

# Southwest HYDROLOGY

The Resource for Semi-Arid Hydrology

Volume 7/Number 3 May/June 2008



## Aquifer Recharge, Storage, and Recovery

Southwest Hydrology  
University of Arizona - SAHRA  
P.O. Box 210158-B  
Tucson, AZ  
85721-0158

Address Service Requested



### *Announcing Some New Principals*

Back in 1999, we assembled our new company on one guiding principle: that the value of our services would equal the sum of our staff.

Over the years, our success in growing our small company has been a reflection of this principle—such that the scope and range of what we provide is the result of the integrity of our collective professional capabilities.

So it is with complete confidence that we are promoting **Mike Alter**, **Don Hanson**, and **Tom Suriano** to positions as principal hydrogeologists at Clear Creek Associates, responsible for technical, contractual, and business matters.

So, three new principals; one long-standing principle; and a single priority: to provide quality-focused, very responsive, integrated hydrologic services.

*Joining founding partners (from left) Doug Bartlett and Marvin Glotfelty as Principals of Clear Creek Associates in Phoenix are:*

**Thomas R. Suriano, R.G.**, joined Clear Creek in 2006, bringing twenty-two years of experience managing environmental and water resources projects.

**Donald P. Hanson, R.G.**, joined Clear Creek in 2000 and has twenty-two years of experience managing environmental and water resources projects.



*And in Tucson:*

**Michael L. Alter, R.G.**, joined Clear Creek Associates at its inception in 1999 as head of the Tucson office and brings thirteen years of experience consulting on environmental and water resources projects.

*in Phoenix:*

6155 E. Indian School Rd., Suite 100, Scottsdale, Arizona 85251  
(480) 659-7131, (480) 659-7134 fax

*in Tucson:*

221 N. Court Ave., Suite 101, Tucson, Arizona 85701  
(520) 622-3222, (520) 622-4040 fax

[www.clearcreekassociates.com](http://www.clearcreekassociates.com)

**CLEAR  
CREEK  
ASSOCIATES**



*Practical Solutions in  
Groundwater Science*

# Levelogger Proven to be Worth its Weight in Gold



## Mandate To Deliver Quality

Since the Levelogger Gold was launched at the beginning of 2006, Solinst has shipped thousands and thousands of units to satisfied customers all over the world.

*"Our mandate is to design and deliver high quality products, and back it up with our 3 Year Warranty, demonstrating the Solinst commitment to our customers."*

— Sarah Belshaw, President

## Dependable Water Level Datalogger

- Maintenance Free Design/Lifetime Calibration
- Backwards Compatible
- 3 Year Warranty
- Real-Time View
- User-selectable Sampling Schedule
- 10 Year Battery (1 reading/minute)
- SCADA Ready (SDI-12)

The Levelogger Gold is a self contained water level datalogger, which is completely designed, developed and manufactured in-house, in the tradition of all Solinst high quality products. The Levelogger Gold uses infra-red data transfer, providing the flexibility of installing by use of a simple wireline or by using a Direct Read Cable to surface. The Levelogger Gold includes a pressure transducer, temperature thermistor, 10 year lithium battery (based on 1 reading per minute), and internal data logger with a capacity of 40,000 temperature and water level data points.

**Solinst**<sup>®</sup>

Solinst Canada Ltd., 35 Todd Road  
Georgetown, ON L7G 4R8  
Tel: +1 (905) 873-2255; (800) 661-2023  
Fax: +1 (905) 873-1992; (800) 516-9081

## Junior ...

...the newest addition to the Levelogger Family



**\$375 US**

## Reduce Your Bottom Line

A low cost alternative in the Levelogger Series

- Accuracy of 0.1% FS
- 32,000 Datapoints
- 5 Year Battery
- 1 Year Warranty
- Compatible with Levelogger Gold Series, Software and Accessories

## Levelogger Gold



- Rugged Data Transfer Device
- Dedicated to Levelogger Series
- Stores 1.39 Million Datapoints
- Real-Time View
- Re-program in the Field

Website: [www.solinst.com](http://www.solinst.com)  
E-mail: [instruments@solinst.com](mailto:instruments@solinst.com)

# Southwest HYDROLOGY

The Resource for Semi-Arid Hydrology

A bimonthly trade magazine for hydrologists, water managers, and other professionals working with water issues.



## From the Publisher

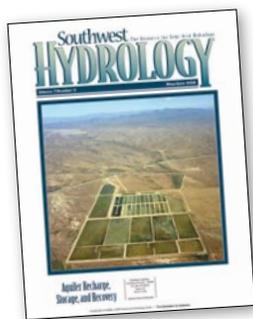
*Does your region have extra water now that you want to save for later, when there might be a drought? You could keep it in a reservoir if you have access to one, but you'll lose some of the water to evaporation. Or you could let it seep into the ground or inject it down a well to an aquifer, and plan to pump it back out when you need it. Your biggest problem may be figuring out what to call this process: in preparing this issue, we discovered strong and diverse opinions on terminology, especially among experts. Not all will agree with our decision (see page 16 sidebar), but we believe "aquifer storage and recovery" most clearly describes what we're talking about.*

*Did you pay someone for your Southwest Hydrology subscription, or receive it as a "gift"? Say it ain't so! We recently learned that some unscrupulous entities are offering Southwest Hydrology subscriptions for around \$10/year and pocketing the money. Southwest Hydrology is FREE! We are taking steps to stop this activity; if you paid, please let us know.*

*Thanks to all of you who responded to our online survey, which was sent to the roughly 4,300 subscribers for which we have valid email addresses. We received some excellent suggestions, many of which we hope to implement in future issues, and learned a lot about our readers. We will provide more on the results in the next issue. Bottom line: most respondents are quite satisfied with Southwest Hydrology and are also happy in their jobs. And more than half usually or always read this letter—not just my mother!*

*We thank our newest sponsor of Southwest Hydrology: Salt River Project. They, along with existing sponsors (see page 9) and our advertisers, help make continued free publication possible. We also thank all contributors to this issue.*

Betsy Woodhouse, Publisher



*The Vidler Recharge Facility, about 90 miles west of Phoenix, recharges Central Arizona Project water through some 460 acres of infiltration basins. The water will be recovered in the future by Vidler or its buyer, for currently undetermined use(s).*

## Southwest Hydrology

**Publisher**  
Betsy Woodhouse

**Technical Editor**  
Howard Grahn

**Editor**  
Mary Black

**Graphic Designer**  
Mike Buffington

**SAHRA Knowledge Transfer**  
Gary Woodard

### Contributors

Cortney C. Brand	Mario R. Lloria
Greg Bushner	Sharon B. Megdal
Mark Cross	Ari M. Michelsen
Denise D. Fort	Christian E. Petersen
Peter Fox	Taylor Shipman
Gerald E. Galloway	Cat Shrier
Kenneth Glotzbach	

### Advisory Board

David Bolin, R.G.  
Charles Graf, R.G.  
Jim Holway, Ph.D.  
Jeff Johnson  
David Jordan, P.E.  
Karl Kohlhoff, P.E., B.C.E.E.  
Stan Leake  
Ari Michelsen, Ph.D.  
Mark Murphy, Ph.D.  
Peggy Roefer  
Martin Steinpress, R.G., C.HG.

Printed in the USA by CityPress

Southwest Hydrology is published six times per year by the NSF Center for Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA), College of Engineering, The University of Arizona. Copyright 2008 by the Arizona Board of Regents. All rights reserved. Limited copies may be made for internal use only. Credit must be given to the publisher. Otherwise, no part of this publication may be reproduced without prior written permission of the publisher.

ISSN 1552-8383

### Subscriptions

Subscriptions to *Southwest Hydrology* are free. To receive the magazine, contact us as shown below.

### Advertising

Advertising rates, sizes, and contracts are available at [www.swhydro.arizona.edu](http://www.swhydro.arizona.edu). Please direct ad inquiries to us as shown below. Space must be reserved 50 days prior to publication date.

### Free Job Announcements

Southwest Hydrology will publish job announcements in the Employment Opportunities section. The first 70 words for each announcement is free; after that, the charge is \$70 per additional 70 words. To place an ad, contact us as shown below. All announcements, of any length, may be posted on our website for no charge ([www.swhydro.arizona.edu](http://www.swhydro.arizona.edu)).

### Editorial Contribution

Southwest Hydrology welcomes letters and contributions of news, project summaries, product announcements, and items for The Calendar. Send submissions by mail or email as shown below. Visit [www.swhydro.arizona.edu](http://www.swhydro.arizona.edu) for additional guidelines for submissions.

### Web Sites

Southwest Hydrology - [www.swhydro.arizona.edu](http://www.swhydro.arizona.edu)  
SAHRA - [www.sahra.arizona.edu](http://www.sahra.arizona.edu)

### CONTACT US

Southwest Hydrology, The University of Arizona, SAHRA  
PO Box 210158-B, Tucson, AZ 85721-0158.  
Phone 520-626-1805. Email [mail@swhydro.arizona.edu](mailto:mail@swhydro.arizona.edu).

[SOUND PRINCIPLE NO. 33]

WE **MEASURE** FLOW

*(in places you never thought possible)*



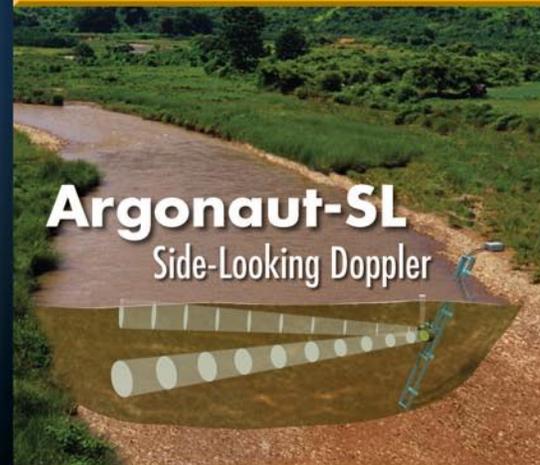
**Argonaut-SW**  
Shallow Water Doppler®

**Irrigation Canals**



**FlowTracker**  
Handheld ADV®

**Natural Streams**



**Argonaut-SL**  
Side-Looking Doppler

**Real-Time Discharge**

**A remarkably simple concept that you can afford.**

- 💧 We understand what it's like out in the field, because that's where we got our start.
- 💧 We have made using precision-based acoustic Doppler technology easy to use in even the most rugged, and challenging conditions.
- 💧 More options, better customer support and more value for less money.



YSI incorporated

Sound Principles. Good Advice.

[+1.858.546.8327]

9940 Summers Ridge Road  
San Diego, California, USA

For **FREE** technical notes, access to web-based training and product information, visit [www.sontek.com](http://www.sontek.com).  
Questions? E-mail: [inquiry@sontek.com](mailto:inquiry@sontek.com).

## Departments

### 8 On the Ground

- WRDA 2007 water policy provisions, by Gerald E. Galloway and Ari M. Michelsen
- Arizona's groundwater savings program, by Sharon B. Megdal and Taylor Shipman

### 12 Government

- Water scarcity and growth in Southern California
- New Mexico mulls regulation of deep aquifers
- New Mexico and Texas resolve 29-year dispute
- Rio Grande pits Mexico versus Texas; disagreement heads to Canada
- Oil shale projects could impact Colorado water
- EPA wastewater infrastructure needs \$202 billion
- Bromate spike in Los Angeles reservoirs

### 12 HydroFacts

### 34 R&D

- Dire predictions for Colorado River reservoirs
- Mussel menace update: they seem to be thriving
- Water quality impacts to shallow groundwater
- Human activities linked to changes in water resources
- Coachella Valley is sinking at increasing rates
- Extreme precipitation events linked to global warming
- Integrated energy/water model in the works

### 41 In Print

*Damming Grand Canyon: The 1923 USGS Colorado River Expedition*, reviewed by Betsy Woodhouse

### 42 Calendar

## Aquifer Recharge, Storage, and Recovery

In this issue we define the deliberate recharge and temporary storage of “excess” (unneeded) water in an aquifer, with the intent of recovering that water for future use, as aquifer storage and recovery (ASR). The technique is increasingly being used as a water management tool. The implementation of ASR projects varies widely in the type of water used, method of recharge, aquifer type, and engineering of the project, as described in these feature articles. Furthermore, water quality changes resulting from mixing two different waters must be considered, as well as regulatory and policy constraints. And do you really get that water back? Read all about it...

### 16 An ASR Primer

*Courtney C. Brand*

What is aquifer storage and recovery? What are its benefits and limitations? How does it work? Who is doing it? Comparing a number of ASR projects in the Southwest illustrates the range of objectives, water sources, aquifer types, and recharge and recovery methods utilized.

### 18 Hydrogeology and ASR Design

*Greg Bushner*

Site hydrology is critical to the success of an ASR project. What factors should be considered in evaluating land and water? Which data are needed to determine site and soil suitability and ensure nondegradation of water quality?

### 20 ASR and the “Big Picture”

*Cat Shrier*

A recent National Research Council report and forum identified institutional issues that have prevented ASR from being more widely accepted. Although the details of any project are local, some actions taken at the federal and regional levels could facilitate more widespread use of aquifers as potential storage zones and for conjunctive water management.

### 22 ASR from a Legal Perspective

*Denise D. Fort*

The regulatory structure for ASR is complex because the legal system has historically addressed water quality issues independently of water quantity, as it has groundwater and surface waters. Authority over a project may also be divided between federal and state governments.

### 24 Water Quality Changes During Subsurface Storage

*Peter Fox*

Mixing of existing groundwater and introduced water in an ASR system can impact water quality as well as the hydraulic capacity of injection wells. What are the potential problems and methods of treatment that can be used to prevent or mitigate these challenges?

### 26 What About the “R” in ASR?

*Betsy Woodhouse*

After injecting water underground via wells or letting it seep through shallow basins, is it possible to get all that water back again when you need it? What is storage? How does recovery actually work?

### 28 Water Spreading in the Desert

*Mario R. Lluria*

Following completion of the CAP aqueduct, the Salt River Project and Phoenix-area municipalities investigated in-channel recharge as a way to preserve Arizona's unused allocation of Colorado River water. Today two recharge facilities store almost one million acre-feet of water annually.

### 30 ASR in Roseville: Navigating Water Quality Issues

*Christian E. Petersen and Kenneth Glotzbach*

An ASR demonstration project in Roseville, California, is improving understanding of the water quality implications of underground injection and recovery. Results show a five-foot rise in groundwater levels, significant reductions in TDS levels, and attenuation of disinfection byproducts.

Publishing **Southwest Hydrology** furthers SAHRA's mission of promoting sustainable management of water resources in semi-arid regions.

