



26th Groundwater Resources Association Annual Meeting 2017: Time for Collaboration and Innovation Toward Sustainable Management of Groundwater for Quality and Supply

By Tim Godwin, Murray Einarson, Adam Hutchinson, Jim Strandberg, Jean Moran, Dan Gamon, Thomas Harter, Tara Moran, Steve Phillips and Tim Parker

A **Time for Collaboration and Innovation** was the theme of Groundwater Resources Association's (GRA) 2017 Groundwater Conference and 26th annual meeting, which was held on October 3-4, in Sacramento. For over a quarter century, GRA has been providing the opportunity to learn about the state of the science, current policies, and regulations, and technical challenges affecting the use and management of groundwater in California, and beyond. This year for the first time GRA expanded the meeting format to offer three parallel tracks. This resulted in 65 presentations covering a wide range of topics organized into sessions with the following titles:

1. Sustainable Groundwater Management Act (SGMA) Data
2. Sustainable Groundwater Management Act Modeling and Other Tools
3. Contaminant Trends
4. Sustainable Groundwater Management Act Planning
5. Collegiate Colloquium
6. Land Use Planning and Groundwater Resources Under SGMA
7. Groundwater Replenishment
8. Innovative Site Characterization
9. Sustainable Groundwater Management: Lessons Learned over 20 Years of the "Danish SGMA"
10. Advances in Site Remediation
11. Surface Water/Groundwater
12. Tools for Visualization and Analysis
13. Regional Groundwater Quality

The complete agenda for the conference can be found [here](#). Individual presentations from each session are on our website. With current membership you will have access to them as well as presentations from other events.

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MEETING FACTS:

Number of Attendees

244

Number of Sponsors & Exhibitors

23

Number of Student Attendees

20

SAVE THE DATE

Next year's annual conference is sure to be an exciting one that will be improved from any event GRA has hosted. GRA's **"First Annual Western Groundwater Congress"** will be a 3-day event featuring up to four parallel tracks on **September 25-28, 2018** at the DoubleTree by Hilton Sacramento.



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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.

Photo above: The SWP is the nation's largest state-built water and power development and conveyance system. This unique facility provides water supplies for 23 million Californians and 755,000 acres of irrigated farmland. Photo: John Karachewski, Ph.D.

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What Did We Accomplish and What Does the Future Hold?

By Chris Petersen



Boy, two years passed so quickly and here I am writing my last president's message. Time really does fly when you are having fun! What an incredible journey this was together. I told GRA's Board of Directors at our final 2017 Board meeting last weekend at the Roscoe Moss Company in Los Angeles, that this is without a doubt the most fulfilling leadership post of my entire career. It's been especially meaningful because I've had the privilege of serving with and enjoying the support of Directors and Officers who are fun to work with and equally passionate about achieving GRA's mission of providing information and education to protect California's groundwater quality and quantity.

Thank You

I want to begin by thanking the State Officers and Directors who I've had the pleasure of working side by side with these past two years. If you don't know who these wonderful people are, please take a moment to familiarize yourself with them by clicking on this link: <https://www.grac.org/board-of-directors/>

These are amazing people who give generously of their time and talents to run this non-profit organization. "That's right none of us receive a dime of payment for leading this organization, it's a true labor of love."

I want to recognize three board members who, after years of service, are stepping aside in 2018 to allow new leaders to step in. These are Ted Johnson, Lisa O'Boyle, and Emily Vavricka. Ted served on the Board 11 years, chaired numerous committees and served as President in 2014 and 2015. As Chief Hydrogeologist of one of the most progressive groundwater management agencies in California, the Water Replenishment District of Southern California, Ted brought insight, innovation, and great leadership to GRA. Thank you, Ted! Emily led our Southern California (Orange County) Branch for many years and served on our Board for the past 8 years, chairing our Membership Committee

for most of that time. Emily provided leadership in the planning of our Dry Cleaner Events. Thank you, Emily! Lisa served on the Board for the past three years in this capacity bringing leadership and passion to our Education and Membership Committees and serving as secretary for the past two years. Nobody is better at developing and driving action items for GRA than Lisa. She single-handedly increased our net productivity. Thank you, Lisa! Each of these Directors were recognized with a Tribute of Appreciation at our recent Board meeting.

Finally, I want to thank all our Branch Officers for the fabulous work each of you do leading your branch activities and making GRA happen at the local level. Check out the Branches page on our [website](#) to find out who these people are and please lend your support to these individuals.

What Did We Accomplish These Past Two Years?

Here's a list:

1. We delivered and received very positive feedback on sixteen (16) conference, symposia, and short course groundwater events.

Continued on the following page...

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Chris Petersen recognizing outgoing Directors Ted Johnson, Lisa O'Boyle, and Emily Vavrika with a Tribute of Appreciation

2. We delivered 31 GRACasts. That's more than 1 per month!
3. We delivered 8 *HydroVisions* Issues!
4. We have 1,000 members throughout California.
5. We remain financially strong with a healthy cash reserve for special projects.
6. After 25 years as a 5-Branch organization, we launched a new Northern Sacramento Valley Branch in Chico in the summer of 2016, a San Diego Branch in January of 2017, and an Inland Empire Branch in Summer of 2017. The branch growth is my favorite accomplishment!
7. We drafted a 2017 Vision to guide the activities of our Legislative Committee in 2017 and beyond to give GRA even greater voice at the Capitol.
8. We expanded our Board of Director seats from 15 to 19 because GRA should play a larger role in the successful implementation of the Sustainable Groundwater Management Act as well as other groundwater regulatory programs.
9. We updated our Strategic Plan to better focus our efforts to achieve our mission.
10. We took positions on multiple groundwater bills.
11. We served on the technical and policy advisory committees for the Water Storage Investment Program and the 2018 Water Plan Update.
12. We reviewed and commented on the Draft Water Storage Investment Program Regulations, Draft

Groundwater Sustainability Plan Regulations, and are currently reviewing and developing comments on DWR's Draft Best Management Practices for Sustainable Groundwater Management.

13. We convened a Recharge Roundtable Call to Action to identify activities that will result in significant gains in managed aquifer recharge during wet periods, like the 2016/2017 water year.

These accomplishments are a testament to the hard work of our directors and the many member volunteers serving on our committees. Who are these people you ask? Check them out and consider joining one of these committees today: <https://www.grac.org/committees/>

What Does the Future Hold for GRA?

The future is bright folks! We are headed into 2018 with a very enthusiastic Board of Directors, a slate of Officers and new Directors with impressive technical and leadership credentials, and a strong financial position enabling us to take on more special projects. Here's a preview of things to come:

1. 16th Biennial Symposium on Managed Aquifer Recharge – March 5th -7th in San Diego
2. Annual Legislative Symposium – Late March in Sacramento: GRA is joining forces with the California Groundwater Coalition and Brownstein Hyatt Farber Schreck LLP to significantly increase the number of attendees, and sponsors this year so that GRA can influence Legislation, Policy, and Funding for Groundwater.

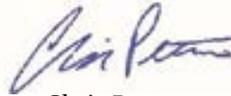
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3. First Annual Groundwater Sustainability Agency (GSA) Summit – June 6-7th in Sacramento – GRA is convening this event as a forum for learning and information exchange among the newly formed GSAs in California. GRA believes this event will be a catalyst for innovation in California Groundwater Management.
4. First Annual Western Groundwater Congress – September 25-27th in Sacramento.
5. Increased diversification of our members including more GSA representatives, more members from the Ag community, and more engineers.
6. Development of webtools to provide groundwater information more effectively to our members.
7. Development of a web-based groundwater discussion forum to share information and ideas and to create a knowledge archive for SGMA and other groundwater topics.

I hope you will plan to attend these events in 2018 and be sure to sign up early because we are expecting all of them to sell out. Registration is already open for some and will open soon for the others. <https://www.grac.org/events/search/>

If you are not yet a member of GRA yet, treat yourself and join today and gain access to relevant and timely information on all things Groundwater in California.

It's been a pleasure serving you these past two years!



Chris Petersen

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2017: Time for Collaboration and Innovation – *Continued*

Recharge Roundtable: Call to Action

Plenary Session – Summary of Call to Action to Recharge California’s Depleted Aquifers: October 2nd GRA-UC Water Roundtable

Prior to the conference, on October 2, [GRA](#) and [UC Water](#) sponsored a one-day Roundtable to bring together academic, agricultural, private sector, and agency leaders and experts to develop short- and long-term goals and actions to significantly increase managed aquifer recharge (MAR) in California. The Center for Collaborative Policy (CCP) provided facilitation services to make the one-day discussion highly efficient and productive. Attendees discussed a variety of MAR pertinent topics, including institutions, legal framework needs, technical resources, and economics, needed to increase recharge. The goal of the workshop was to write an action plan, a five-year strategy including potential actions. Participants included staff from Association of California Water Agencies, Bureau of Reclamation, California Department of Food and Agriculture, California Department of Water Resources, Environmental Defense Fund, Governor’s Office of Planning and Research, Lawrence Berkeley National Laboratory, Public Policy Institute of California, State Water Resources Control Board, Sustainable Conservation, numerous water districts, ground-water consultants and other local agencies.

The first and plenary session of the conference was a panel entitled “Call to Action to Recharge California’s Depleted Aquifers” to summarize and provide highlights from the prior day’s recharge roundtable.

Tim Parker, GRA, moderated the speakers: Dr. Graham Fogg, UC Water; Alicia Forsythe, USBR; Dave Bolland, ACWA; Amanda Montgomery, SWRCB. Important concepts were aquifers should be considered part of water supply infrastructure, much like surface water reservoirs, and recharging depleted aquifers should be considered a public benefit. California faces a triple threat of less recharge with (1) increasing demand, (2) changing land uses, and (3) climate change related rainfall frequency and intensity changes that reduce infiltration and increase runoff. UC Research suggests that statewide deficits of about 5 to 15 MAF/Y occurred during 2001-2010 versus the 0.5 to 2.8 MAF/Y from other sources underscoring the critical need to increase recharge in the state. Most of the deficit occurred in the San Joaquin Valley, and additional characterization is needed to locate optimum recharge areas due to shallow confining layers. A significant amount of recharge is needed which translates to many recharge sites and projects. Farmland and active landscapes can provide the area needed, and peak floods can provide the water; DWR has coined this Flood MAR. CDFA indicated that more research is needed

in this area, including studies on quantity and duration of crop submergence, and has a public forum planned in early November. Incentives will be needed to increase recharge significantly, and UC Santa Cruz is working on a project with net-metering to account for the benefits of recharge in the Pajaro Valley. DWR recently evaluated reoperation of reservoirs to provide additional water for recharge and reduce flood risk; the flood and water supply communities should try to optimize both goals. The Bureau of Reclamation is supporting water contractors’ conjunctive use by increasing water allocations and reducing price when possible. The SWRCB’s temporary permitting program is an option for increasing recharge until permanent permits are obtained. Other topics discussed were:

- The newly formed GSAs may serve as regional permittees
- There should be a safe harbor consideration for unforeseen consequences, for example, not considering a recharge pond a wetland over time
- Since access to and interpretation of geology is key to effective recharge projects we would benefit from a centralized governmental approach to managing the state’s geologic data.

Next steps include development of the GRA-UC Water Action Plan and the DWR Flood MAR white paper. Both parties plan to coordinate on these efforts.

Concurrent Sessions

Not surprisingly, a dominant theme for many of the concurrent sessions was the Sustainable Groundwater Management Act (SGMA). This groundbreaking legislation is reshaping how groundwater is and will be managed in California. With the deadline for Groundwater Sustainability Agency (GSA) formation behind us, the task ahead is to develop the required Groundwater Sustainability Plans (GSPs).

The groundwater management and land use planning session speakers discussed the limited legal and regulatory requirements for coordinating GSPs with city and county general plans under SGMA; areas of potential synergy and overlapping authority between land use planners and GSAs; and the need to coordinate these processes early, and on an ongoing basis, during GSP development and implementation to maximize benefits and minimize conflict.

The SGMA Planning session speakers discussed the necessity and benefits of conducting outreach early, often, and extensively. The speakers provided information on outreach guides, questions to expect from stakeholders, information

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from clean-up sites, and strategies used by groundwater-dependent communities.

Modeling and other tools were discussed in two sessions. Presentation topics included a framework on data management strategies in support of model development, regional collaboration, and model selection in the development of groundwater and integrated hydrologic models; user-friendly datasets of future climate scenarios required for GSPs; and statistical methods.

Another SGMA related session focused on data acquisition, analysis, and management. Presentation topics included data gaps, centralized database benefits, groundwater monitoring protocols, and access to statewide datasets. The speakers illustrated these topics with examples of specific projects or programs. These projects gave real world examples of the challenges that lie ahead for technicians and professionals as they comply with SGMA. One highlight from this session was DWR's progress in providing technical assistance and access to statewide groundwater data. A new DWR website provides groundwater related data tools and access to relevant reports. These include a land use data viewer and groundwater well completion report map application (http://www.water.ca.gov/groundwater/sgm/data_tools_reports.cfm). There was also a session devoted to speakers from Denmark sharing their experience and lessons learned implementing SGMA-like laws put in place 20 years ago.

A session on regional groundwater quality featured a wide variety of topics, including approaches developed for managing water resources in New Zealand, and agricultural non-point sources of contamination. Ex-situ and in-situ treatment methods were discussed for remediation of 1,2,3-Trichloropropane, a contaminant of emerging concern. Also presented were temporal trend results from the analysis of 38 constituents collected during 1985–2014 from over 13,000 public-supply wells in California. A web page is being developed to allow exploration of over 30,000 trend results for wells statewide, representing the largest, most comprehensive trends dataset of groundwater quality in the U.S.

Surface/groundwater interactions was the focus of another SGMA related session. The speakers shared their experience to aid users when developing sustainable management criteria. Presentations focused on the ability to quantify this relationship to develop minimum thresholds consistent with SGMA. The presenters considered the spatial and temporal distribution of monitoring sites to address specific needs for recharge from streams, management of hydraulic head to maintain groundwater quality and availability, or protection of groundwater dependent ecosystems. The approaches included detailed observations to aid in constraining numerical modelling to address seasonal stream-aquifer interactions. However, for many purposes,

direct observation of the occurrence of groundwater near streams may serve to inform management strategies for protection of groundwater dependent ecosystems or other management conditions. Also highlighted, geologic heterogeneity and interconnectivity was identified as a significant factor for characterization to begin to develop sustainability criteria. It was acknowledged that data defining the geologic heterogeneity and interconnectivity are critical to support numerical modelling and to reduce uncertainty in quantifying stream depletions. Continued focus on stream-aquifer interactions on a local level will be a critical part of developing groundwater sustainability plans.

As the steps needed to implement sustainable groundwater management in California become clearer, it is apparent that ensuring high-quality drinking water remains a key focus of the California groundwater community. With that in mind, several sessions were devoted to water quality and contaminated site characterization, including contaminant trends, innovative site characterization, advances in site remediation, and regional groundwater quality. In uniquely GRA style, the various water quality and contaminant presentations ranged from case studies at individual sites to surveys of contaminant occurrence in drinking water aquifers throughout the state. Contaminants released at individual sites may become regional issues via widespread distribution through sewer lines. Releases of agricultural contaminants like 1,2,3-Trichloropropane (1,2,3-TCP) may become regional problems due to the scale of the applications. There were several excellent presentations on new in situ remediation technologies to treat emerging contaminants like 1,4-Dioxane, 1,2-DCA, and 1,2,3-TCP. New regulatory guidance and metrics were described that optimize the effectiveness of site remediation activities. Finally, enhancing the quality of water recharged in spreading basins using low-cost, wood-chip denitrification filters shows that California is truly an innovator in practical groundwater protection and management.

Groundwater replenishment was an important focus at this conference. With SGMA, there is a growing recognition that without additional recharge, future reductions in groundwater pumping are going to be significant. Increasing stormwater recharge is a new frontier, especially on farms that have water delivery infrastructure in place and large areas to spread water. Determining where to best recharge this water is also being investigated as geologic information in areas such as the Central Valley is sparse when it comes to looking at where recharge will infiltrate into the aquifers used for water supply. New geophysical techniques are being looked at to cost-effectively find these optimum recharge areas. Another recharge initiative is to see how to incentivize many landowners to recharge runoff from their properties.

Continued on the following page...

Collegiate Colloquium

It was a great year for the Collegiate Colloquium. Four graduate students gave outstanding talks at a well-attended session. An additional eleven students presented posters on their research during the evening President's Reception. Eight different universities from around the state were represented. The Central Coast Branch generously sponsored awards for the best student presentations. GRA branches also generously awarded funds for students to travel to and attend the conference. Patrick O'Connell (CSU Long Beach) won best student talk and Cab Esposito (CSU Chico) was awarded best student poster.



Cab Esposito (CSU Chico) wins best student poster



Patrick O'Connell (CSU Long Beach) wins best student talk

Awards

At the Awards Luncheon, GRA President Chris Petersen provided an overview of the state of GRA, which is doing well with membership and creating new branches. Recently formed new branches include Northern Sacramento Valley, San Diego, and Inland Empire (Riverside and San Bernardino Counties). Efforts are also underway to revitalize the San Joaquin Branch. Mr. Petersen presented the President's awards and introduced the next class of Directors Emeriti: Anthony Saracino, Tony Ward, Paul Ward, and Bob Van Valer. Career highlights of these past directors are available at our [website](#).

Joining a distinguished list, Daniel B. Stevens was awarded the 2017 Lifetime Achievement Award. The Kevin J. Neese Award, which recognizes a recent, significant accomplishment by a person, persons, or entity that fosters the understanding, development, protection, and management of groundwater, was given to Stanford University's Center for Groundwater Evaluation and Management. Dr. Rosemary Knight received the award on behalf of Stanford University.

David Keith Todd Lectures

The conference ended on a high note with the presentation of GRA's 2017 David Keith Todd lectures, Claudia Faunt and Rosemary Knight.

The 2018 lecturers for the David Keith Todd series were announced, with Kirby Brill, former General Manager of the Mojave Water Agency and Dr. Jeffrey Mount, Senior Fellow with the Public Policy Institute of California Water Policy Center.

Parting Thoughts

GRA would like to thank the presenters and many sponsors and co-sponsors that made this event possible: GEI Consultants, Inc., INTERA Incorporated, Montgomery & Associates, TRC, Yellow Jacket Drilling, Water Replenishment District of Southern California, Wellntel and Woodard & Curran. Also, thank you to all the exhibitors that participated: Blaine Tech Services, Cascade Drilling, Confluence Environmental Field services, Daniel B. Stephens & Associates, Inc, Earthfx Inc., ESA, Formation Environmental, Gregg Drilling and Testing, Inc., Hydromodel Host, I-GIS, In-Situ, OnMaterials, REGENESIS, Silver State Analytical, and Specialty Earth Sciences, LLC. This event would also not have been possible without the hard work and leadership of conference chair Jim Strandberg and support from co-chairs Adam Hutchinson, Alyx Karpowicz, John McHugh, and Steve Phillips as well as the entire planning committee. We would also like to recognize Sarah Erck, the Administrative Director for GRA and her assistant, Vanessa Henderson.



Workshop Summary

Stream Depletion through the SGMA Lens: Practical Solutions for a Complex Problem

By Rich Juricich, Department of Water Resources

On August 29, 2017 Groundwater Resources Association of California (GRA) in partnership with the California Department of Water Resources (DWR) conducted a full day workshop using expert panels exploring the regulatory, policy, and technical aspects of depletions of interconnected surface water including practical solutions by water management agencies. Panel topics included:

- Regulatory Framework
- Measuring and Monitoring Stream Depletion
- Using Integrated Hydrogeologic Models to Evaluate Future Stream Depletion
- Practical Solutions by Groundwater Sustainability Agencies.

The *Regulatory Framework* panel provided valuable context about the different laws and regulations affecting stream flow and connections to groundwater including the Sustainable Groundwater Management Act (SGMA), water transfers, water rights, and ecological conditions. During this panel Trevor Joseph (DWR) described linkages between stream depletion and the groundwater sustainability plan regulations under SGMA. Sheri Looper (United States Bureau of Reclamation) described linkages to water transfers. Sam Boland-Brien (State Water Resources Control Board) provided a water rights perspective and Kristal Davis-Fadtke, (California Department of Fish and Wildlife) described Stream Depletion from an ecological perspective.

The *Measuring and Monitoring Stream Depletion* panel highlighted the latest technical methods using real time data to assess stream depletion. Kirk Klausmeyer (Nature Conservancy) described mapping groundwater and surface water interactions using groundwater depth and groundwater dependent ecosystems. Maurice Hall (Environmental Defense Fund) provided a practical approach for conducting a stream-aquifer assessment. Celia Rosecrans (USGS) discussed real time measurement of stream depletion and Chris Bonds (DWR) spoke about monitoring surface water-groundwater interactions in the Sacramento Valley.

The panel *Using Integrated Hydrologic Models to Evaluate Future Stream Depletion* provided case studies using the latest analytical tools to conduct long term assessments of stream depletion. Graham Fogg (University of California,



Rich Juricich, Department of Water Resources, Event Chair, and Session Moderator

Davis) discussed the role of aquifers and aquitards in stream depletion and recharge on the Cosumnes River. Jon Traum (USGS) discussed a case study for San Joaquin River Restoration Program. Linda Bond (DWR) discussed the SVSIM and C2VSIM models covering the Sacramento Valley and Central Valley respectively. Howard Reeves (USGS) provided examples from Michigan.

And the final panel, *Practical Solutions by Groundwater Sustainability Agencies*, provided the latest thinking from local agency practitioners on what they are doing to consider stream depletion for SGMA. Rob Swartz (Sacramento Groundwater Authority) discussed sustainable management in the Lower American River. Marcus Trotta (Sonoma County Water Agency) provided a case study for the Russian River. Christina Buck (Butte County Department of Water and Resources Conservation) provided an update and current thinking for Butte County, and Bryan Bondy (Calleguas Municipal Water District) talked about activities of the Fox Canyon Groundwater Management Agency.

Managed Aquifer Recharge as a Water Management Tool



MARCH 5-7, 2018 – SAN DIEGO

The theme of the Sixteenth Biennial Symposium on Managed Aquifer Recharge is “Recharge to the Rescue! Managed Aquifer Recharge as a Water Management Tool”. This event will take place on March 5-7, 2018 at The Dana on Mission Bay in San Diego, CA. This event continues a long-standing series of symposia originating in Arizona in 1978. The Groundwater Resources Association of California and the Arizona Hydrological Society have teamed up to hold the BSMAR event with the location alternating between California and Arizona. Please visit the GRA website at www.grac.org for updates.

BSMAR 16 will be a 1.5-day symposium that will feature numerous oral presentations, poster presentations, a luncheon to honor the 2018 Herman Bouwer Award recipient, optional Surface Recharge & ASR Workshops, and an optional half-day field trip to the Carlsbad Desalination Plant the day prior to the symposium.

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Wells and Words

By David W. Abbott, P.G., C.Hg., Consulting Geologist

The Hydrologic Budget – Part 3

INFLOW = OUTFLOW ± CHANGE IN STORAGE. Part 1 discussed some of the definitions of the hydrologic budget and provided common URLs for various sets of raw or processed precipitation data (INFLOW); while Part 2 provided URLs for raw or processed evapotranspiration (ET) data (OUTFLOW). Usually, the next significant and basic element of the OUTFLOW part of the hydrologic budget is streamflow derived ultimately from precipitation that occurs in a catchment or watershed.

Streamflow is a type of channel flow applied to that part of surface runoff traveling in a stream regardless of diversion or regulation. The sources of streamflow can be direct rainfall on the watershed or surface water, melting of snow or glaciers, rejected overland flow that finds its way to the channel, rejected imported water, and/or groundwater emanating from springs or contributing to an effluent stream. An *effluent* (gaining) stream receives water from the zone of saturation (groundwater) and provides base flow to the stream while an *influent* (losing) stream contributes water to the zone of saturation and develops bank storage¹. Different reaches of the same stream can have both effluent and influent sections. *Base flow* (runoff) is the sustained or fair-weather flow of a stream, regardless of modification; it is primarily composed of effluent groundwater, but also of runoff delayed by slow passage through swamps or lakes¹.

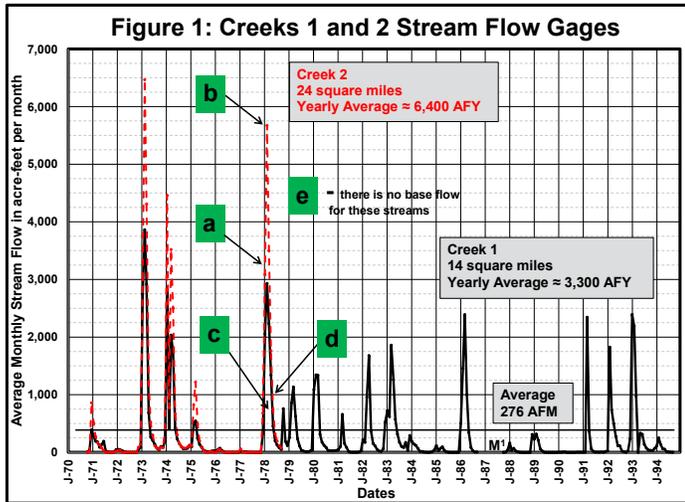
Stream discharge can be measured directly with long-term and permanent surface water gaging stations. Stream discharge can also be measured with short-term tools (i.e., weirs and flumes), and other equipment (pygmy and other current meters, and transducers) to calibrate stage height and staff gages. *Stream gaging* is the measurement of the velocity of a stream of water in a channel or open conduit and of the cross-sectional area of the water, to determine discharge, while a *stream gage* is a device for measuring the water surface in a channel¹. The gage height measured from a stilling well or staff gage can be related to the stream discharge if the cross-sectional area and the velocity of the stream are measured. Stream gaging procedures and methods are discussed in a 1943 [USGS Water Supply Paper 888](#)² and a 1968 paper on Techniques of Water-Resources Investigations of the USGS: Chapter [A6](#)³. Ideal streamflow gaging stations are located where stream underflow is small (i.e., on a reach of the stream where the stream bed is thin and is impermeable bedrock near the ground surface so that all the water in the channel is measured and underflow beneath or around the gage is minimized).

Streamflow can also be estimated using various rainfall-runoff models^{4,5}, in ungaged watersheds. The methods rely on various variables including: ground surface gradients (slopes), geomorphology, geology, precipitation intensity, vegetation cover, soil properties, etc. For example, in Part 2 of this Hydrologic Budget series, a simple soil moisture balance model was used to roughly estimate the amount of groundwater recharge and streamflow. Special attention should be taken in selecting which rainfall-runoff model could be used since some of these stream routing models may have been designed to predict special responses from ungaged streams (like maximum floods, high runoff rates, levees, hydroelectric power, or reservoirs). The model used should be appropriate for the objectives of the application, the characteristics of the hydrological system, and the available data⁴. The Hydrologic Engineering Center ([HEC](#))⁶ modeling series are used primarily for stream routing and flooding predictions and may provide different results than a soil moisture approach to predict stream discharges. The US Soil Conservation Service has developed charts in [Chapter 4](#)⁷ for estimating the volume of storm runoff from rainfall from various hydrologic soil cover complexes.

Historical⁸ (up to about 1981) surface water measurement stations in CA can be identified in Department of Water Resources (DWR) [Bulletin 230-81](#)⁹. Table 1 of that document (pages 20 to 89) lists alphabetically the station name which then can be used in cross referencing to Table 2 (pages 94 to 163) which lists the stations by DWR Station alpha-numeric number. Table 1 provides basic location information including Latitude/Longitude and Township/Range; while Table 2 summarizes length of record information, gage reliability, drainage area, and station elevation; Table 2 groups the stations regionally. The DWR areal designation for CA stations telescopes down from Hydrologic-Basin, -Unit, -Area, and -Subarea. Hence, relevant, and nearby gaging stations can be easily identified for a study area in Table 2. A hydrologic unit (HU) is a geographic area representing a surface drainage basin or distinct hydrologic feature or portion thereof¹⁰. Bulletin 230-81 does not include the digitized or raw data which may be stored in boxes, older computer formats, or microfiche.

If digitized, the raw or processed streamflow data can be down-loaded from the USGS National Water Information System ([NWIS](#))¹¹ or the DWR CA Data Exchange Center ([CDEC](#))¹². In 1994, the USGS ([Fact Sheet FS-066-95](#))¹³ had 7,292 continuous-record stream-gaging stations in the US and its territories; the first stream-gaging station (1889)

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operated in the US was established on the Rio Grande near Embudo, New Mexico. Prior to 1994, historical daily discharge data sets may also be found in a series of USGS annual publications titled Water Resources Data – (state name) for [example](#)¹⁴. These publications conveniently provide a one-page matrix of daily mean discharge values in cubic feet per second (cfs) for each station for an entire year and annual summary statistics. Included in the preamble of each station is location information drainage area, period of record, description of the gage, remarks about the gage, and extremes. Note that in 1994, about 766 gages (10.5%) of the stations in the US and Puerto Rico were in CA.

Local flood agencies and water districts, Federal Emergency Management Agency (FEMA)¹⁵, the US Corp of Engineers (COE)¹⁶, and the US Bureau of Reclamation (BOR)¹⁷ may also be a source of local streamflow data and analysis. For example, many county agencies and water districts have a *Hydrology and Hydraulics Manual* ([example](#) for Alameda County)¹⁸ specially adapted for local hydrologic conditions including detailed mean annual precipitation, slope, and hydrologic soil groups; much of this data can be downloaded for free and used in a GIS platform.

If a stream has two gages on it and one is located entering the HU and the other exiting the HU then simple subtraction of the two gages will provide an estimate of the losses or additions of the water in the stream between the two gages along a riparian corridor which may include ET and groundwater losses or tributary and groundwater additions.

Figure 1 shows two hydrographs from two different, but adjacent coastal watersheds that drain into the Pacific Ocean. A *hydrograph*¹⁰ is a graph showing stage, flow, velocity, or other characteristics of water with respect to time. Creeks 1 and 2 have similar hydrologic characteristics with basically similar geologic formations and rainfall patterns. Creek 1 (plotted in black) has a drainage area of about 14 square miles (mi²) and a 24-year record which is complete

except for water year (WY) 1987 which is missing. The average monthly discharge from this streamflow station is 276 acre-feet (AF); while the average annual discharge is about 3,300 AF per year (AFY). Creek 2 with an 8-year record with a drainage area of 24 mi² and has an average discharge of 6,400 AFY based on the shorter record.

Figure 1 also shows the following labels on the hydrograph: (a) rising limb; (b) peak; (c) storm runoff; (d) recession limb; and (e) base flow. Remember that streamflow measurements usually combine base flow (from groundwater) and flood waters. Dunne and Leopold⁵ show various techniques in estimating base flow from storm hydrographs. Note that the overlapping portion of the hydrographs between WY 1971 and WY 1978 has a remarkable similar response from precipitation and storm events. Creek 2 has a peak storm flow whose ratio is about two times that of the smaller watershed (Creek 1). The hydrograph for Creek 1 can be used to extend the predicted responses of the Creek 2 watershed during similar storm events after the gage was abandoned.

Don't ignore partial, incomplete, or small data sets for streamflow records which can be used even if they are old. These partial or short data sets can be correlated, adjusted, and extended with help from nearby long-term records. These comparisons and correlations should be made considering the similarities or differences of the hydrologic characteristics and weather patterns between the watersheds.

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- <https://pubs.usgs.gov/wdr/#CA>
- <https://www.fema.gov/> FEMA's mission is "Support our citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate all hazards".
- <http://www.usace.army.mil/> the COE's mission is "Deliver vital public and military engineering services, partnering in peace and war, to strengthen our Nation's security, energize the economy and reduce risks from disasters".
- <https://www.usbr.gov/> the BOR's mission is "Manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public".
- <http://www2.oaklandnet.com/oakca1/groups/pwa/documents/report/oak049855.pdf>

Legislative Update – November 2017

By Tim Parker, Parker Groundwater, GRA Director and Legislative Committee Chairman

GRA's Legislative Committee and Board of Directors had an exceptionally active year in the Capitol, tracking more than 50 bills. The Committee also hosted another highly successful Annual Legislative Symposium, in partnership with the California Groundwater Coalition. Additionally, GRA was very engaged with the Water Storage Improvement Program (WSIP) discussions, participated in Water Plan development, and worked tirelessly on groundwater related legislation, making 2017 Another Year of Groundwater.

Committee Members: Carolyn Berg - San Luis Obispo County, Pete Brown - Water Replenish District of Southern California, Alicia Dunkin - Orange County Water District, Robert Ennis - City of Riverside, Thomas Harter - UC Davis, Paul Hendrix - Tulare Irrigation District, Chris Petersen - GRA President, RT VanValer - Roscoe Moss, and Tim Parker (Chairman) - Parker Groundwater Management.

Groundwater Sustainability Progress

Implementation of the sustainable Groundwater Management Act (SGMA) passed its first key milestone and SGMA high- and medium- priority basins are mostly complying, having formed groundwater sustainability agencies covering nearly all areas required. DWR and SWRCB seem confident that they will soon solve those relatively small areas where either GSAs overlap, or GSA coverage is absent.

The next major task for GSAs is to develop, adopt, and submit to DWR groundwater sustainability plans by either January 31, 2020 (critically overdraft basins) or January 31, 2022. Proposition 1 GSP grant applications were due to DWR on November 13th, with \$86M available for the 127 SGMA priority basins. It seems likely that requests for funding will far exceed the funds available.

Several draft guidance documents released by DWR this year include:

- Guidance Document for Stakeholder Communication and Engagement
- Guidance Document for Engagement with Tribal Governments
- Best Management Practice for Sustainable Management Criteria.

More information is available at <http://www.water.ca.gov/groundwater/sgm/index.cfm>

Administrative and Policy Items

- **New DWR Director** – Gov. Jerry Brown has appointed Sonoma County Water Agency General Manager Grant Davis to serve as director of the California Department of Water Resources, effective Aug. 1. Davis joined Sonoma CWA in 2007 as assistant general manager and became general manager in 2010. As general manager, he worked with more than 280 employees and oversaw core functions of providing drinking water to more than 600,000 residents in portions of Sonoma and Marin counties, wastewater management for 60,000 customers, maintaining nearly 100 miles of streams and detention basins for flood protection, and restoring habitat for three federally listed fish species in the Russian River. He served as executive director of the Bay Institute from 1997 to 2007 and was the senior district representative in the Office of U.S. Rep. Lynn Woolsey from 1993 to 1997 and principal of Impact Consulting from 1990 to 1993. GRA highly supports Grant as the new DWR Director, with his strong understanding of environmental, habitat, water, and groundwater management; he is a great choice for DWR.
- **Oroville Dam** – The initial repair to Oroville Dam on the lower portion of the flood control spillway and preliminary reinforcement of the emergency spillways were completed at the end of October. Next year the upper portion of the flood control spillway will be replaced and reinforcement work conducted on the emergency spillway. Additionally, recent reports suggest that nearly 100 dams need further assessment for safety and maintenance.
- **Cal Water Fix** – Next to Oroville Dam, this is the second largest challenge to complete the state conveyance and supply infrastructure. There has been mixed support, with Westlands Water District not supporting the project, Santa Clara Valley Water District, supporting a smaller project and Metropolitan Water District of Southern California providing strong support for the complete project. DWR is currently looking at the potential of a one or two tunnel project.
- **New Recharge Initiative** – Several organizations are focusing on recharge opportunities and pursuing increasing recharge in California, including Central Valley Flood Control Plan, Department of Water Resources (Flood-MAR), California Department of Food and Agriculture, UC Water, and Sustainable Conservation. GRA and UC Water are in the process of developing a White Paper “Call to Action to Increase Recharge in California.”

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GRA Tracked/Supported/Opposed Legislation

This was the first year of the Legislature's current two-year session, which ended on September 30, 2017. Lawmakers are now on recess until they reconvene January 3, 2018. GRA tracked closely and took positions on the following bills.

AB18 Garcia – California Clean Water, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 – in Senate Appropriations - 2-year bill

AB196 Bigelo – Greenhouse Gas Reduction Fund - Mathis – Water and Wastewater Loan and Grant Program – grants for drinking water and wastewater for counties and NPOs – Held under submission

AB313 Gray – Water – would establish a new Water Rights Division within the Office of Administrative Hearings – Vetoed

AB321 Matthis – Groundwater Sustainability Agencies – specifically include farmers, ranchers, and dairy professionals in the agricultural users whose interests a groundwater sustainability agency is required to consider – Chaptered.

AB574 Quirk – Potable Reuse – consistency in water reuse terminology – Chaptered – *GRA took a support position*

AB1000 Friedman – Water Conveyance and Use of Facility with Unused Capacity – Targets Cadiz Project that has completed full EIR and CEQA compliance for additional environmental review by the State Lands Commission and Department of Fish and Wildlife – 2-year bill – *GRA took an oppose position since it does not agree with policy that requires additional environmental review beyond CEQA*

AB1009 Mathis – GSAs – Shell bill – 2 Year bill

AB1369 Gray – Water Quality and Storage – would require DWR to increase water storage capacities by 25% by 2025 and 50% by 2050 – would continuously appropriate 25% of the annual proceeds from the Greenhouse Gas Reduction Fund beginning in 2019 – 2 Year bill

AB1427 Eggman – Underground Storage and Beneficial Use – 2 Year bill

SB5 De Leon - California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 – Chaptered

SB231 Hertzberg – Articles XIIC and XIID of the California Constitution regarding Proposition 218 Omnibus Implementation Act definition of the term “sewer” – Chaptered

SB252 Dodd – Water Wells – Additional requirements for county well permitting in critically over drafted basins – Chaptered – *GRA submitted a letter of support if amended*

SB623 Monning – Safe and Affordable Drinking Water Fund – Would impose a fertilizer fee on fertilizer sellers and distributors, and a Dairy Fee on milk handlers, a public goods

fee (water fee) on water users, and requires SWRCB annually prepare a map of aquifers exceeding MCLs – 2 year bill – *GRA was going to take a support position on part of the bill but lacked consensus on public goods fee.* GRA will watch this bill in 2018, as the discussion on whether a public goods charge versus some sort of additional state tax continues.

Water Bonds

There is a significant funding need for the major water and groundwater sustainable management projects in California, yet current funding is limited. One way our state has successfully funded many water, and groundwater related projects is through the development of propositions and issuance of bonds. Propositions need to go on the ballot for voters to approve, and if readers who are in the water and groundwater industry are so inclined to support bonds for water, they could also consider explaining to friends and neighbors the importance of funding for water and especially for groundwater at this time. There are two Water Bonds in process:

- 1) SB5 – The California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (\$4.1B), and
- 2) California Water Bond of 2018 Initiative – The California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (\$4.1B).

SB5 – The California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (\$4.1B)

https://leginfo.legislature.ca.gov/faces/billCompareClient.xhtml?bill_id=201720180SB5

After much debate, discussion and public comment, SB 5 (De Leon) emerged as the bi-partisan water bond proposal passed by both houses and signed by Governor Brown in October. This bill will be placed on the June 2018 ballot as a \$4.1 billion bond measure. The bill allocates \$2.83 billion in funding for parks and natural resources projects, including over \$1 billion to local parks throughout the state with the majority going to fund new parks in neighborhoods that lack parks. The measure allocates \$1.27 billion in funding for water related investments including safe drinking water projects, groundwater cleanup and management as well as funding to better protect California communities from the twin threats of drought and flood. It will be on the spring 2018 ballot for voter approval. A very small portion of the proposed funding (3%) is directed specifically to support SGMA implementation, including \$80M for groundwater cleanup and \$50M for groundwater sustainability plans. This underscores the need for more outreach toward the Legislature and policymakers to better fund California's water supply infrastructure, sustainable groundwater man-

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agement, and replenishment of our depleted aquifers. We should inform our leadership that groundwater storage is a “public benefit.” As the process and criteria are developed for the subsequent grant application process (should the proposition pass), it will be critical to try to instill incentives for linking grants for flood protection, regional sustainability, and drought resiliency with groundwater recharge, storage, and water banking projects.

If passed, this new bond would authorize the issuance of \$4.0 billion in new debt as follows:

Parks and Natural Funding \$2.83B

- Chapter 2: Investments in Environmental and Social Equity, Enhancing California’s Disadvantaged Communities (\$725M)
- Chapter 3: Investments in Protecting, Enhancing, and Accessing California’s Local and Regional Outdoor Spaces (\$285 M)
- Chapter 4: Restoring California’s Natural, Historic, and Cultural Legacy (\$218M)
- Chapter 5: Trails and Greenway Investment (\$30M)
- Chapter 6: Rural Recreation, Tourism, and Economic Enrichment Investment (\$25M)
- Chapter 7: Chapter 7: California River Recreation, Creek, and Waterway Improvements Program (\$162M)
- Chapter 8: State Conservancy and Authority Funding (\$767M)
- Chapter 9: Ocean, Bay, and Coastal Protection (\$175M)
- Chapter 10: Climate Preparedness, Habitat Resiliency, Resources Enhancement, and Innovation (\$443 M)

Water Funding \$1.27B

- Chapter 11: Clean Drinking Water and Drought Preparedness (\$250M)
 - \$250M for clean and safe drinking water
 - \$30M for regional supply projects in San Joaquin area
- Chapter 11.1: Groundwater Sustainability (\$80M)
 - \$80M for groundwater cleanup
- Chapter 11.5: Flood Protection & Repair (\$550M)
 - \$550M total for flood protection and repair
 - \$350M for flood protection facilities and levee improvements
 - \$50M for delta levee repairs
 - \$300M multi-benefit flood projects
 - \$100M for stormwater, mudslide, and other flood related protections
 - \$100M for urban multi-benefit flood projects

- Chapter 11.6: Regional Sustainability for Drought and Groundwater, and Water Recycling (\$390M)
 - \$290M total for regional sustainability
 - \$50M for groundwater sustainability plans
 - \$100M for water recycling
 - \$20M CDFA for SWEEP program

**Note that the bond allocates \$100 million of unissued bonds from Props 1, 40, and 84, so the total amount of allocations in SB5 adds up to \$4.1 billion.*

California Water Bond of 2018 Initiative – State Water Supply Infrastructure, Water Conveyance, Ecosystem and Watershed Protection and Restoration, and Drinking Water Protection Act of 2018 <https://waterbond.org/>

The Water Supply and Water Quality Act of 2018 is a new water bond initiative proposing to provide significant new water supplies for urban, agricultural, and environmental purposes. This bond proposal includes at least \$675M for groundwater sustainability programs and projects. It is planned to appear on the November-2018 statewide California ballot. Here is an overview of the proposed \$8.877B allocation:

- Chapter 5.1 Safe Drinking Water for Disadvantaged Communities (\$750M)
 - \$500M – Safe Drinking Water
 - \$250M – Wastewater treatment systems
- Chapter 5.2 Wastewater Recycling and Groundwater Desalination (\$800M)
 - Priority is given to water supply or water quality improvements benefitting disadvantaged communities (86022f).
 - Wastewater recycling (\$400M)
 - Desalting of brackish groundwater (\$400M)
- Chapter 5.3 Water Conservation (\$365M)
 - \$300M – Statewide turf replacement, leak detection, toilet replacement, etc.
 - \$15M – Energy Commission for Water Energy Technology Program
 - \$50M – Agricultural water conservation projects
- Chapter 5.4 Flood Management for Improved Supply (\$500M)
 - \$200M – To Central Valley Flood Control Board for enlargement and environmental enhancement of existing floodways and existing bypasses
 - \$100M – Reservoir repair or reoperation that will increase amount of water stored that will be put to beneficial use
 - \$200M – To San Francisco Bay Restoration Authority for matching grants for flood management, wetlands restoration, and other projects

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- Chapter 5 – Funding for Water Measurement and Information (\$60M)
 - \$20M – To DWR for the development of methods and installation of water measuring equipment to improve water information to support water management activities
 - \$10M – To SWRCB for development of information systems, technologies, and data that improve SWRCB’s ability to manage water rights
 - \$10M – To Water Data Administration Fund to be used by DWR in consultation with SWRCB to make California water information interoperable
 - \$5M – To the University of California for its multi-campus Water Security and Sustainability Research Initiative
 - \$5M – To the California Water Institute at California State University, Fresno to undertake research leading to improvement and conservation of water supplies and improved water quality in California
 - \$5M – To the Irrigation Training and Research Center at California Polytechnic State University San Luis Obispo to undertake research leading to improvement and conservation of water supplies and improved water quality in California
 - \$5M – To the Office of Water Programs at California State University, Sacramento to undertake research leading to improvement and conservation of water supplies and improved water quality in California
- Chapter 5.6 Capture and Use of Urban Water Runoff and Stormwater (\$550M)
 - \$400M – To SWRCB for grants for projects to capture and use urban dry weather runoff and stormwater runoff
 - \$30M – To the California Tahoe Conservancy for projects to capture and use dry weather runoff and stormwater runoff in the Lake Tahoe Basin
 - \$40M – to the Santa Monica Mountains Conservancy for projects to capture and use dry weather runoff and stormwater runoff
 - \$40M – To the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy for projects to capture and use dry weather runoff and stormwater runoff
 - \$40M – To the State Coastal Conservancy for projects to capture and use dry weather runoff and stormwater runoff
- Chapter 5.7 Integrated Regional Water Management (\$5M)
 - To DWR to provide direct funding support to approved Integrated Regional Water Management (IRWM) regional water management groups
- Chapter 6.1 Watershed Improvements for Water Supply and Water Quality Enhancement (\$2.355B)
- Chapter 6.2 Land and Water Management for Water Supply Improvement (\$100M)
- Chapter 6.3 Conservation Corps (\$40M)
- Chapter 6.4 Central Valley Fisheries Restoration (\$400M)
- Chapter 7 Groundwater Sustainability and Storage (\$675M)
 - \$640M - Grants to groundwater sustainability agencies implementing groundwater sustainability plans
 - Groundwater recharge and storage projects including, but not limited to acquisition of land and groundwater pumping allocations from willing sellers, facilities planning such as feasibility studies and environmental compliance, distribution systems, and monitoring facilities
 - Projects that implement groundwater sustainability plans including, but not limited to feasibility studies, environmental compliance, engineering work used to develop groundwater use and sustainable yield for specific projects, well use measurement, and innovative decision support tools
 - Projects that assess, and address saltwater intrusion including future impacts related to climate change
- Chapter 8 – Water for Wildlife, Pacific Flyway Restoration, and Dynamic Habitat Management (\$300M)
- Chapter 9 – Bay Area Regional Water Reliability (\$250M)
- Chapter 10 – Improved Water Conveyance and Water Conservation (\$855M)
 - \$750M – Grant to the Friant Water Authority for water conveyance capital improvements, including restored and increased conveyance capacity to and in the Madera and Friant-Kern canals
 - \$100M – To Natural Resources Agency for actions that support projects defined in paragraph 11 in the settlement agreement to restore the San Joaquin River referenced in Section 2080.2 of the Fish and Game Code
 - \$5M – To DWR to plan for a diversion of water from the Sacramento River to the North Bay Aqueduct to reduce the adverse impact on listed fish species
- Chapter 11 Oroville Dam Flood Safety and Feather River Sediment Management (\$221M)

Kingdom of Denmark – State of California MOU – September 20, 2017

Governor Brown entered into a Memorandum of Agreement with the Kingdom of Denmark to work together strategically on water issues in addressing current global, national, regional, and local challenges. The Government of the Kingdom of Denmark was represented by the Danish

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Ministry of Environment and Food, the Embassy of Denmark in Washington D.C., the Danish Water Technology Alliance in Palo Alto, and Chicago. The Government of California was represented by the Governor's Office, the State Water Boards, the Department of Water Resources, and other parties are included when relevant and mutually agreed upon.

Denmark had its version of SGMA in 1999, with the creation of legislation requiring additional groundwater studies and management. Denmark is 100 percent reliant on groundwater for supply, does not disinfect, and surface water is dedicated to environmental and recreational demands. The Danes decided early in implementation of their version of SGMA to develop tools and technologies for dense data collection to map groundwater. The tools and advanced approaches used include:

- Surface geophysics
- Development of detailed 3D hydrogeologic conceptual models
- Transformation and upscaling of the hydrogeologic conceptual models to appropriate resolution groundwater flow and fate and transport models
- Using all the available data of suitable quality
- Advanced streamlining of data management
- Making data, models and reports readily available online
- Vulnerability assessments for protection of aquifers and to determine land use management decisions
- Preparation and implementation of groundwater management plans for sustainability.

The groundwater mapping project work is conducted collaboratively, largely led by the state (Ministry of Environment and Food). The databases for the national well, geophysical, oil & gas, models, groundwater reports, and geological maps are maintained by the Geological Survey of Denmark and Greenland. Visit <http://www.geus.dk/UK/data-maps/Pages/default.aspx> for more information on Denmark's and Greenland's data and maps.

Looking Ahead

As GRA expected, groundwater was a fundamental part of legislative discussions in Sacramento this year. Continued, significant groundwater industry work is on the horizon to successfully implement the Sustainable Groundwater Management Act in 2018. Additionally, after the June election, we will know if the voters approved the water and parks bond which, if passed, will provide much needed funding for projects throughout the state. If the additional water bond initiative makes it to the November ballot, and if the voters approve it, it will add significantly more funding to help where it is really needed for the new GSAs to comply with SGMA. Another initiative in 2018 may be to add a water tax on income, or a public goods charge for water.

Next year, with discussions already in process, the Administration is committed to work with the Legislature and industry to increase recharge statewide. This has huge implications for statewide groundwater sustainability and compliance with SGMA in the next 20 years. DWR has a tremendous amount of work to do over the next three years to meet the mandates outlined in SGMA, and continue work on Oroville Dam and other state infrastructure to address flood risk and safety. GRA will provide assistance and input to DWR as needed.

Next year is also the last year for Governor Brown, as he will term out. This governor has done more to help bring recognition and effect good policy on groundwater than any previous California governor. Legislative Committee will sadly miss Governor Brown and will be looking to continue our efforts to meet our mission of resource management that protects and improves groundwater supply and quality through education and technical leadership in the industry and at the capitol. GRA will continue to be an important source of information and sound science for the Legislature, the administration, and their staff as the groundwater discussion continues, including the SGMA implementation process within state agencies and departments and any groundwater-related legislation next year.

PLAN TO ATTEND THE
2018 ANNUAL LEGISLATIVE SYMPOSIUM
 on March 21, 2018 in Sacramento

Find out why the new water bond, water fees, and increasing recharge statewide are important to you – and what's next!

The Federal Corner

By Jamie Marincola, U.S. EPA

USDA Natural Resource Conservation Service California Offers Post-Fire Disaster Assistance

In response to multiple wildfires which devastated Napa and Sonoma Counties in October, NRCS offered post-fire assistance to assess and mitigate damages to landscape and prevent hazards such as flooding and erosion to the already fire-damaged watersheds and the people who live in them. In addition to a variety of fact sheets and videos on installing Best Management Practices, NRCS offers a suite of funding resources including their Emergency Conservation Program, Tree Assistance Program, and Emergency Loans. For more on resources offered by NRCS, please visit: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/ca/newsroom/features/>.

EPA Releases Superfund Remedy Report, Fifteenth Edition

The Superfund Remedy Report (SRR), Fifteenth Edition, was published by the EPA Office of Superfund Remediation and Technology Innovation (OSRTI) in August 2017. The report focuses on Superfund remedial actions selected in fiscal years 2012, 2013 and 2014, and on remedy trends since 1982. The SRR compiles data on overall remedy selection and remedies for source materials (such as soil and sediments), groundwater, surface water and air related to vapor intrusion. The report also analyzes media and contaminants for sites with remedies. The appendices summarize the remedy components selected for sources and groundwater in each decision document signed in 2012, 2013, and 2014. View or download at: <https://clu-in.org/asr/>.

EPA Issues Ecosystem Services at Contaminated Site Cleanups Issue Paper

The Engineering Forum, as one of three technical forums within the EPA Technical Support Project, developed the Ecosystems Services at Contaminated Site Cleanups paper to provide cleanup site teams with information on services that produce the many life-sustaining benefits we receive from nature-clean air and water, fertile soil for crop production, pollination, and flood control. Information about ecosystem services may be considered in the characterization of future land use options or the design of a cleanup that is consistent with anticipated ecological reuse, depending on the regulatory authority of the cleanup program. The concepts and tools described in this issue paper are useful in communicating the positive results of cleanup in addition to achieving the goals of cleanup. Find the paper at: <https://semspub.epa.gov/src/document/11/100000459>.

USGS Launches Low-Flying Airplane to Map Parts of Northeastern California

For a couple of months this fall, an airplane operated under contract to the U.S. Geological Survey will be making low-level flights over parts of northeastern California, covering parts of Shasta, Lassen, Modoc, Siskiyou, and Plumas counties. The airborne survey is designed to remotely study the geologic and hydrologic units that lie below the land surface. It is part of an ongoing USGS program to identify hidden features such as changes in rock types, ultimately providing a better understanding of the geology and hydrology of the area for assessing groundwater, and seismic and volcanic hazards. For more info, see: <https://www.usgs.gov/news/low-flying-airplane-mapping-parts-northeastern-california>.

Jamie Marincola is an Environmental Engineer at the U.S. Environmental Protection Agency Region 9 Water Division. For more information on any of the above topics, please contact Jamie at 415-972-3520 or marincola.jamespaul@epa.gov.

Fire and Water

By Bart Simmons, Ph.D., retired DTSC

As we in California recover from a devastating fire season, one concern is the impact of fire on water quality. Ash contains elevated levels of trace elements, and might meet the criteria for hazardous waste. However, the use of the California Waste Extraction Test (WET), may largely overestimate the release of trace metal cations (e.g., Pb, Cu, and Zn). Actual impacts of fires on surface water and groundwater have been investigated, including some studies which included prescribed burns as well as control (unburned) areas. Generally, they show the following:

Turbidity, nitrate nitrogen and sulfate show rapid increases post-fire. Dissolved organic carbon (DOC), color, and temperature elevations have also been reported.

For example, the 2002 Hayman Fire was the largest fire in recent Colorado history. The possible effects on Denver's water supply focused public attention on the effects of wild-fire on water quality. The investigators monitored stream chemistry, temperature, and sediment before the fire and at monthly intervals for 5 years after the fire. The proportion of a basin that was burned or that burned at high temperature was closely related to post-fire stream water nitrate and turbidity. Basins that burned at high temperature on greater than 45% of their area had twice the stream water nitrate and four times the turbidity as basins burned at a lower temperature and these measurements remained elevated through 5 years post-fire. Summer stream water was 4.0°C higher in burned streams, on average, compared with unburned streams; the investigators concluded that these persistent post-fire stream temperature increases are probably sufficient to alter aquatic habitat suitability.

In another example was the study of granitic catchments in the Sierra Nevada. Burning of the forest understory and litter layer increased solute concentrations in soil solution and stream water. Mean soil solution Ca^{2+} , Mg^{2+} and K^+ concentrations increased more than 10-fold. Sulfate concentration, which was very low in soil solutions of undisturbed stands, increased more than 100 times following fire. Ammonium concentration exhibited a rapid, short-term increase and then a decrease below pre-burn levels. Changes in soil solution chemistry were reflected in catchment outputs.

Most research on the effects of wildfires on stream water quality has focused on suspended sediment and nutrients in streams and water bodies, and relatively little research has examined the effects of wildfires on trace elements. The purpose of one study was two-fold: 1) to determine the effect of the 2009 Station Fire in the Angeles National Forest

northeast of Los Angeles on trace element concentrations in streams, and 2) compare trace elements in post-fire stormflow water quality to criteria for aquatic life to determine if trace elements reached concentrations that can harm aquatic life. Pre-storm and stormflow water-quality samples were collected in streams located inside and outside of the burn area of the Station Fire. Ash and burned soil samples were collected from several locations within the perimeter of the fire. Filtered concentrations of Fe, Mn, and Hg and total concentrations of most trace elements in storm samples were elevated. In contrast, filtered concentrations of Cu, Pb, Ni, and Se and total concentrations of Cu were elevated primarily due to storms and not the Station Fire. Total concentrations of Se and Zn were elevated because of both storms and the Station Fire. Cu, Pb, and Zn apparently originated from ash in the suspended sediment. Fe primarily originated in burned soil in the suspended sediment. As, Mn, and Ni originated in both ash and burned soil. Filtered concentrations of trace elements in stormwater samples affected by the Station Fire did not reach levels that were greater than criteria established for aquatic life. However, total concentrations of Fe, Pb, Ni, and Zn were detected at concentrations above total criteria established for aquatic life.

Aerially deposited fire retardants might also affect water quality. The U.S. Forest Service list of approved retardants consists of several formulations of "Phos-Chek" for use on wildfires. Phos-Chek is typically composed of an ammonium phosphate salt, such as monoammonium phosphate (MAP; $\text{NH}_4\text{H}_2\text{PO}_4$) or diammonium phosphate (DAP; $(\text{NH}_4)_2\text{HPO}_4$), plus a gum thickener and an iron oxide coloring agent. The subsequent potential effects of the nutrients nitrate and phosphate can include algal growth and eutrophication.

The human cost of fires is real and often permanent. In contrast, the impacts to surface water and groundwater appear to be limited.

Bart can be reached at bartonps@aol.com.

GRA's David K. Todd Distinguished Lecturers for 2018

By Stephanie Diaz, Education Committee Co-Chair

GRA proudly announces the speakers for the eighth year of the David Keith Todd Distinguished Lecture Series. Dr. Jeffrey Mount (northern California) and Mr. Kirby Brill (southern California) have enthusiastically accepted the 2018 David Keith Todd Lectureship. The objective of this program is to foster interest and excellence in applied groundwater science and technology through GRA-sponsored lectures at California universities, local GRA meetings, and statewide GRA events. These lectures further a key GRA objective: to develop scientific educational programs that promote the understanding and effective implementation of groundwater assessment, protection, and management.

GRA held Dr. David Keith Todd in the highest esteem for his enormous contributions to groundwater science and technology, and in 1999 awarded him GRA's Lifetime Achievement Award. We named the series in his honor to pay tribute to his legacy as groundwater science and education leader. The nomination and evaluation process for lecturers ensures that highly-qualified individuals are selected to represent GRA and David Keith Todd's legacy.

Mr. Brill will generally give presentations in southern California, and Dr. Mount will generally give presentations in northern California. Each will provide a minimum of five lectures, including lectures at two GRA branch meetings, two academic institutions, and the First Annual Western Groundwater Congress. Lecture series funding comes from sponsors; voluntary support from the lecturer's institution, organization, or firm; and universities hosting the lecturer. Universities and GRA branches interested in hosting a lecture should contact the GRA Education Committee (dk2018@grac.org) no later than January 31, 2018. Look for the Lecture Series schedule to be posted on GRA's website.

Jeffrey Mount, Ph.D. (Northern California)

Senior Fellow, Public Policy Institute of California Water Policy Center, Professor Emeritus, Department of Earth and Planetary Sciences at University of California, Davis

Lecture: The Consequences of Groundwater Sustainability in California



Bio: Dr. Jeffrey Mount is a Senior Fellow with the Public Policy Institute of California Water Policy Center. He is the Founding Director of the UC Davis Center for Watershed Sciences and Professor Emeritus in the Department of Earth and Planetary Sciences. While at UC Davis he held the Roy Shlemon Chair in Applied Geosciences and UC President's Chair in Undergraduate Education.

During his long career Dr. Mount has published widely on the science and management of rivers, including his award-winning book, *California Rivers and Streams* (UC Press). He is co-author of the recent synthesis *Managing California's Water: From Conflict to Reconciliation* (Public Policy Institute of California). His work at the Public Policy Institute of California focuses on bringing together multi-disciplinary teams of researchers to develop novel solutions to water problems, particularly in California.

Continued on the following page...

Kirby Brill. P.E. (Southern California)
Former General Manager, Mojave Water Agency
Lecture: Building Bridges to a New World in Water Resource Management



Bio: As Mojave Water Agency's (MWA) former General Manager, Mr. Brill worked for over 16 years to develop and execute a diverse portfolio of strategies that now provides the foundation to meet the current and projected water supply needs of a rapidly growing population in San Bernardino County, California. Throughout his tenure at MWA, there was a complex array of challenges driven by ever changing local, regional, state and federally driven forces that drove the need for innovative and creative solutions. Mr. Brill began his career in private consulting and migrated to the public sector at Orange County Water District (OCWD) where he led efforts to maximize the District's ability to capture available water for artificial recharge along the lower Santa Ana River, in Orange County California. Mr. Brill also led the development of a basin-wide groundwater monitoring program consisting of more than 50 deep multi-level monitoring wells and a data collection system with computerized reporting tools that now serve as the backbone of OCWD's current groundwater basin management activities. Mr. Brill left OCWD to take on the challenge of cleaning up groundwater contamination in the San Gabriel Basin, the geographically largest Superfund site in the nation. While at the San Gabriel Basin Water Quality Authority, Mr. Brill served as Assistant Executive Director and later as Executive Director and led efforts to bring local, state, and federal stakeholders together to develop and support practical solutions which could be financed, constructed, and operated using the collective capabilities and assets of the group. Mr. Brill holds a Bachelor's Degree in Civil Engineering, a minor in Geology, and a Master's Degree in Business Administration. Mr. Brill is a registered California Civil Engineer.

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Presentation of GRA's 2017 Lifetime Achievement Award to Dr. Daniel B. Stephens of Daniel B. Stephens & Associates, Inc.

GRA presented its 2017 Lifetime Achievement Award to Dr. Daniel B. Stephens of Daniel B. Stephens & Associates, Inc. (DBS&A) for his significant and enduring impact on the scientific community at the 26th GRA Annual Groundwater Conference and Meeting in Sacramento, California. Dr. Stephen Cullen (DBS&A), Dr. Graham Fogg (University of California at Davis), and Mr. Jeff Gilman (San Francisco Public Utilities Commission) presented the award on behalf of the GRA's Awards Committee and Board of Directors, in recognition of Dr. Stephens' career-long dedication to the groundwater industry and as a pioneer in his field.

Former Lifetime Achievement award recipient, Shlomo P. Neuman, Ph.D., Regents Professor Emeritus, Hydrology and Atmospheric Sciences, University of Arizona, was among other distinguished members of the water resources industry and academia who contributed to Dr. Stephens' nomination with letters of support. Dr. Stephens' supporters conveyed immense respect for him, personally and professionally, and genuine appreciation for his impact on the industry. Dr. Cullen said "I can report that on top of his scientific achievements, Dan has provided an example as a groundwater business person that we can all look to with admiration and pride. He is a fair person, an honest person, and a decent person. He is a person that we are proud to honor with a lifetime achievement award."

Dr. Stephens received his Ph.D. in hydrology from the University of Arizona; his M.S. in hydrology from Stanford University; and his B.S. in geological science (with honors) from Pennsylvania State University. After serving as Assistant and Associate Professor, he became Chairman of the Geoscience Department at New Mexico Institute of Mining and Technology (New Mexico Tech) in Socorro, New Mexico.

In 1976, Dr. Stephens began private consulting and founded the water resources, environmental, and engineering consulting firm, Daniel B. Stephens & Associates, Inc. (DBS&A), in 1984. With a modest start in Socorro, New Mexico, DBS&A grew to a \$17-million corporation with seven offices in California, New Mexico, Colorado, and Texas. In 2015, DBS&A joined Geo-Logic Associates (GLA), which now has 27 offices and 250 employees.

Over his 40-year career in consulting, research and education, Dr. Stephens directed hundreds of hydrogeological projects, to quantify natural recharge, design infiltration



facilities, study groundwater quality, and fate and transport of subsurface contaminants. Dr. Stephens was a pioneer in developing methods to characterize soil hydrologic properties. Using extensively instrumented field sites, Dr. Stephens with his colleagues discovered new physical processes that induce significant horizontal flow components to soil-water movement in the vadose zone. Other research focused on field investigations of natural soil-water movement and recharge in semi-arid climates. His work in vadose zone hydrology resulted in significant and enduring impacts on the scientific community by improving its ability to understand, monitor, and model subsurface contaminants.

Dr. Stephens presents nationally and internationally on the vadose zone, and published Vadose Zone Hydrology and more than 100 articles in scientific journals and conference proceedings.

His renowned expertise led to important advisory roles, including:

- Serving on the Board of Directors of the National Ground Water Association (NGWA).
- Chairing the National Vadose Zone Science and Technology Roadmap Executive Committee for the U.S. Department of Energy (DOE) to develop a national interdisciplinary research program to identify knowledge gaps impeding clean-up or stabilization of subsurface contamination.

Continued on the following page...

- Contributing to an expert panel on unsaturated zone systems at Yucca Mountain nuclear waste repository, evaluating the site's suitability for permanent disposal of radioactive waste.
- Chairing the Peer Review Team for the DOE, Technology Innovation and Development, Office of Environmental Management, Advance Simulation Capability for Environmental Management.
- Participating in the Blue Ribbon Panel to review hydrogeologic data needs for the Environmental Restoration Program at Los Alamos National Laboratory.
- Participating in the review committee for the Ernest Orlando Lawrence Berkeley Laboratory, Berkeley, California, Earth Sciences Division.

In 2004, Dr. Stephens received the University of Arizona Alumni Association's Sydney S. Woods Alumni Service Award, and in 2016, he received the Keith E. Anderson Award from the NGWA in recognition of his significant contributions and commitment to the NGWA Scientists and Engineers Division.

Dr. Stephens has dedicated his life to advance groundwater science, and apply those advancements to solutions that improve people's lives.

GRA Honors Stanford's Center for Groundwater Evaluation and Management (GEM)

The GEM Center has conducted groundbreaking research and applications of Geophysics to the evaluation and management of groundwater resources

By Steve Phillips

At GRA's 2017 Groundwater Conference and 26th Annual Meeting, Steve Phillips, the GRA Vice President (2016-2017), presented to the GEM Center the *Kevin J. Neese Award* for its efforts toward advancing groundwater management in California through applications of geophysics. Dr. Rosemary Knight, Director of the GEM Center, accepted the 2017 *Kevin J. Neese Award* on behalf of the Center.

Dr. Knight founded the GEM Center, in 2007 with co-founder Adam Pidlisecky, to advance and promote the use of geophysical methods "through the development of partnerships with real people, in the real world, with real problems." Having worked for over 30 years on the challenge of using geophysical methods to image groundwater systems, Dr. Knight's research, and that of the GEM Center, ranges from laboratory to large-scale field experiments designed to explore new ways of remotely imaging hydrologic properties and processes. The founding sponsor for the GEM Center was Schlumberger Water Services.

Foundational work by the GEM Center on applying geophysical methods (in combination with hydrogeologic and other information) to problems associated with seawater intrusion, land subsidence, and other issues is featured on their web site: <https://gemcenter.stanford.edu/>.



These examples clearly show the relevance and potential of geophysical methods in helping to promote and enable effective groundwater resource management in California. The *Kevin J. Neese Award* celebrates significant accomplishment by a person or entity that fosters the understanding, development, protection, or management of groundwater in California. In 2017, GRA recognizes the accomplishments of the GEM Center that embody the spirit of this award.

GRA Welcomes the Following New Members

AUGUST - OCTOBER, 2017

Letizia Tjiupek	Amanda Beam
Richard Rees	JennyTest Qian
R. Brad Thoms	chloe liu
Andrew Rich	Micah Clark
Alyssa Leidel	Ken Kirby
Richard Fink	Joelle Alley
Edana Fruciano	Ryan McCoy
Jessica Tibor	Dana Files
Cordie Qualle	Richard Townsend
Rick Rogers	Michael Serfes
Jeremy Kobor	Maggie Scarpa
Timothy Delany	Christina Babbitt
Brian Schmid	Samuel Araya
Raymond Dienzo	Matt Kennedy
George Paul	Joseph Trapasso III
Mark Roberson	Arne Anselm
Robert Pennington	James Norris
Alejandro Perez	Allison Brumbaugh
Alonzo Poach	Willy Cunha
Angela Ruberto	Juliet Hutchins
Roy Thun	Matt Stone
Brian Wallace	Cathy Hollomon
Julie Haas	Rick Viergutz
Marian Singer	Liz DaBramo
Aaron Lewis	Richard Johnson
Dick Tzou	Lisa Race
Dave Tamayo	Michael Ng
Thomas Ng	Shirley Leu
Dwight Wilson	Robert Greenberg
kristen mckillop	Max Halkjaer
Kirk Koester	Michael Preszler
Gary Vanderslice	Ryan O'Sullivan
Bruce Lytle	Coreen Weintraub
Sophia Lee	Andy Wong
Eric Osterling	Austin George
Paul Peschel	Valerie Petela
Casey Creamer	Adam Secondo
Earl James	Diane Johnson
Lauren Ledesma	Glen Low
Ryan Teubert	Kathy Shin
Matt Carney	Mariia Balkan
Chris Lee	Paresh Khatri
Demond Mayfield	Sierra Ryan
Cherith Merson	Jesse Roseman
Douglas Baumwurt	Josue Medellin-Azuara
Lawrence Fujiwara	Nick Tomera
Daniel Pelikan	Nicole Gleason
John Wolfenden	Anne Baptiste

Dates & Details

GRA EVENTS & KEY DATES

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



16th Biennial Symposium on Managed Aquifer Recharge
March 5-7, 2018 | San Diego, CA

2018 Legislative Symposium
March 21, 2018 | Sacramento, CA

First Annual Groundwater Sustainability Agency Summit
June 6-8, 2018 | Sacramento, CA

For information on how to sponsor or exhibit at an upcoming event, please contact Sarah Erck at serck@grac.org.

Mackenzie R Johnson	Bill Duong
Michael Jaubert	Weston Ellis
Michael Hickey	William Ryan
Erin Smith	Strandberg, P.G.
Jesus Gastelum	Robert E. Logan, III
Karen Petryna	Neville Madden
Todd Herrington	philip goalwin
Kristin Robrock	Jaydeep Purandare
Kelly Archer	Gabriel Fuson
Emily Honn	Wesley Toups
Glenn Leong	Robert Emmens
Elvin Kumar	Tariq Kadir
Julie Harriman	Timothy Wood
Rima Chaib	Trevor Hartwell
Regina Hirsch	Sydney Ward
Philip Bachand	Ken Mateik
Robert DiNatale	Cheri Page
Megan Zivic	Jesse Boyd
Kelly Bourque	Bryan Shams
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Special Thanks to Our Event Chairs, Sponsors and Exhibitors

2017: Groundwater Supply, Quality and Sustainability: The Challenges Ahead

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NORTHERN SACRAMENTO VALLEY

By Eddy Teasdale, Branch President

The Northern Sacramento Valley Branch hosted two excellent speakers in September in Chico, CA. Members from as far as Red Bluff, Redding, and Yuba City all participated in the festivities. The event featured talks from geologists at Burns & McDonnell (MCD) Environmental Technologies: Rick Cramer and Dr. Michael Shultz. Approximately 30



members including many students enjoyed excellent food, networking, and gained invaluable information about what MCD calls "Environmental Sequence Stratigraphy." The talk introduced approaches traditionally used in the oil/gas industry to applications within the environmental realm that have recently been incorporated in the Sustainable Groundwater Management Act (SGMA) procedures. They showed many case studies where uncertainty was greatly reduced in areas where the aquifer framework was highly heterogeneous.

The NSV-GRA Branch will also host Dr. Rosemary Knight, a current GRA David Keith Todd Lecturer, in Chico, CA, on November 9. Dr. Knight's presentation will be about new geophysical methods for groundwater evaluation and management. Both of these events, as well as those held during the Spring Quarter earlier this year are consistent with the NSV-Branch's goal to host speakers that directly relate to SGMA's mandate to avoid "undesirable results".



SACRAMENTO

By Linda Bond, Branch President

It's been a busy year for the Sacramento Branch. We've had a great lineup of speakers at our monthly meetings. In August we hosted Steven Springhorn from the Department of Water Resources (DWR) who summarized the scope of DWR's technical assistance for the Sustainable Groundwater Management Act (SGMA Technical Assistance: Building Capacity to Achieve Sustainability). In September we hosted Deborah L. Hathaway, S.S. Papadopoulos & Associates Vice President, who provided a technical overview and techniques for the management of stream depletion caused by groundwater pumping (Reflections on Stream Depletion...



Samuel Araya with his Poster

Staying on Course). In November we hosted Dr. John Kornuc with the Naval Facilities Engineering and Expeditionary Warfare Center, who provided an exceptional overview of PFASs and their concern to the Navy. We look forward to hearing Rick Cramer with Burns & McDonnell who will talk

Continued on the following page...

about the Application of Environmental Sequence Stratigraphy to Groundwater Studies and John Fio, Principal Hydrologist with HydroFocus, Inc., who will speak on reaching technical consensus with stakeholders at our joint GRA-AEG Holiday meeting in December. With our speakers' permission, the Sacramento branch is posting our branch presentations on the GRA website under <https://www.grac.org/members/speaker-presentations/>.

The Sacramento branch program for student support was also very active this year with the help of a great lineup of monthly Scholastic Sponsors who contribute to our annual student scholarship awards. We will be making awards at our annual David Keith Todd (DKT) lecture February 13, 2018 at the Alumni Center at California State University, Sacramento. Jeffrey Mount, the 2018 GRA DKT lecturer will be our featured speaker. In addition, the Sacramento branch sponsored three students from UC Davis and UC Merced, who presented posters at the GRA 2017 Conference and 26th Annual Meeting in October. Melissa Shaw's poster addressed Surface Water-Groundwater Interactions in a Sierra Nevada Headwater Catchment using tritium and stable isotopes; Andy Wong's poster addressed Estimating Field Scale Crop Evapotranspiration using Landsat and MODIS satellite observations; and Samuel Araya's poster addressed Soil moisture recharge estimation – a mass balance approach for quantifying effective precipitation. The branch provided registration and travel funds to all three students. We also provide students a special \$10 rate to attend our monthly meetings!

Sacramento's branch monthly meetings are usually held the second Wednesday at the Aviator Restaurant at the Sacramento Executive Airport on Freeport Boulevard (Check the GRA website for details). Please, come join us if you are in town! Don't miss our big joint GRA-AEG December 13th Holiday meeting and raffle!

SAN DIEGO

By Patrick Rentz, Branch Secretary

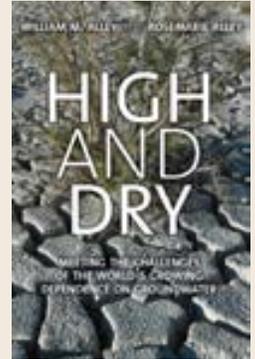
The San Diego Branch hosted its inaugural event on February 28th, 2017 with Dr. Claudia Faunt of the USGS as the featured speaker. Approximately 60 attendees gathered at Stone Brewing to enjoy some delicious food, sample local craft beverages, network, and to learn about the interaction of climate and groundwater resources in California. Dr. Faunt presented an engaging summary of California's groundwater resources, climatic observations, and legislative environment. Using specific data from the Central Valley, Dr. Faunt provided lessons and insights to prevent undesirable results and adaptively achieve groundwater sustainability.

The second meeting of the San Diego Branch was held on June 20th, 2017 with Dr. Bill Alley of the National Groundwater Association as the featured speaker. Approximately 40 attendees gathered at Ballast Point in Miramar for an evening of good food,

locally crafted beverages and to learn about the challenges of the world's growing dependence on groundwater. Dr. Alley's presentation stepped outside of the local

perspective and gave many examples of groundwater dependence and aquifer management worldwide. Reviewing case studies from other parts of the globe, Dr. Alley provided suggestions on successful groundwater management, pointing to a collaborative approach utilizing various spatial-temporal datasets to model groundwater resiliency and response, particularly to climate variability.

The San Diego branch is actively seeking a speaker for the November meeting. Several branch members have requested the topic of regional climatic variability, scaling climate effects and how these factors would impact future water budget scenarios.



Dr. Claudia Faunt's David Keith Todd Distinguished Lecture Series at Inaugural San Diego Branch Event

SAN FRANCISCO BAY AREA

By Eric Sandberg, Branch President

The Bay Area Branch of GRA is pleased to announce the upcoming events for the remainder of the year. On November 9th there will be a co-sponsored free membership drive event in Sebastopol at the Hop Monk Tavern and the always fun and lively Holiday party will be on December 5th. The December 5th party is a joint event with AEG and PEMA and a good opportunity to network. Please come and participate in all our upcoming GRA events!

SAN JOAQUIN VALLEY

By Paul Hendrix,
Tulare Irrigation District

After a several-year hiatus, the San Joaquin Valley Branch is alive once again! The September 12th dinner meeting held in Fresno had 19 attendees. As the news spreads of our resurrection, we hope to increase our attendance.

The meeting began with a “pep talk” about the relevance of GRA and membership benefits by Amer Hussain and Chris Johnson. Our speaker for the evening was Sarge Green with the California Water Institute at Cal State Fresno. He enlightened the group on the underlying relationships between recent hurricanes, Sierra forest fires, and the state’s new SGMA groundwater management responsibilities. He linked the flooding devastation in Texas with land use planning and potential flood situations that could arise in a fire-scorched Sierra watershed. He emphasized that a more holistic approach will be needed to integrate upper watershed management for flood control, water supply, and groundwater sustainability in the Valley’s vast underlying aquifer. Mr.

Green closed by urging attendees to do what they can to overcome industry silos, bring in land use planners into the discussion, and to continue to participate in educational venues when possible.

Our second meeting scheduled for November 7th will include branch officers’ elections, and speaker Daniel Mountjoy of Sustainable Conservation. He will be addressing the latest developments regarding the potential for groundwater recharge via on-farm programs, a topic gaining attention in Sacramento as a way to mitigate for overdraft plaguing the San Joaquin Valley, and to assist in complying with SGMA.

SOUTHERN CALIFORNIA

By Herbert Vogler, Branch Secretary

The Southern California Branch, focusing on Los Angeles and Orange Counties, held one branch meeting last quarter at the Orange County Water District (OCWD) on Tuesday, October 10, 2017.

Approximately 45 people attended. OCWD’s Adam Hutchinson, PG, CHG, gave a presentation on OCWD and its Groundwater Replenishment System (GWRS). He then led a tour of the GWRS facility. After the tour (and dinner), Brian Villalobos, PG, CEG, CHG, of Geoscience Support Services, Inc., gave his interesting presentation entitled “Subsurface Intakes for Desalination Feed Water Supply: Current Lessons from the On-Going MPWSP Test Slant Well Long-Term Pumping Test Program located near the City of Marina, Central Coast of California.”

Adam’s presentation included: OCWD’s more than 80-year history, the Orange County Groundwater Basin’s hydrologic setting and OCWD’s management of the basin responsibilities. His presentation then focused on the GWRS, which he explained is

presently the world’s largest “Indirect Potable Reuse” project. The GWRS is a joint project between OCWD and the Orange County Sanitation District. The GWRS uses a state-of-the-art, three-stage purification process to purify sewer water into near-distilled quality. The project provides a water supply that is added to the basin via both direct percolation and injection into coastal barrier wells (helping keep seawater out of the basin). The GWRS facility tour included the three treatment processes, which consist of microfiltration, reverse osmosis, and ultraviolet light treatment with hydrogen peroxide.



Tour group in front of a Microfiltration Building



Tour group within the treatment plant basement

Brian’s presentation focused primarily on the use of subsurface intakes for desalination feed water supply and on lessons learned by his firm during its work on the new, innovative Monterey Peninsula Water Supply Project (MPWSP). His firm developed and is a leader in slant well subsurface intakes for seawater reverse osmosis (SWRO) desalination plants. He explained that, with California’s

Continued on the following page...

on-going need to develop new water supplies, ocean desalination has moved up on the list of priorities for water supply agencies. Also, near-shore subsurface intakes are new, innovative approaches to extract seawater. These intakes are engineered structures that collect groundwater from beneath the ocean floor. Subsurface intakes are favored among regulatory agencies because:

- There are no ocean construction impacts
- Entrainment and impingement impact to marine organisms may be avoided
- There is no permanent visual impact to coastal areas.

Additionally, subsurface intakes are beneficial to plant operations via their elimination (or reduction) of costly pretreatment, and minimization of marine organism growth inside intake pipelines. His firm designed and drilled the first successful artificially filter-packed-slant-well, near Dana Point for the Metropolitan Water District of Orange County. Testing showed consistent high-efficiency pumping with a very low silt density index.

Brian then informed the audience that the California-American Water Company (CalAm) is developing new water supplies to replace groundwater supplies that historically have come from the Carmel River and Seaside Groundwater Basin groundwater. This includes the MPWSP, which involves constructing a subsurface

subsea seawater intake system and a multi-MGD desalination plant. CalAm commissioned his firm to construct a 724 foot-19 degree-test-slant well at the CEMEX sand and gravel mine site near Marina, California. His talk concluded with a discussion of lessons learned, including early establishment of a collaborative working group, public outreach, and adequate drill site size and accessibility. One well design and construction consideration was telescoping and use of an innovative half-moon perforated well screen.

The Southern California Branch again thanks our two speakers for presenting their informative and interesting talks to us, and as always, we thank all GRA Members who participate in the Branch.

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The Parting Shot



Between 65 and 34 million years ago, the ancestral Yuba River flowed down a much different course than today and was much larger, with a broad floodplain and thick channel deposits. The white gold-bearing (auriferous) gravels are prominent in the lower half of the bluff. The fluvial deposits also contain plant and vertebrate fossils. The plant fossils suggest a rainforest setting and a temperate to subtropical climate that was probably between 10 and 15 degrees Fahrenheit warmer than at present.

Between the mid-1850s and 1885, approximately 885,000,000 cubic yards of debris was mobilized by hydraulic mining throughout the Sierra Nevada foothills. That value is over 3.5 times greater than the volume excavated for the Panama Canal. About 73% of the total was associated with just four rivers, the Yuba, Bear, American, and Feather. An Auburn newspaper, the Placer Herald reported in 1872, that 80 feet of the debris had accumulated in parts of the Bear River: *"Tall pine trees, formerly far above the stream, have*

been gradually engulfed season after season, until now only the top branches appear above the current." In 1884, Judge Lorenzo Sawyer issued California's first environmental ruling with a permanent injunction against the dumping of mine tailings into the Yuba River.

By the early 1880s hydraulic mining had transformed the river environments of the Sierra Nevada and the Sacramento Valley. Thirty years of hydraulic mining overturned the ecological order of these environments: it washed away hilltops, raised riverbeds above the level of their banks, destroyed salmon habitat, and flushed mercury and sediment into San Francisco Bay and beyond the Golden Gate. Hydraulic mining left large excavations and pits with steeply eroded badlands similar to landscapes found in the Rocky Mountains. This erosional process took millions of years in South Dakota and Wyoming, but a mere three decades in California.

Photographed at Malakoff Diggins State Historic Park by John Karachewski, Ph.D.