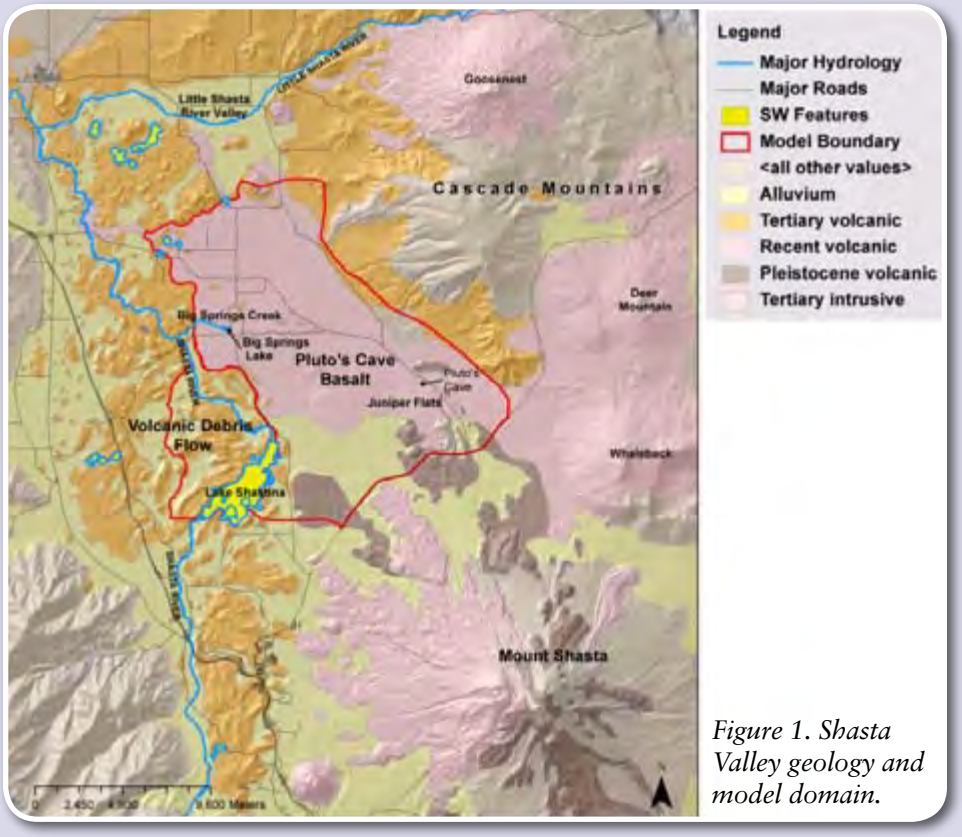

Figure 1. Shasta Valley geology and model domain.

Geology and Model Development

The Shasta River watershed is a geologic mix of Coastal Range alluvial valley, volcanic debris flow, and basalt flows (Figure 1). Marine sedimentary rocks of the Hornbrook Formation and volcanic debris flow underlie the basalt (Ward and Eaves 2008). An adjacent volcanic debris flow resulted from a debris avalanche off Mount Shasta. Its chaotic deposition resulted in a lack of internal structure and low permeability. The debris flow effectively impedes groundwater flow from the basalt, thereby giving rise to numerous springs along the contact between the two formations; an example is the Big Springs complex, which contributes significant flow to the Shasta River (Ward and Eaves (2008). DWR Bulletin 87 (1964) describes groundwater in the basalt aquifer as "transmitted along the vesicular contacts between flow layers, through joints and fractures within the flow, and through open and collapsed lava tubes where these occur below the water table."

The Pluto's Cave basalt conducts large volumes of water presumably recharging from snowfall and spring and stream discharge from the north side of

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Understanding Shasta Valley Groundwater through Modeling – *Continued*

Mount Shasta (Ward and Eaves 2008). Near Mount Shasta, the general direction of groundwater flow is understood to be from the southeast to the northwest and then westward toward the Shasta River. Smaller recharge sources include leakage from Lake Shastina and from water districts' irrigation canals, and deep percolation of applied water during the irrigation season. In the rain shadow of Mount Shasta, the valley is a high desert characterized by hot, dry summers and cool winters. Low precipitation on the valley floor (33 to 38 cm) limits recharge from deep percolation of precipitation. Spring flow is the primary form of groundwater discharge, exceeding agricultural pumping. Some groundwater flow between the basalt and debris flow material is likely, but had not been estimated. This aspect was further explored using the numerical model (Buck 2013).

Based on this conceptual model, an unconfined steady-state MODFLOW model was developed for 2008 conditions. The one-layer model is a 200 x 210 grid with 100 meter square grid cells. A subset of the 42,000 cells are active (see Figure 1), with the rest designated as inactive (no flow).

General-head boundaries (GHB) are specified along the northern and a portion of the western boundary of the model. A specified-head boundary represents Lake Shastina, and the River Package is used to represent surface water – groundwater interaction along Shasta River and Parks Creek near the western boundary, south of the Big Springs Creek confluence with the Shasta River. A specified-flux boundary along the southeastern edge of the model distributes estimated recharge originating from Mount Shasta. The eastern edge of the model was initially designated as a no-flow boundary. Other fixed fluxes within the model area represent irrigation wells or leaking irrigation canals. The Drain Package represents 11 of the major springs in the model domain and also Big Springs Creek. The simulated springs include: Big Springs Lake complex, Alcove springs complex, Little Springs, Hole in the Ground, Clear Spring, Hidden Valley Spring, Kettle Springs, Black Meadow Springs, Bridge Field Springs, Mack Spring, and spring-fed lakes in the northwestern corner of the model domain.

Results

Initial calibration efforts showed that spring flow from the Big Springs complex is sensitive to groundwater flow across the northern and western boundaries. These boundaries are also a source of great uncertainty. Therefore, instead of calibrating the model to reflect a single conceptual model with respect to these GHBs, three model cases were developed, calibrated, and explored by changing flow dynamics across these boundaries.

After model development and calibration, a group with considerable experience (hydrology, geology, and/or biology related) in the Shasta Valley gathered to evaluate the reasonableness of model results. A general consensus revolved around the model boundary conditions: recharge from Mount Shasta seemed low, flux across the northern boundary seemed too large, and likely some of the flow across the northern border was more likely to come from the east side instead. In response, recharge potential from the east side was evaluated, as was additional recharge from Mt. Shasta, and the northern and eastern borders were changed to specified-flux boundaries. Initial model calibration and results are presented (Figure 2). The model reasonably represents groundwater head and spring flow throughout the model domain.

The steady-state model indicates the regional K value for the Pluto's Cave basalt is on the order of 120 m/d with a likely range of about 100 to 300 m/d. This is well within the range estimated in other studies with similar hydrogeology. Calculated hydraulic conductivities in Jefferson et. al. (2006) range from about 25 to 860 m/d for volcanic aquifers in Oregon's High Cascades. In contrast, a calibrated K value of about 1.6 m/d represents the debris flow material with a likely range of 1.5 to 2 m/d. Lake Shastina leakage and Parks Creek valley spring flows were highly sensitive to this K value.

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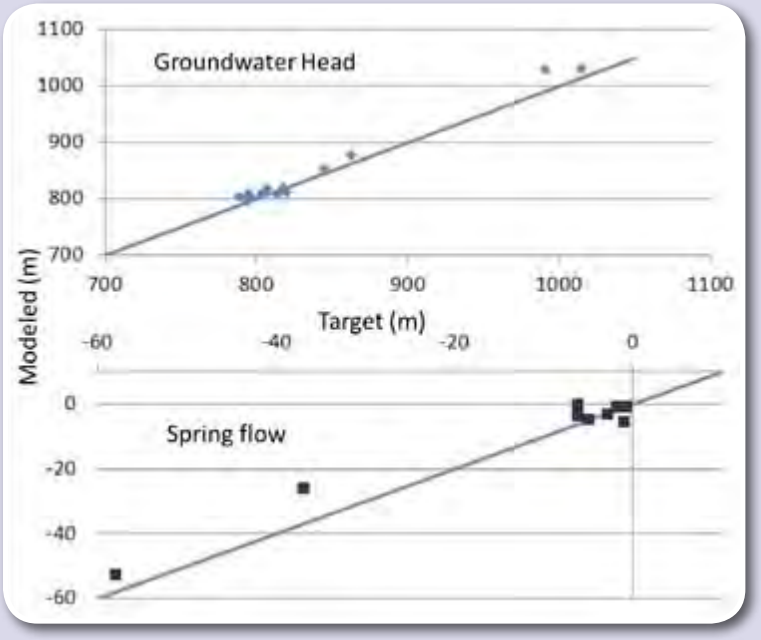

Figure 2. Target vs. modeled groundwater head (meters) and spring flow (MCM) with one-to-one line.

Understanding Shasta Valley Groundwater through Modeling – *Continued*

Developing the mass balance of a system—estimating its major inflows and outflows—is useful for assessing our understanding of a system and the relative importance of flow paths. Figure 3 shows the simulated mass balance of inflows (+) and outflows (-) within the model domain. The dominant outflow is spring flow, whereas the inflow is more divided between several sources, but is largely from boundary flows.

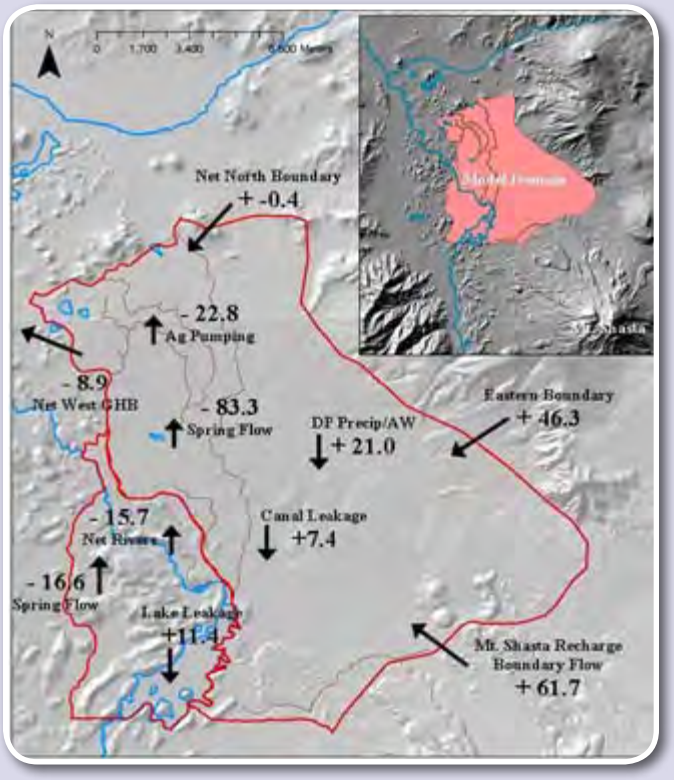

Figure 3. Simulated mass balance with approximate flows in million cubic meters (MCM). Model domain outlined in red. Inflows are positive, outflows negative.

Limitations

Modeling efforts inherently have limitations, as simplifications, imperfect data, and assumptions are unavoidable. The greatest simplification in this case involved using an equivalent porous media model to represent a complex fracture flow system. This has validity if the model scale far exceeds the scale of individual fractures. However, this model is not intended to be used to assess pumping effects of a specific well on spring flow or even groundwater flow direction at a specific location, as these depend highly on local hydrogeologic features.

Several other limitations discussed in the dissertation (Buck 2013) generally are related to limitations on data accessibility. Also, this steady-state model is not able to simulate the timing and effects of time-varying, seasonal fluxes. Transient simulation is needed to explore the timing of peak groundwater discharge and its relationship to seasonal regional pumping and recharge. The assumption of the one-layer model with no leakage or interaction with the underlying formation is also potentially limiting and should be further explored.

Conclusions

This work identifies, describes, and quantifies the major flow paths and fluxes in the Pluto's Cave basalt aquifer system and a portion of the debris flow in the Parks Creek valley. In a largely unexplored and un-modeled system, such modeling helps organize and quantify the conceptual model and major flow paths, providing a framework for resource management discussions and advancing system understanding.

Future model development should transition this steady state model to a transient simulation. Eastern boundary recharge should be further explored and evaluated. Estimates of Mount Shasta recharge should be refined by identifying elevation bands corresponding to the average recharge elevation indicated by available isotope data for the Big Springs complex. Additional work remains to further develop this model. However, the development thus far provides a tool for testing and adjusting our conceptual model of the system and exploring groundwater dynamics, and provides some guidance on future field research needed for improved understanding of the groundwater flow system.

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NGWA to Offer Conference on Groundwater and Food Production

By Cliff Treyens, NGWA Public Awareness Director

The National Ground Water Association will hold a Conference on Groundwater and Food Production on October 10-11 in Dallas, Texas, targeted to groundwater professionals, government officials, policymakers, and food- and beverage-industry professionals. Among the themes to be explored are: How will we use new and existing tools and technology to plan, manage, protect, and allocate increasingly stressed groundwater resources to provide adequate food and drinking water supplies to nourish more than seven billion people as we move through the 21st century?

The abstract submission deadline is 11:59 p.m. ET on June 22.

Potential topic areas to be examined include agricultural wells, aquaculture, biofuels, CAFOs, climate change, drought mitigation, emerging contaminants, groundwater sustainability, and pesticides.

Those who would benefit from the conference include:

- Agricultural planners and operations managers
- Beverage, brewing, and bottling company officials
- Dairy operators
- Food producers (grain, livestock, dairy, fish)
- Groundwater consultants and engineers
- Local and state land-use planners
- Water management and land-use policymakers
- Water management district officials.

A study released a year ago by the University of Texas at Austin found that the nation's food supply may be vulnerable to rapid groundwater depletion from irrigated agriculture. According to the university, groundwater depletion has been most severe in areas of the High Plains in parts of the Texas Panhandle, western Kansas, and the Tulare Basin in California's Central Valley. The study, which appeared in the journal *Proceedings of the National Academy of Sciences*, paints the highest-resolution picture yet of how groundwater depletion varies across space and time in California's Central Valley and the High Plains of the central U.S. Researchers hope this information will enable more sustainable use of water in these areas, although they think irrigated agriculture may be unsustainable in some parts.

Three results of the study are particularly striking; first, during the 2006–09 drought in California's Central Valley, farmers in the south depleted enough groundwater to fill Lake Mead, the nation's largest man-made reservoir—this level of groundwater depletion is unsustainable at current recharge rates. Second, a third of the groundwater depletion in the High Plains occurs in just 4% of the land area. And third, the researchers project that if current trends continue, some parts of the southern High Plains that currently support irrigated agriculture, mostly in the Texas Panhandle and western Kansas, will be unable to do so within a few decades.

For more information about the NGWA Conference on Groundwater and Food production, visit http://www.ngwa.org/Events-Education/conferences/Pages/5022oct13.aspx.

GRA Requests Nominations for the 2013 "Lifetime Achievement" and "Kevin J. Neese Awards"

The purpose of the GRA Awards Program is to recognize noteworthy projects and exceptional individual contributions related to the understanding, protection, and management of groundwater resources. The objectives of the annual Awards Program are:

1. To provide recognition to individuals who have demonstrated leadership and continuous dedication in groundwater hydrology
2. To provide recognition for unique contributions to groundwater hydrology in 2012–2013.

All nominations for the Lifetime Achievement and Kevin J. Neese Awards must be received by David W. Abbott (dabbott@dbstephens.com or 607 Chetwood Street, Oakland, CA 94610-1433) no later than **Friday, June 21, 2013**.

Nominations should be completed using the nomination forms available on the GRA website at http://www.grac.org/awards.asp. Nominations should not exceed one page, identify the award for which the nomination is made, and include justification for the award based on the criteria listed below.

The GRA Awards will be presented to the recipients selected by the GRA Board of Directors during the 29th Biennial Groundwater Conference and the 22nd GRA Annual Meeting in Sacramento, CA, October 8-9, 2013.

Awards

Lifetime Achievement: presented to individuals for their exemplary contributions to the groundwater industry, and contributions that have been in the spirit of GRA's mission and organization objectives. Individuals that receive the Lifetime Achievement Award have dedicated their lives to the groundwater industry and have been pioneers in their field of expertise.

Previous Lifetime Achievement Award recipients include:

- 2012 – Anne J. Schneider*
- 2011 – Joseph C. Scalmanini
- 2010 – John A. Cherry, Ph.D.
- 2009 – T.N. Narasimhan, Ph.D.
- 2008 – Perry L. McCarty, Ph.D.
- 2007 – Herman Bouwer, Ph.D.
- 2006 – Glenn A. Brown
- 2005 – Luna P. Leopold, Ph.D.
- 2004 – John D. Bredehoeft, Ph.D.
- 2003 – Rita Schmidt Sudman
- 2002 – Thomas W. Dibblee
- 2001 – Carl J. Hauge
- 2000 – Joseph H. Birman, Ph.D.
- 1999 – David Keith Todd, Ph.D.
- 1998 – Eugene E. Luhdorff, Jr.

*posthumously.

Kevin J. Neese: recognizes significant accomplishment by a person or entity within the most recent 12- to 24-month period that fosters the understanding, development, protection, or management of groundwater.

Previous Kevin J. Neese Award recipients include:

- 2012 – David L. Orth, General Manager of the Kings River Conservation District for his leadership and dedication to the collaborative initiatives to develop the Upper Kings River Basin Integrated Regional Water Management Plan
- 2011 – Sacramento County Environmental Management Department for its Abandoned Well program, the first of its kind in California
- 2010 – Senator Fran Pavley for leadership in the enactment of the comprehensive, statewide groundwater level monitoring legislation in California
- 2009 – U.S. Geological Survey, California Water Science Center for development of a new 3-dimensional groundwater-modeling tool for California's Central Valley and report "Groundwater Availability of the Central Valley Aquifer," Professional Paper 1766
- 2008 – Orange County Water District for its Groundwater Replenishment System (GRS), a new water purification plant
- 2007 – University of California Cooperative Extension Groundwater Hydrology Program for its efforts to engage scientists, regulators, farm advisors, dairy industry representatives, and dairy farmers to better understand the effects of dairy operations on water quality

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GRA Requests Nominations for the 2013 "Lifetime Achievement" and "Kevin J. Neese Awards" – *Continued*

- 2006 – Senator Sheila Kuehl for her work to improve the production and availability of information about California's groundwater resources
- 2004 – California Department of Water Resources for publication in 2003 of its updated Bulletin 118: "California's Groundwater."
- 2002 – Glenn County Water Advisory Committee for formulating a significant groundwater management ordinance that was adopted by the Glenn County Board of Supervisors
- 2001 – American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership for fostering the understanding and development of a cooperative approach to regional planning, protection and management of groundwater
- 2000 – Board of Directors of the Chino Basin Watermaster for delivering a remarkable OBMP that created a consensus-based approach for making water supplies in the Chino Basin more reliable and cost effective
- 1999 – Governor Gray Davis for his work and leadership in addressing MTBE.

Dear GRA Member,

On behalf of the Education Committee, I'd like to share a story of one member's generosity, and discuss how you can help groundwater students by accepting the challenge he presents to our membership. Spoiler alert: donations can be made at the website listed below.

For over a decade, GRA's Branches have promoted the Scholastic Fund Program, which was developed to offer support to the groundwater professionals of tomorrow. As part of our organization's outreach to students, this program aims to encourage academic interest in groundwater issues through several channels, including support to academic departments, student scholarships, research grants, reduced student registration rates for GRA conferences, and subsidized attendance at Branch meetings.

To encourage donations to this important program, GRA partnered with the Water Education Foundation (WEF) in 2010 to create a tax-deductable GRA-WEF Scholastic Fund Program under WEF's 501(c)(3) status. Support for this program takes the form of Branch dinner meeting sponsorship by individuals, and by companies that provide groundwater-related products and services. In addition, GRA members provide critical support through their contributions.

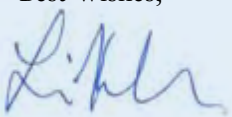
Moved by the impact this program has had on the lives of students, member Steven Zigan has once again challenged us to increase participation in this important program. As Mr. Zigan has said, "The students who have received support greatly appreciate the opportunity to expand their study of important water resource issues in California. It is time for us to do more."

With a desire to expand the participation of members like you and me, Mr. Zigan has placed a $2500 challenge grant on the table. Individual member donations generally total about $2500 per year, and this grant challenges us to double our participation. For every two dollars donated, we can claim one dollar of his challenge; your participation is needed to reach the $5000 goal and claim his full donation for a total of $7500. As of this writing, we have raised just over $2000, which is 40% of our goal.

Won't you make a donation today to help us claim these challenge funds? Simply go to http://www.watereducation.org/secure/GRAScholastic.asp to make you tax-deductible donation!

We hope that you extend financial support to help engage students in a lifelong interest in groundwater!

Best Wishes,



Lisa Kullen
Education Committee Chair

GRA Welcomes the Following New Members

FEBRUARY 23 – MAY 24, 2013

Adamson, Kim	Soquel Creek Water District
Afshari, Soheil	Rubicon Engineering Corporation
Agunwah, Reginald	
Behrooz, Mehrnoosh	AMEC Environment & Infrastructure, Inc.
Brown, Anthony	Aquilogic, Inc.
Cadaret, Erik	CSUF
Cross, Bradley	ARCADIS
De Safey, Frank	Sequence
Diem, Nathan	Conestoga Rovers and Associates
Dufour, Taj	Soquel Creek Water District
Eisen, Brandon	Aquilogic, Inc.
Gleason, Nicole	DOWNEY | BRAND
Gupta, Neha	Ohio University
Harms, Patrick	
Hawkins, Adam	AMEC Environment & Infrastructure, Inc.
Heathcote, Lee Ann	Kiff Analytical, LLC
Hess, Gordon	Gordon Hess and Associates, Inc.
Hogshead, David	Rubicon Engineering Corporation
Imamura, Alison	DD&A, Inc.
Javandel, Kamran	Allen Matkins Leck Gamble Mallory & Natsis LLP
Jonas, Mark	
Kienow, Karl	Blair, Church & Flynn Consulting Engineers
Kokkinaki, Amalia	University of Toronto
Lister, Katherine	
Mader, Anne	MWH Global
Martinez, Angel	ERM
Mawer, Chloe	Stanford University
McClain, Cynthia	Stanford University
McKinney, Lelye	City of Roseville
Mead, Christine	Soquel Creek Water District
Moors, Scott	BTC LABS – Vertical Five
Moran, Tara	Stanford University
Murdock, Kevin	CH2M HILL
Naglestad, Stacy	University of California, Berkeley
Nusenow, Matt	Aquilogic, Inc.
Popkin, Barrney	
Prowell, Cheryl	Regional Water Quality Control Board
Reller, Greg	Burleson Consulting, Inc.
Rhudy, James	Accutest Laboratories, Inc.
Robinson, Jack	ERM
Roe, Dilan	Alameda County Environmental Health
Sabol, Stacy	TRC Solutions
Scroggs, Linda	NV5
Sepehr, Mansour	SOMA Environmental
Simpson, John	University of Southern California
Sun, Jason	United Water Conservation District
Swann, Ben	CDM Smith
Tripolone, Brian	AECOM
Verwiel, Ann	ToxStrategies
Weir, Donald	Rio Tinto Diamonds – Diavik Diamond Mine
Wendell, Daniel	The Nature Conservancy
Whitney, Bridget	The Source Group, Inc.
Zerai, Biniam	Kleinfelder

2013 Contributors to GRA – Thank You

(as of 5/24/13)

FOUNDER *($1,000 and up)*
Brownstein Hyatt Farber Schreck
Janie McGinn
Nossaman LLP
Roscoe Moss Company
Steve Zigan

PATRON *($500-$999)*

CORPORATE *($250-$499)*

CHARTER *($100-$249)*
David Abbott
Stanley Feenstra
Thomas Harter
Mary Kean
Sally McCraven
Steven Phillips
Brian Wagner

SPONSOR *($25-$99)*
AECOM
Aegis Groundwater Consulting, LLC
Michael Akoto
Cathy Aviles
Thomas Ballard
Diane Barclay
Linda D. Bond
Richard Booth
Ahnna Brossy
Kevin J. Brown
Rae Brownsberger
Mary Rose Cassa
Bruce Castle
Julie Chambon
Dean Coblish
Alan Churchill
Crawford Consulting, Inc.
Kit Custis
Jessica Donovan
David Dunbar
Lunde Eads
EMAX Laboratories, Inc.
Erler & Kalinowski, Inc.
Joshua Ewert
Marina Feraud
Fred Flint
Miranda Fram
Laura Frost
Scott Furnas
Jacob Gallagher
Thomas K. Gallagher
Golder Associates
Francis Goldsberry III
Rob Haney
Thomas Harder
Robert Harrington
Carl Hauge
Hopkins Groundwater Consultants, Inc.
Horizon Environmental, Inc.
HydroFocus, Inc.
Alison Imamura
Iris Environmental
Ian Jones
Patrick Keating
Carol Kendall
Karl Kienow
Ted Koelsch
Frank Kresse
Taras Kruk
Kristopher Larson
Richard Laton
Katherine Lister
Anne Mader
Robert Martin
Steven Michelson
Jean Moran
Danielle Moss
Jason Muir
Alec Naugle
Aaron O'Brien
Tim Parker
Rene Perez
Rob Pexton
Bryan Pilkington
Lisa Porta
Iris Priestaf
Richard Raymond
Greg Reller
Jack Robinson
Laura Roll
Rubicon Engineering Corporation
Robert Ruscitto
William Sedlak
Pawan Sharma
Marc Silva
Linda Spencer
Phyllis Stanin
Michele Staples
Robert Stollar
Rachel Sultan
Eddy Teasdale
Ross Tinline
The Source Group, Inc.
Mark Wanek
Paul White
Michael Wright
Carol Yamane
Gus Yates
Brian Zagon

SUPPORTER
John W. Anthony
Cynthia Burt
Chris Iiyama
Bruce Lewis
Richard Makdisi
Elizabeth Peters
Tim Rumbolz
Jeffrey Zane

Central Coast

By Jeff Kubran
Branch Secretary

In March, Dr. David Huntley of San Diego State University and GRA's 2013 David Keith Todd Lecturer for southern California presented *The Movement of Light Non-Aqueous Phase Liquids – a Risk Perspective*. Dr. Huntley began his talk with a model demonstration of a migrating plume of degradable and non-degradable liquids. The plume source was cut off after 1,000 days and the non-degradable liquid continued to migrate down gradient. Then he set some basic controls on plume attenuation, demonstrating that the down-gradient extent of the plume is a function of degradation rate and solute velocity, and concentration is a function of source strength, location, and attenuation rate. Sources of risk for LNAPL migration come from the dissolved phase, vapor phase migration, and LNAPL migration. These sources of risk are a result of direct movement of LNAPL to the receptor with an extension of the dissolved-phase plume in the direction of the LNAPL movement.

NAPL becomes trapped in smaller pores, based on the soil capillary curve; the NAPL will typically reach a threshold of 10%, despite re-wetting with high pressure water to flush out the NAPL. This is known as residual saturation and is critical in risk evaluation. Once the source of NAPL is removed, the fixed mass will eventually stabilize and NAPL saturation and intrinsic permeability control NAPL mobility; these effects are synergistic. The trailing edge of the NAPL plume is immobile when saturation is less than residual. The leading edge will become immobile when the capillary pressures are below entry pressure, which is highly dependent on geology, and is irregular when extending further in coarse deposits. Therefore, capillary properties of site soils provide significant insight into future mobility; there is a need to know residual saturation, relative permeability, intrinsic permeability, and entry pressure.

In May, Dr. Jay Lund, the Director of the Center for Watershed Sciences at UC Davis and GRA's 2013 David Keith Todd Lecturer for northern California, presented *Can We Stop Undermining Our Groundwater Supplies? – Groundwater and California's Water Future*. Dr. Lund discussed some of the major groundwater problems in California, such as undermining surface water, overdraft, local and regional contamination, loss of riparian and wetland ecosystems, land subsidence, and allocation of water and discharge rights. He emphasized that almost all groundwater problems are local; however, regional groundwater quality—salt accumulation and nitrate contamination—are major state problems. Citing the Tulare basin, the most overdrafted basin in California, Dr. Lund estimated the cost of cleanup to be approximately $20–40 million/year. Even if the contaminant sources were stopped, there would still be legacy contamination affecting groundwater quality for decades.

Successful groundwater management can come from local control and management, pricing water to affect groundwater use, adjudications, local recharge projects, and aquifer banking/water-transfer markets. Integrated water management is important for addressing the major groundwater problems through a portfolio approach that includes conjunctive use, wastewater reuse, optimal irrigation inefficiency, and conservation. Some of the future groundwater problems include climate warming, stressed environmental objectives, higher surface-water costs, more high-value and permanent crops, and increased urbanization. In summary, Dr. Lund noted that groundwater and surface water are connected, and groundwater storage capacity is huge and already constructed; however, regional contamination is a very long-term problem.

Sacramento

By Troy Turpen,
Branch Secretary

January's meeting featured Ms. Katrina Harrison, a hydraulic engineer with the U.S. Bureau of Reclamation, who spoke about *Groundwater Seepage Monitoring, Management and Solutions* associated with the San Joaquin River Restoration Program (SJRRP). Ms. Harrison, who manages all groundwater seepage projects for the SJRRP, presented an overview of seepage-related activities and discussed recent efforts, including geophysical investigation of paleochannels, replete with full-color maps, diagrams and photographs. These paleochannels, which are sand-filled remnants of former components of the San Joaquin River system, may act as conduits for preferential flow from the current channel into the subsurface of adjacent fields. The geophysical investigation and other ongoing work will address this question and potentially lead to engineering solutions.

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Sacramento – *Cont.*

In February, Liz Haven, P.G., C.E.G., Deputy Director, Division of Financial Assistance, State Water Resources Control Board (SWRCB), presented *Groundwater Contamination Priorities and Funding: The Underground Storage Tank Cleanup Experience*. Ms. Haven, who has worked at the SWRCB since the early 1990s, approached concerns about groundwater contamination from natural and anthropogenic sources within hydrogeologically vulnerable areas of the state from the perspective of current efforts to clean up underground storage tank releases using funding provided by the Underground Storage Tank Cleanup Fund. A comparison of relative groundwater priorities and available funding was presented as well. Groups such as the Drinking Water Stakeholder Group and several new bills introduced in 2013 to address challenging groundwater contamination issues were discussed.

March's meeting attendees were entranced by Meredith Nikkel's presentation of *Down the Rabbit Hole: California's Alice in Wonderland World of Subterranean Streams*. The SWRCB exercises permitting authority over surface water and "subterranean streams flowing through known and definite channels;" the quagmire of legal interpretations and physical realities of such "subterranean streams" have been described as having an "Alice in Wonderland" quality. Ms. Nikkel, a member of Downey Brand's Water Practice Group, presented the legal factors for distinguishing percolating water from subterranean streams; the four-part legal test to draw the distinction; and discussed how the structure of the law can be applied to complex physical realities, such as subsurface channels, alluvial deposits, and bedrock formations.

The Sacramento Branch extends thanks to our Scholastic Sponsors for the first quarter of 2013: TestAmerica and AMEC! Our Scholastic Sponsors allow the Sacramento Branch to continue its financial support of Geology students at California State University, Sacramento.

San Francisco

By Jenny Cherney
Branch Secretary

In March, Dr. Jay Lund gave the 2013 David Keith Todd lecture for northern California: *Can We Stop Undermining Our Water Supplies? Groundwater and California's Water Future*. Dr. Lund discussed the importance for California's water future of integrating groundwater into water and environmental management. He discussed the changing role of groundwater, from an isolated and convenient source of clean water to an increasingly contaminated and diminishing source, with increasing effects on surface water bodies, users, and ecosystems. Lowered water tables, overdraft, and accumulations of salts, nitrate, and other contaminants have brought widespread effects to almost every part of the state. Dr. Lund reviewed the diverse roles of groundwater in water management in California, current and growing issues for groundwater supply and management, and promising approaches for integrating groundwater (along with surface water, demands, and infrastructure) into broader water and environmental management. Political and scientific challenges for accomplishing such management were also discussed.

In April, Ms. Barbara Cook, PE, (Assistant Deputy Director) and Ms. Dot Lofstrom, PG (Chief, Geological Services unit) presented the always popular Annual DTSC Regulatory Update. Ms. Cook discussed new appointments and management changes at DTSC, and provided an overview of the organization and staff of the Brownfields and Environmental Restoration program. She discussed life after the redevelopment agencies, including funding options, working with successor agencies, and local housing and restructuring of city planning departments. A PEA manual update is taking place, and a draft is expected to be complete this summer; it will include soil vapor information and AAI compliance. An update on Green Chemistry was provided. Draft regulations for Safer Consumer Products were released April 10. Ms. Cook discussed emerging issues at the DTSC, including TCE, lead, and CHHSLs versus USEPA RSLs. Ms. Lofstrom presented information related to frequently asked questions regarding the April 2012 Soil Gas Advisory. Questions included use of particular technologies such as a vapor pins or older probes, requirements when using summa canisters and the need for shrouds, and acceptable materials for probe construction. What to do when there is moisture present and the appropriate use of the SGA for measuring oxygen at petroleum sites were also discussed.

The May meeting highlight was a talk by Tim Kustic, the State Supervisor of the Division of Oil, Gas and Geothermal Resources. Mr. Kustic discussed how the traditional use of hydraulic fracture stimulation in California's *conventional* oil and gas reservoirs for many decades is significantly different than *unconventional* shale gas and coal bed methane operations. Current Division well construction regulations require operators to seal-off and protect oil, gas, and freshwater resources. Although there are no known negative impacts to groundwater under current requirements, the Division is reviewing

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well construction regulations, and moving forward with regulations specific to hydraulic fracturing to address heightened public concern. Additionally, the Dept. of Conservation is pursuing an independent study on hydraulic fracture stimulation in California. According to Mr. Kustic, the regulation development process will have input from diverse interested parties and numerous stakeholder comments are anticipated. The regulation development process will consider pre-hydraulic fracturing notification, definitions, pre- and post-hydraulic fracturing well integrity testing, fracture design, confinement layer evaluation, evaluation of nearby wells and geologic structures, seismic impact potential and reporting requirements.

Southern California

By Emily Vavricka,
Branch Secretary

In March, the Southern California Branch held a joint meeting with the South Coast Geological Society featuring the 2013 GRA David Keith Todd Distinguished Lecturer for southern California, Dr. David Huntley. Dr. Huntley, a Professor Emeritus of Geological Sciences at San Diego State University, has taught both graduate and undergraduate classes in groundwater hydrology for the past 31 years. His research has included the mobility and dissolution of non-aqueous phase liquids, or NAPLs, and the effects of geologic heterogeneity on dissolved-phase solute transport. In his presentation, Dr. Huntley focused on the natural attenuation of dissolved-phase contaminants and the new change in focus to the source of these plumes. He explained that the velocity, likely expansion of the footprint, and future extent of the NAPL are critical issues both to the regulatory agencies and responsible parties. Dr. Huntley further

explained the nature of such NAPL sources and their contribution to the behavior of dissolved-phase plumes, and provided a variety of approaches to assess the mobility of NAPLs, and the typical time frames that should be considered when putting NAPL mobility into a risk context.

Dr. Huntley's presentation was well attended by members of both organizations, including former students of Dr. Huntley. An energetic Q&A session followed the presentation, which fostered many engaging discussions on NAPL transport and behavior in groundwater, and on what this means for future groundwater cleanups.

The Southern California Branch would again like to thank GeoSyntec Consultants, Regenesis, and Luhdorff & Scalmanini, Consulting Engineers for sponsoring the 2013 GRA David Keith Todd Distinguished Lecture Series. The Branch would also like to thank PTS Laboratories, who sponsored the Branch Scholastic Fund for the March meeting.

The Big Sur River

The 16-mile Big Sur River flows through the largest coastal watershed (62 square miles) in the rugged Santa Lucia Mountains of central California. Most of the river's watershed is in the Ventana Wilderness of the Los Padres National Forest. Precipitation increases with altitude and the ridges or peaks at 5,000 feet can receive as much as 50 inches of rain and minor snow per year. The peak streamflow for the Big Sur River, based on USGS data, was 10,700 cubic feet per second in January 1978.

The Big Sur River east of Highway 1 has eroded steep canyons into gneiss, schist, and Mesozoic granitic rocks of the Salinian block. Just beyond the gorge shown in this photograph, the river changes its course from west to northwest as it follows the trend of the Sur thrust fault. From a regional perspective, the metamorphic rocks of the Sur Series and Salinian granitic rocks share petrochemical and geochronologic characteristics with rocks in the western Mojave Desert and inboard Tehachapi Mountains. A right-lateral displacement of approximately 190 miles along the San Andreas Fault is plausible.

Pfeiffer-Big Sur State Park is famous for its narrow gorge and old-growth redwoods that line the river. A century ago, John and Florence Pfeiffer refused offers from a developer, and in 1933 they sold and donated much of their homestead to the state park commission. On June 21, 2008, lightning strikes caused a wildfire that burned more than 160,000 acres along the Big Sur coast; some of the burn areas within the park may be closed to public use.

Photographed along the Big Sur River (approximate GPS coordinates: 36.247565°, -121.770635°) by John Karachewski, PhD (DTSC), www.geoscapesphotography.com.

Additional information about Pfeiffer-Big Sur State Park is available at: http://www.parks.ca.gov/?page_id=570.

The Peninsula Geological Society also published a field trip guidebook to the Big Sur coast: http://www.diggles.com/pgs/2000/PGS-Big_Sur_field_guide72.pdf.