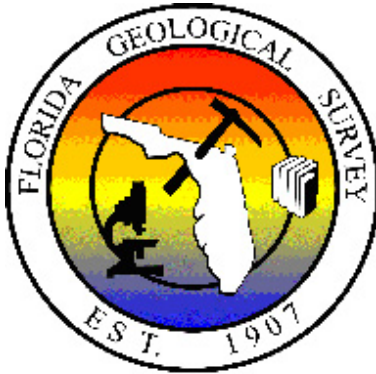


# Aquifer Storage Recovery IV

Holiday Inn Busch Gardens Tampa, Florida - April 15 -16, 2004

**Science, Technology, Management and Policy**



An educational program sponsored by

American Ground Water Trust  
FDEP/Florida Geological Survey  
Hydrogeology Consortium

## **PROGRAM DETAILS**

## **PRESENTER BIOGRAPHIES**

## **POSTER ABSTRACTS**

Co-sponsored by: International Association of Hydrogeologists



Also co-sponsored by:

United States Geological Survey  
Florida Ground Water Association  
South Florida Water Management District  
St Johns River Water Management District  
Florida Association of Professional Geologists  
South West Florida Water Management District

## ASR – SCIENCE AND TECHNOLOGY - April 15

- 7:00 – 8:00     **Registration** (Continental breakfast, CEU sign-in)
- 8:00 – 8:15     **Welcome**  
 Introductions/Recognitions, Review of Schedule, Goals of Forum  
*Andrew Stone, Executive Director, American Ground Water Trust, Concord, NH*
- Morning Sessions Moderator:** *Albert Muniz, Hazen & Sawyer, Boca Raton, FL*
- 8:15 – 9:35     **From California to Florida: Plans, Trends and Updates**  
 ASR Activities in The Western United States  
*Terry Foreman, Vice President, CH2M Hill, Thousand Oaks, CA*  
 Comprehensive Everglades Restoration Plan (CERP) ASR Pilot Study Update  
*Pete Kwiatkowski, Lead CERP ASR Project Manager, SFWMD, West Palm Beach, FL*  
 ASR Performance and Recovery in Southern Florida  
*Ron Reese, Hydrologist, US Geological Survey, Miami, FL*  
 ASR Water Quality Trends in Southern Florida  
*June Mirecki, Hydrogeochemist, US Army Corps of Engineers, Vicksburg, MS*
- 9:35 – 10:20   **Keynote Speaker** – Peter Dillon  
 Aquifer Recharge – A Global View and an Australian Perspective  
*Peter Dillon, CSIRO, Adelaide, Australia*
- 10:20–10:40   **Break** (poster & exhibits)
- 10:40–12:00   **Zooming in on Water, Rocks and Microorganisms**  
 Water-Rock Interactions During ASR and Effects on Water Quality  
*Jon Arthur, Hydrogeology Program Supervisor, Florida Geol. Survey, Tallahassee, FL*  
 Significance of Native Microbial Populations in ASR Storage Zones  
*John Lisle, Microbiologist, US Geological Survey, St Petersburg, FL*  
 Survival of contaminant microorganisms in model ASR conditions for Florida  
*David John, Microbiologist, University of South Florida, Tampa, FL*  
 Water Treatment Options for ASR  
*Don Thompson, Vice President, CDM, Inc., Jacksonville, FL*
- 12:00 – 1:30   **Lunch** - Invited Luncheon Speaker – David Moore  
 The role of ASR as a water resource alternative in Southwest Florida  
*David Moore, Executive Director, Southwest Florida Water Management Dist., Brooksville, FL*
- Afternoon Sessions moderator:** *Walter Schmidt, FGS, Tallahassee, FL*
- 1:30 – 2:30     **Case Studies, Modeling and What’s Next...**  
 Recent ASR Developments in Southwestern Florida  
*Mark McNeal, Hydrogeologic Sciences Manager, CH2M Hill, Tampa, FL*  
 Improving ASR recovery efficiency using modeling  
*Mark Pearce, Vice President, Water Resource Solutions, Cape Coral, FL*  
 ASR Dynamics, Issues and Solutions  
*David Pyne, President, ASR Systems LLC, Gainesville, FL*
- 2:30 – 3:00     **Break** (posters & exhibits)
- 3:00 – 3:40     **Case Studies, Modeling and What’s Next...** (continued)  
 Modeling ASR Hydraulics and Plume Geometry  
*Thomas Missimer, Vice President, CDM-Missimer, Fort Myers, FL*  
 Geochemistry, Geophysical Applications and Data Gaps  
*Sam Upchurch, Vice President, SDII Global, Tampa, FL*

3:40– 4:40 **Discussion, Deliberation and Recommendation Session**

**Science & Technology - Session Leaders:**

Walter Schmidt, State Geologist, Florida Geological Survey, Tallahassee, FL,  
and Albert Muniz, Hazen & Sawyer, Boca Raton, FL

This session will include discussion among presenters and attendees. The objective will be to interactively generate (in electronic format) an ASR state-of-the-art summary with where-do-we-go-from-here (?) recommendations.

Discussion topics are likely to include:

- ⇒ What have we learned from operational ASR facilities?
- ⇒ Which technologies appear to be most effective?
- ⇒ What are the research gaps and how can they be funded?
- ⇒ What science and engineering issues are of greatest uncertainty?
- ⇒ What are strategies for maximizing ASR performance and recovery?
- ⇒ How water quality issues being addressed and what are the associated costs?

4:40 Day one program ends [CEU sign-out]

5:00 – 6:30 **Reception** (Cash bar, posters, exhibits) (No scheduled evening activities)

## ASR – MANAGEMENT AND POLICY – April 16

7:00 – 8:00 **Registration** (Continental Breakfast, posters, exhibits)

8:00 – 8:15 **Welcome**

Introductions/Recognitions, Review of Schedule, Goals of Forum  
*Andrew Stone, Executive Director, American Ground Water Trust, Concord, NH*

8:15 – 8:45 **Summary of Day One Presentations & Discussions**

Consensus Report-back from ASR IV Program Organizers  
*Albert Muniz, Vice President, Hazen & Sawyer, Boca Raton, FL*

8:45 – 9:30 **Keynote speaker:** Charles Pattison

Florida Water Resources in 2020  
*Charles Pattison, Executive Director, 1000 Friends of Florida, Tallahassee, FL*

**Morning Sessions Moderator:** *Elliott Grosh, Senior VP, PBS&J, West Palm Beach, FL*

9:30 – 10:30 **Florida Regulations: Protecting People and Resources**

Florida Aquifer Protection: The Regulatory View  
*Judy Richtar, UIC Program Manager, Florida DEP, Southwest District, Tampa, FL*

Water Quality and Human Health  
*Bart Bibler, Water Programs, Florida Department of Health, Tallahassee, FL*

Water-Resource Management: The View from Here  
*Don Ellison ASR Projects Coordinator, SWFWMD, Brooksville, FL*

10:30 –11:00 **Break** Posters, Exhibits and room checkout opportunity

11:00–12:00 **Facility Operations, Management and the Law**

A City Utility's Perspective  
*Pete Mazzella, Deputy Director of Utilities, City of Boynton Beach, FL*

The Environmentalists' Perspective  
*Scott Randolph, Attorney, Legal Environmental Assistance Foundation, Tallahassee, FL*

State and Federal Regulations: Is Everything Black and White?  
*Cynthia Christen, Senior Attorney, Florida Dept. of Environmental Protection, Tallahassee, FL*

12:00 – 1:30 **Lunch** Invited Luncheon Speaker – John Mulliken  
 ASR Issues in South Florida  
*John Mulliken, Acting Director, Water Supply Department, SFWMD, West Palm Beach, FL*

**Afternoon session moderator:** *Andrew Stone, Executive Director, American Ground Water Trust, Concord, NH*

1:30 – 2:30 **Thoughts from Beyond Florida**  
 Regulatory Issues and Solutions: The Wisconsin Story  
*Richard Roth, UIC Program Director, Wisconsin Dept. of Natural Resources, Madison, WI*  
 From the Outside Looking in: Is ASR Right for Georgia?  
*Bill McLemore, State Geologist, Georgia Geological Survey, Atlanta, GA*  
 The EPA Perspective on a Continually Developing and Needed Technology  
*John Taylor, Senior Environmental Engineer, US EPA, Region V, Chicago, IL*

2:30 – 2:40 **Break**

2:40 – 3:40 **Discussion, Deliberation and Recommendation Session**

**Management & Policy - Session Leaders:**

Peter Dillon, CSIRO, Adelaide, Australia  
 and Jon Arthur, Hydrogeology Program Supervisor, Florida Geol. Survey, Tallahassee, FL

This session will include discussion among presenters and attendees. The objective will be to interactively generate (in electronic format) an ASR state-of-the-art summary with where-do-we-go-from-here (?) recommendations.

Discussion topics are likely to include:

- ⇒ Is there enough time for research to address the unknowns?
- ⇒ Is the CERP ASR timeline in synch with regulatory requirements?
- ⇒ Cycle-test durations – how long is enough?
- ⇒ What are regulatory interpretations of “point of compliance,” and other terms?
- ⇒ How can the permitting process be improved?
- ⇒ Should Class I standards be applied to ASR?

3:40 – 4:00 **Closing Statements from ASR IV Organizers**

4:00 **Adjourn** [CEU sign-out]

**Disclaimer:** *The participation of speakers at this program from specific private sector companies, organizations or agencies, does not imply that the ASR IV sponsors or co-sponsors endorse or recommend particular companies, products or commercial applications of technology.*

## Florida ASR I, II, III and now ASR IV

The American Ground Water Trust held ASR I on September 10, 2001, in Orlando. This program provided exposure for the whole concept of Aquifer Storage Recovery and was a discussion opportunity for “environmental” and “engineering” perspectives of ASR as a water management strategy. ASR II took place on January 7, 2002 in Orlando and included sessions related to the treatment technology available for recharge water. In 2003, ASR III, also held in Orlando, served to provide a technical and policy update across the spectrum of Florida’s ASR issues. This April 15-16 program in Tampa (ASR IV) is taking a different format. The Trust has teamed up with the Florida Department of Environmental Protection (Florida Geological Survey/ Hydrogeology Program) and the Hydrogeology Consortium. The two-day ASR IV program will review the status of current ASR science and technology on day one, and then relate the science to policy and management issues on day two. We hope attendees will be there for both days, but recognizing time and budget constraints, the organizers have framed each day as “stand-alone” to facilitate one day participation. ASR V will be held in Florida in 2005. Your comments on the evaluation sheets will be helpful in guiding the Trust to select content and format.

## What is the ASR IV Forum All About?

The Tampa ASR IV Forum brings scientists, planners, water-resource managers, concerned citizens, etc... together to share up-to-date information regarding challenges and successes of ASR implementation. There will be

technical presentations and panel discussions. The program is designed for exchange of ideas and opinion. The critical mass of expertise focused on ASR for two days should provide an opportunity for an assessment of technology trends and research needs for future ASR-related activities. The content of the presentations and an edited transcript of the discussions will be prepared as a post forum publication that will be provided to all registered participants in CD format.

ASR IV is a one-stop shop for the latest perspectives on an important emerging and ongoing issue. The program has a Florida focus but the basic science, technology, management and policy issues have direct relevance for ASR programs throughout North America and overseas.

## Continuing Education



Employee Development University is a learning partner with the Trust and 1.2 CEU credits are available for conference attendees who complete the sign-in and sign-out sheet at registration and who submit an evaluation form. [Visit [www.eduniv.com](http://www.eduniv.com) for more information about this CEU program.] Lists will be available at registration. Signatures will be required for both days. One-day attendees will get 0.6 CEU credits.

## American Ground Water Trust

The American Ground Water Trust is a member-supported national not-for-profit organization. The Trust was founded in 1986. The educational mission of the Trust is to:

- ⇒ Promote groundwater protection and resource sustainability
- ⇒ Communicate the environmental and economic value of groundwater
- ⇒ Showcase groundwater science and technology solutions
- ⇒ Increase citizen, community and decision-maker awareness of resource issues, and
- ⇒ Facilitate stakeholder participation in water resources decisions.

The Trust's education programs include:

- ★ Organizing specialist conferences & workshops (Such as ASR IV)
- ★ Convening *Ground Water Institutes for Teachers*™ (645 educators trained, 140,000 students impacted since 2001)
- ★ Managing Scholarship programs (over \$100,000 awarded since 1987)
- ★ Responding to citizen ground water questions via 800 number and e-mail
- ★ Producing a quarterly publication for well owners (*THE AMERICAN WELL OWNER*™)
- ★ Preparation of information pamphlets on ground water subjects
- ★ Providing citizen and community advice over local ground water issues
- ★ Maintaining an informative web-site on ground water and water well subjects

The Trust's 2004 Board of Directors:

**Chair**

Denise Kruger, Senior VP of Operations, Southern California Water Company, Rancho Cordova, CA

**Vice-Chair**

Rob Fisher, Director of Operations, Nestle Waters America, Lee, FL

**Secretary**

Ron Peterson, Senior Account Representative, Baroid Industrial Drilling Products, South Jordan, UT

**Treasurer**

Jim Nattier, Executive VP & CFO, Dresser, Inc., Addison, TX

**Board Members**

Edward Breiner, Exec. Vice President, Schramm, Inc., West Chester, PA

Dennis Coggins, Vice President of Sales, Goulds/ITT Industries, Seneca Falls, NY

Kenneth Davis, Managing Director, Public Affairs Management LLC, Philadelphia, PA

Gary DuPuy, Hydrogeologist, Geomatrix Consultants, Inc., Seattle, WA

Terry Foreman, Sr. Hydrologist and VP, CH2M Hill, Thousand Oaks, CA  
 Cole Frates, Executive Vice President, Western Development and Storage, Los Angeles, CA  
 Don Hobbs, Vice President of Marketing, Franklin Electric Company, Bluffton, IN

Claude Laval, Chairman, Claude Laval Corporation, Fresno, CA  
 Randy Lyne, President, Preferred Pump and Equipment, Fort Worth, TX  
 John Oneacre, President, Ground Water Solutions, Inc., Houston, TX  
 Robert Schreiber, GW Subdiscipline Leader, Camp Dresser & McKee, Cambridge, MA  
 Scott Slater, Attorney at Law, Hatch & Parent, Santa Barbara, CA  
 Kathleen Stanley, Executive Director, Water Systems Council, Washington, DC  
 John Stodder, Senior Vice President & Senior Partner, Fleishman-Hillard Inc., Los Angeles, CA  
 Fred Tregaskes, President, Weber Group LC, Chandler, AZ  
 Bob Van Valer, President, Roscoe Moss Company, Los Angeles, CA  
 John "Woody" Wodraska, National Services Manager, PBS & J, West Palm Beach, FL  
 Gregory Zlotnick, Director, Santa Clara Valley Water District, San Jose, CA

## Florida Geological Survey

The Florida Geological Survey (FGS), established in 1907, is a bureau of the Florida Department of Environmental Protection. The primary FGS mission is to collect, interpret, disseminate, store and maintain geologic data, thereby contributing to the responsible use and understanding of Florida's natural resources. In 2001, the Florida Legislature and the FDEP authorized creation of the FGS Hydrogeology Program, the mission of which is to conduct hydrogeologic research in support of the need for unbiased, scientific knowledge of Florida's groundwater resources with specific emphasis on aquifer systems. The program also administers research through outsourcing. Knowledge gained through these activities can be applied to rule making, regulatory, and policy decisions that facilitate efficient, science-based protection of the quantity and quality of Florida's water resources.

State Geologist and Chief, Florida Geological Survey, Walter Schmidt, Ph.D., P.G.  
 Hydrogeology Program Staff:

Professional Geologist Supervisor, Jonathan D. Arthur, Ph.D., P.G.

Rick Copeland, Ph.D., Professional Geologist III	Adel Dabous, Ph.D., OPS Research Associate
Rodney DeHan, Ph.D., DVM, Senior Scientist	Jim Cichon, OPS Environmental Specialist III
Rick Green, Professional Geologist I	Cindy Fischler, OPS Environmental Specialist I
Tom Greenhalgh, Professional Geologist I	Will Evans, OPS Professional Geologist I
Steve Spencer, Professional Geologist I	Clint Kromhout, OPS Environmental Specialist I
Alan Baker, OPS Environmental Specialist III	Elizabeth Moulton, OPS Environmental Specialist I
Kristy Baker, OPS Secretary Specialist	Alex Wood, OPS Environmental Specialist II
Roberto Davila, OPS Environmental Specialist I	

## Hydrogeological Consortium

The Hydrogeology Consortium is a not-for-profit organization established in 1998. Affiliated with Florida State University, the Consortium mission is to: *“Cooperatively provide scientific knowledge applicable to ground water resource management and protection.”* The Consortium is principally a vehicle for encouraging, facilitating and coordinating cooperative interactions across disciplinary and administrative boundaries. Recognizing a need for more accurate models to predict groundwater flow and groundwater-surface water interactions in multi-porosity karst regions, scientists in the fields of hydrogeology, mathematical modeling, and water resource management and protection formed the Hydrogeology Consortium.

The Consortium's 2004 Board:

Tim Hazlett - President - Hazlett-Kincaid, Inc.  
 Rodney DeHan - Treasurer - Florida Geological Survey  
 Todd Kincaid - Communications Officer - Hazlett-Kincaid, Inc.  
 Gary Maddox - At Large - Florida Dept. of Environmental Protection  
 Angela Chelette - At Large - Northwest Florida Water Management District  
 Rick Copeland - Vice Pres. - Florida Geological Survey

# Aquifer Storage Recovery IV

Tampa, Florida - April 15 -16, 2004

## Presenter and Moderator - Biographical Information

Listings are in program order followed by Poster Paper abstracts and author biographies

### Albert Muniz

#### Hazen & Sawyer, Boca Raton, FL

Mr. Muniz is a civil engineer by education, and a registered professional engineer in the States of Florida and New York. He received his degree from the University of Florida with honors, and has been working in the water/wastewater industry for over 24 years. Mr. Muniz is a Vice President with the environmental engineering firm of Hazen and Sawyer, P.C. Much of Mr. Muniz's experience has been in the water resources arena, especially with aquifer storage and recovery.

Mr. Muniz has worked as project manager for successful ASR systems in Palm Beach, Broward, Miami-Dade, Monroe, Okeechobee and Lee Counties. He was one of the first to develop the raw water ASR concept. Mr. Muniz is Vice Chair of the National AWWA Groundwater Committee. He and Mr. Bloetscher were involved in the development of the National ASR survey for AWWA, and he has written numerous papers on the subject.

### Terry Foreman

#### Senior Hydrogeologist & Vice President CH2M Hill, Thousand Oaks, CA

Terry Foreman's roles at CH2M HILL include Senior Hydrogeologist, Global Technology Leader for Groundwater Resources, Vice President and the Thousand Oaks Area Office Manager. Mr. Foreman's technical expertise is in the management and development of groundwater resources, including water supply development, conjunctive use of surface waters, groundwater, and recycled water, remediation of contaminated groundwater, and regulatory support. Mr. Foreman has over 20 years of consulting experience in water resources projects, mostly in the Southwestern United States. Mr. Foreman has served as project manager for the Las Posas Basin ASR project, the largest ASR project in California, the West Basin Water Recycling Program Injection Barrier Project, which involves injection of highly treated wastewater into the 9-mile long West Coast Basin Seawater Intrusion Barrier, the Dominguez Gap Seawater Intrusion Barrier Extension project. Mr. Foreman has authored over 30 technical papers and presentations.

Mr. Foreman received his Bachelors and Masters degrees in Geology from the University of Missouri – Columbia. He is a Registered Geologist and Certified Hydrogeologist in California. He is on the Board of Directors of the American Ground Water Trust, where he has held offices of Secretary, Vice Chairman, and Chairman (2002). He is the President of the Central Coast Branch of the Groundwater Resources Association of California.

### Pete Kwiatkowski

#### Lead CERP ASR Project Manager, SFWMD, West Palm Beach, FL

Peter J. Kwiatkowski, P.G. has been employed at the South Florida Water Management District (SFWMD) for over five years and is currently a Lead Project Manager in the Water Supply Department. He is the SFWMD's project manager for the Lake Okeechobee ASR Pilot Project and ASR Regional Study associated with the Comprehensive Everglades Restoration Plan (CERP). Prior to working at the SFWMD, he spent 11 years with a consulting firm (CH2M HILL) as project manager and senior hydrogeologist, focusing on ASR projects. He holds a B.S. in Geology from Rensselaer Polytechnic Institute, Troy, N.Y., a M.S. in Hydrogeology from the University of South Florida, Tampa, FL, and has been a professional geologist in the State of Florida since 1992.

### Ron Reese

#### Hydrologist, US Geological Survey, Miami, FL

Ronald Reese received his undergraduate degree in Geological Engineering from the Colorado School of Mines. He worked for several oil companies as a petroleum production geologist for a number of years, but twice returned to school to pursue graduate studies. He obtained a master's degree in Petroleum Geology from the Colorado School of Mines and a second masters in Hydrology from the University of Arizona. He returned to work with the U.S. Geological Survey in 1990 to Miami Florida and been there ever since. His main focus at the USGS has been hydrogeologic mapping of the Floridan aquifer system in southern Florida.

### June Mirecki

#### Hydrogeochemist, US Army Corps of Engineers, Vicksburg, MS

June Mirecki is a research geochemist at the US Army Engineer Research and Development Center, Vicksburg MS. Her area of specialization is ground-water geochemistry and geochemical modeling. Before joining the Corps of Engineers, she was an associate professor at the College of Charleston, SC and a ground water hydrologist with the US Geological Survey. She received her Ph.D. in geology/ geochemistry from the University of Delaware. June was recently appointed as an associate editor for the journal Applied Geochemistry, and is a Registered Professional Geologist in Mississippi.

### Peter Dillon

#### CSIRO, Adelaide, Australia

Peter leads the CSIRO Water Reclamation Research Team that since 1992 has been actively involved in developing ASR with stormwater then reclaimed water in brackish aquifers in South Australia in partnership with water resource managers and water utilities. Their work has aimed at developing knowledge to facilitate appropriate siting, design and operation of ASR facilities to ensure technical and economic viability and aquifer protection. CSIRO (Commonwealth Scientific and Industrial Research Organisation) has therefore focussed its ASR research on subsurface processes that affect clogging, water quality improvement and recovery efficiency, and have developed guidelines for ASR with stormwater and reclaimed water. Peter has assisted Australian state government agencies and consultants in mapping ASR potential, in coordinating ASR research and management, and on novel aspects of investigations for establishing ASR operations. He has also led a recent AWWARF project on water quality improvements during ASR, and is involved in new ASR research projects with AWWARF and Water Reuse Foundation. Peter also coordinates the Australian Water Conservation and Reuse Research Program, a cluster of research projects aimed at making more efficient and expanding sustainable and appropriate integrated use of rainwater, stormwater and reclaimed water along with surface water and groundwater supplies.

Since 2002 Peter has chaired the International Association of Hydrogeologists Commission on Management of Aquifer Recharge, a Commission that was motivated by Ivan Johnson, AIJ Consulting (Denver) (who also played a major role in developing ASCE Standard Methods for Artificial Recharge). IAH-MAR is a group of hydrogeologists who as a professional service volunteer their efforts with the aim to expand water resources and improve water quality in ways that are appropriate, environmentally sustainable, technically viable, economical, and socially desirable. It does this by encouraging

development and adoption of improved practices for management of aquifer recharge. This is being achieved by increasing awareness of MAR among IAH members and the community, by facilitating international exchange of information between members (e.g. via a web page [www.iah.org/recharge](http://www.iah.org/recharge) and an email list), by disseminating results of research and practical experience (e.g. via workshops, training programs, conferences and a reference database), and by undertaking joint projects and activities identified as important by its members (currently including publications on MAR strategies, creating an international inventory of MAR, and collating and reviewing international regulations relating to MAR). (More volunteers welcome!) It has a particular interest in ensuring sustainable recharge enhancement in arid and semi-arid developing countries. This AGWT workshop has obvious synergies with IAH-MAR's objectives and has led to IAH's endorsement of the workshop.

**Jon Arthur**

**Hydrogeology Program Supervisor, Florida Geol. Survey, Tallahassee, FL**

Jon Arthur is a licensed Professional Geologist and graduate of Florida State University, where he received his B.S. with honors and Ph.D. degrees in geology. Dr. Arthur began working at the Florida Geological Survey (FGS) as a staff geologist in 1987. He currently supervises the Florida Department of Environmental Protection – FGS Hydrogeology Program and serves on numerous state and federal committees and work groups involving aquifer research and protection. His numerous research publications focus on hydrogeology and geochemistry, with emphasis on water-rock interaction during aquifer storage and recovery activities, regional hydrogeologic framework mapping, and aquifer vulnerability modeling.

Dr. Arthur's professional memberships include the Geological Society of America, Southeastern Geological Society, International Association of Hydrogeologists and the Hydrogeology Consortium. He is also a member of the Florida Association of Professional Geologists, where he serves as the organization's President. Devoted to environmental stewardship, Jon is also active in geology education and outreach. He is producer of the award-winning video curriculum, Florida's Geology Unearthed, and recently co-produced Florida's Aquifer Adventure.

**John Lisle**

**Microbiologist, US Geological Survey, St Petersburg, FL**

Dr. Lisle earned his Ph.D. from University of South Florida's College of Public Health in 1996. He completed a post-doctoral fellowship in Gordon McFeter's laboratory at Montana State University's Department of Microbiology and held a research professor's appointment in the Microbiology Department and NSF sponsored Center for Biofilm Engineering also at Montana State University. Dr. Lisle was employed by NASA's Astrobiology Institute at Johnson Space Center in Houston, TX where he worked as a microbial ecologist and conducted research in extreme environments, including Antarctica. In 2002 Dr. Lisle starting working with the USGS Center for Coastal and Watershed Research in St. Petersburg, FL, where he is working with federal, state and academic groups on microbial ecology issues associated with water quality and quantity in Florida. His expertise is in the use of non-culture based and molecular techniques to assess the role microorganisms play aquatic systems.

**David John**

**Microbiologist, University of South Florida, Tampa, FL**

David is a native of the desert southwest from Arizona. He received his bachelor's and master's degrees from Northern Arizona University and the University of Arizona respectively, while studying environmental microbiology. He came to Florida in 2000 to pursue a Ph.D. with Joan Rose at the College of Marine Science in the University of South Florida. The subject of his Ph.D. research has been the survival of indicator microorganisms in water and conditions that may be encountered for ASR projects in the state, with a project jointly funded by SWFWMD and SFWMD. He is currently working as a postdoctoral researcher with Dr. John Paul, still at USF's College of Marine Science, and is performing research on the genes involved in carbon fixation of marine phytoplankton.

**Don Thompson**

**Vice President, CDM, Inc., Jacksonville, FL**

Donald M. Thompson is a Vice President with CDM and is located in the Jacksonville Florida office. Dr. Thompson has over 25 years experience in advanced water and wastewater treatment processes including membrane, ultraviolet, and ozone technologies. He currently serves as CDM's Membrane Advocate charged with overseeing CDM's efforts in membrane technology applications. Dr Thompson has previously performed treatment studies for ASR injectate water as well as indirect potable reuse projects. He has BS and MS degrees from the University of Florida and a Ph. D. in Environmental Engineering from the University of Central Florida. Dr. Thompson is also a registered professional engineer in the State of Florida.

**David Moore**

**Executive Director, Southwest Florida Water Management District, Brooksville, FL**

David L. Moore was appointed as the District's Executive Director on March 25, 2003. Mr. Moore has extensive experience in all aspects of Florida water resource management activities. He began his career at the District as a hydrologist in 1984, working his way up through the leadership ranks as a project manager, manager and director. Prior to being named the executive director, he served for 11 years as deputy executive director for the District's Division of Resource Management and Development. Mr. Moore has played a key leadership role for many of the District's critical initiatives during the past decade, including restoration and preservation projects on key water bodies such as Tampa Bay and Sarasota Bay, the completion of a management approach for the Southern Water Use Caution Area, the Peace River cumulative impact assessment, the establishment of minimum flows and levels, a regional reclaimed water plan, a regional water supply plan, revisions to District permitting rules, the comprehensive watershed management initiative, and many other water resource issues.

Among other activities, Mr. Moore has chaired the Sarasota Bay National Estuary Program's Management Committee and served as a member of the Tampa Bay and Charlotte Harbor National Estuary Program Management Committees. He is a board member of Leadership Tampa Bay and the WaterReuse Foundation, a national reclaimed water research group. He is a certified professional geologist with a bachelor's degree in geology from the College of Charleston, S.C., a master's degree in geology from the University of South Florida (USF), and a graduate certificate in public administration, also from USF.



**Walter Schmidt**

**Florida Geological Survey, Tallahassee, FL**

Walter Schmidt has served as the Chief of the Florida Geological Survey (FGS) and as the State Geologist of Florida since 1885. In this position, his administrative responsibilities include oversight of personnel, budget, planning, facilities management, and contract & grants tracking. As Chief of the FGS he also directs the activities of the States Oil & Gas Exploration and Production Permitting activities. Dr. Schmidt received an A.S. in Oceanographic Technology from the Florida Institute of Technology (Melbourne, FL.), a B.A. in Geology from the University of South Florida (Tampa, FL.), and a M.S. and Ph.D. both in Geology from Florida State University in Tallahassee. As State Geologist he has been appointed by the Florida Legislature to the Florida Board of Professional Geologists and the Florida Geographic Information Advisory Committee and he has chaired numerous state and federal advisory committees, boards, commissions, to provide the perspective of solid earth science for environmental planning needs.

Dr. Schmidt has published over 90 reports or maps, and has presented dozens of professional talks to scientific groups, environmental organizations, schools and universities, and lay groups. He is a past President of the Association of American State Geologists and is a Fellow of the Geological Society of America, a Certified Professional Geologist within the American Institute of Professional Geologists, a founding member of the Florida Association of Professional Geologists, a member of the Society for Sedimentary Geology and the Ground Water Protection Council. He is a licensed professional geologist in Florida, Alabama, South Carolina, North Carolina, and Pennsylvania.

**Mark McNeal**

**Hydrogeologic Sciences Manager, CH2M Hill, Tampa, FL**

Mr. McNeal has worked with CH2M HILL's Tampa office for 20 years. He has been actively involved in projects that include deep well injection, ASR wells, monitoring wells, and water supply wells. He has served as a project manager and senior hydrogeologist for reclaimed water ASR, potable water ASR, and raw water ASR projects at more than 20 sites serving a dozen water and wastewater utilities in southwest Florida. He is also actively involved with more than 12 deep injection wells in southwest Florida that dispose of municipal and industrial effluent. His areas of expertise include many aspects of well construction and testing, including permitting, design, construction services, and operation and maintenance. Mr. McNeal obtained a B.S. in Engineering Geology at Brigham Young University in 1984.

**Mark Pearce**

**Vice President, Water Resource Solutions, Cape Coral, FL**

Dr. Pearce graduated from Washington State University with a Ph.D. in Chemical Physics. He received his training in general wellfield technology while a member of the Well Completions and Workover Section at Exxon Production Research Company where he studied formation damage in production and injection wells. Dr. Pearce joined Water Resource Solutions in 1994 to enhance their Aquifer Storage and Recovery technical capabilities. In 1996 he successfully permitted the first partially treated surface water ASR system in the State of Florida at Marco Lakes in Collier County. Since then he has participated in the successful application of ASR in eight different communities with a total of 27 wells. The native groundwater quality in the majority of these systems ranges between 4000 and 7000 mg/l TDS.

**David Pyne**

**President, ASR Systems LLC, Gainesville, FL**

David Pyne is the President of ASR Systems LLC, Gainesville, Florida. He has pioneered development of ASR technology during the past 25 years and has directed or provided technical consultant assistance during development of 32 of the 69 operating ASR wellfields in the United States, including 10 of the 13 ASR wellfields in Florida. He is a civil engineer with extensive national and international experience, and is the author of the only book published on ASR.

**Thomas Missimer**

**Vice President, CDM-Missimer, Fort Myers, FL**

Dr. Missimer has practiced as a hydrogeologist for the past 30 years. He is currently Vice President of Camp, Dresser and McKee, Inc. and their practice leader in ASR and artificial recharge. Dr. Missimer has a BA in geology from Franklin & Marshall College, an MS in geology from the Florida State University, and a Ph.D. in marine geology and geophysics from the University of Miami. He has published 4 books and about 200 technical papers in a variety of specialty fields in the geosciences. He is currently working on several ASR projects in the US and the Middle East.

**Sam Upchurch**

**Vice President, SDII Global, Tampa, FL**

Dr. Upchurch received his bachelor's degree in geology from Vanderbilt and Masters and Doctorate degrees from Northwestern University. He has worked for the Tennessee Division of Geology, U.S. Army Corps of Engineers, Michigan State University, University of South Florida (USF), Environmental Resources Management (ERM), and SDII Global Corporation. As an academic he taught undergraduate and graduate courses in hydrogeology, sedimentology and stratigraphy, geochemistry, and statistics and supervised over 30 graduate students. He served as Chairman of Geology at USF. After leaving USF, he became a Partner and Principal Geologist at ERM, where he worked on karst and ground-water contamination. He currently serves as Vice President and Principal Geologist at SDII. Dr. Upchurch served on the Florida Board of Professional Geologists for eight years and served as Chairman in 1990. He is a member of a number of professional societies, including serving as a Fellow of the Geological Society of America, and he is certified by the American Institute of Hydrology and the American Institute of Professional Geologists. Dr. Upchurch's expertise is in Florida hydrogeology, karst, ground-water chemistry, and statistical applications in geology.

**Charles Pattison**

**Executive Director, 1000 Friends of Florida, Tallahassee, FL**

Charles Pattison has served since 1998 as the Executive Director of 1000 Friends of Florida. Previously, he was the Director for the Division of Resource Planning and Management at the Department of Community Affairs from 1992 to 1998. From 1989 to 1992, he worked as a Field Representative for The Nature Conservancy's Virginia Coast Reserve. Between 1983 and 1989, he opened the DCA Florida Keys Field Office in Key West, served as the Monroe County Planning, Building and Zoning Director, and was the first executive director of the Monroe County Land Authority. He also has also served as a planning director in coastal North Carolina and spent five years with the North Carolina Office of Coastal Management in beach access and coastal permitting work.

A North Carolina native and an Eagle Scout, Mr. Pattison received an undergraduate degree from N.C. State in Raleigh and a Masters in Regional Planning from the University of North Carolina. He spent six years working on coastal development issues in North Carolina before moving back to Florida. A member of the American Institute of Certified Planners, he serves on the Florida Conflict Resolution Consortium Advisory Council, Council for Sustainable Florida, Tallahassee/Leon County BluePrint 2000 Citizen Advisory Committee, and Apalachee Land Conservancy. He is a graduate of Leadership Florida,

Class 18 and has served as a member of the 1998-1999 Transportation and Land Use Study Committee and presently serves on the Steering Committee that is working on the update of the 2020 State Transportation Plan.

**Elliott Grosh,  
Sr. Vice President, PBS & J, Tampa, FL**

Mr. Grosh is a Sr. Vice President of PBS & J and serves as the Division Manager for Environmental Services. He is a 20 year veteran of the firm and District Director of the Tampa office. Mr. Grosh earned a Bachelor of Science and Master of Science Degrees in Environmental Engineering from the University of Florida. He has over 35 years of experience in the Water and Wastewater field in both consulting and utility operations. Mr. Grosh has been involved in ASR system planning and design for several clients in Florida. He is a graduate of the Leadership Florida program in the state.

**Judy Richtar  
UIC Program Manager, Florida DEP, Southwest District, Tampa, FL**

Judy Richtar is program manager of the Florida Department of Environmental Protection's (FDEP) Southwest District Underground Injection Control Program located in Tampa, Florida. She has been with the FDEP for 18 years, the past 14 years regulating injection well projects. Currently 8 of the 10 reclaimed ASR projects in FL have been processed through the Tampa district office. She coordinates an internal FDEP ASR workgroup, and is a member of the technical advisory committee for the Fate of Microorganisms in Aquifers Study sponsored by the Southwest and South Florida water management districts. Ms. Richtar is a licensed professional geologist in Florida.

**Bart Bibler  
Water Programs, Florida Department of Health, Tallahassee, FL**

Mr. Bibler is Chief of the Florida Department of Health's Bureau of Water Programs. He is an Environmental Engineer with primary focus on water quality and water management. He served as Director of Environmental Health and Engineering in Collier County, Florida. He was the Water Management Administrator for the Florida Department of Environmental Protection. And, he previously worked in the private sector, including the Orlando, Florida office of Camp, Dresser & McKee, Inc.

**Don Ellison  
ASR Projects Coordinator, SWFWMD, Brooksville, FL**

Don Ellison is a Senior Professional Geologist at the Southwest Florida Water Management District. Among other duties, he tracks and oversees all ASR projects cooperatively funded by the District. He is also project manager of the Fate of Microorganisms in the Floridan Aquifer Study being performed by the University of South Florida and CH2Mhill. Mr. Ellison received his undergraduate degree in Geology from the University of Cincinnati, Ohio and his Masters Degree in Geology from Boston University. He has been at the District for 10 years and has been involved with most issues associated with ASR projects in the District.

**Pete Mazzella  
Deputy Director of Utilities, City of Boynton Beach, FL**

Peter Mazzella has been employed in the water utilities business for over 18 years, and prior to that he worked for the State of Florida in the wastewater permitting area. He has a Master of Science degree in Environmental Sciences from the University of Massachusetts, in addition to a B.S. in Biology. Mr. Mazzella was very involved in the installation of the first ASR well at Boynton Beach, which has been operating since 1992. That experience has convinced him that ASR can be one of the most useful tools regarding water resource management in Florida.

**Scott Randolph  
Attorney, Legal Environmental Assistance Foundation, Tallahassee, FL**

A 1999 graduate of the University of Georgia School of Law, Scott Randolph is a licensed attorney in Georgia and Florida. After stints with the federal government and private practice in Atlanta, he began working with the Legal Environmental Assistance Foundation in Tallahassee, Florida in February 2002. During his legal career Scott has handled complex litigation ranging from an ERISA class action suit to federal labor disputes to dairy concentrated animal feeding operations to underground injection wells. Now focusing on air and water issues at LEAF, he is involved with litigation in Georgia, Florida and Tennessee. He also is regularly involved in public policy and government reform.

**Cynthia Christen  
Senior Attorney, Florida Dept. of Environmental Protection, Tallahassee, FL**

Ms. Christen graduated from the University of Florida College of Law, and accepted a position with the Department in 1980. For three years, she worked in the Enforcement Section of the Office of General Counsel. Since 1983, she has been a water program attorney specializing in ground water, drinking water, underground injection control, water well construction and contractor licensing, water and wastewater operator certification, and the State Revolving Loans Programs. In addition to her love of geology, Cynthia is an avid marathon runner.

**John Mulliken  
Acting Director, Water Supply Department, SFWMD, West Palm Beach, FL**

The District's mission is to manage and protect water resources by balancing and improving water quality, flood control, natural systems and water supply for a 16-county area. A critical effort is the multi-year, multi-billion dollar state and federal partnership to revitalize the Everglades ecosystem and increase water supplies. John Mulliken is the Acting Director of the Water Supply Department for the South Florida Water Management District. He has been with the SFWMD for 15 years, working on Everglades restoration and water supply issues. From 1996 to 2001, he was the project manager of the SFWMD's Regional Water Supply Plan for Southeast Florida. In 2001 he was named Deputy Director of the Water Supply Department and became the Acting Director last October. He graduated from Washington and Lee University in 1975.

**Andrew Stone**

**Executive Director, American Ground Water Trust, Concord, NH**

Andrew Stone is a hydrogeology graduate from London University and has over twenty-five years of ground water experience in Africa and the U.S. as a professor and ground water consultant. He has first-hand experience of ground water exploration, well design and source protection in a wide variety of geologic environments. As the director of the Trust's education programs he has coordinated ten Trust conferences related to ASR, conjunctive use and water banking. Since 1990, as adjunct professor, he has taught an annual course on *Ground Water Protection Policy* in the Masters Degree Program at Antioch New England Graduate School.

**Richard Roth**

**UIC Program Director, Wisconsin Dept. of Natural Resources, Madison, WI**

Richard Roth is employed as a drinking water and groundwater specialist with the Wisconsin Department of Natural Resources (WDNR). He is assigned to the DNR's Bureau of Drinking Water and Groundwater where he has served as state coordinator for Wisconsin's Underground Injection Control (UIC) program for the past 14 years. Rich holds a master's degree in Water Resources Management from the University of Wisconsin – Madison.

**Bill McLemore**

**State Geologist, Georgia Geological Survey, Atlanta, GA**

Dr. William H. McLemore, State Geologist of Georgia has over forty years of experience in solving geological problems and managing large multidisciplinary projects. As State Geologist, he manages the Geologic Survey Branch of Georgia's Environmental Protection Division. The Survey performs comprehensive technical investigations of Georgia's earth, water, and mineral resources as well as coordinates the State of Georgia's ground-water management activities. The Survey also regulates oil and gas activities, water-well construction, and underground injection within the state.

Before coming to the Georgia Geologic Survey, he gained extensive experience with the firm of Dames & Moore in Cranford, New Jersey. While with Dames & Moore, Dr. McLemore served as principal investigator or project manager on a wide variety of complex geological studies. Included among these were nuclear and coal-fired power plant site selection and geotechnical studies, underground gas storage investigations, mineral investigations, environmental impact assessments, and numerous ground-water protection plans. Prior to joining Dames & Moore, he was employed as an economic geologist by the U.S. Forest Service and as a petroleum geologist by the Pan American Petroleum Corporation. Dr. McLemore is a native of Atlanta, Georgia and holds a Ph.D. degree in Geology from the University of Georgia.

**John Taylor**

**Senior Environmental Engineer, US EPA, Region V, Chicago, IL**

John Taylor received his B.S. in Civil Engineering from the Illinois Institute of Technology and has worked in the drinking water, wastewater and ground water fields for the past 34 years, 31 of them with the US Environmental Protection Agency. He is a registered professional engineer and has held a number of leadership positions in the Chicago and Atlanta offices of EPA, including Construction Grants Program Manager for the State of South Carolina and Oversight Chief for the Region 5 UIC Program. He currently serves a senior technical advisor to the Region 5 UIC Program, focusing on Class V wells, state oversight and tribes.

Mr. Taylor has been very active in national activities, including serving as the Regional Co-Chair of the State and Federal Affairs Committee of the Ground Water Protection Council for the past 10 years, as well as UIC representative to the Native American Water Association for the past 8 years. He has also served as the Region 5 representative on EPA's National Class V Workgroup for the past 8 years and played a major role in the development of the Class V Rule, which covers large capacity cesspools and motor vehicle waste disposal wells. He has also been quite active in the Class V Phase 2 focus on additional well types, including aquifer storage and recovery (ASR). He has assisted the Wisconsin DNR in their evaluation of ASR sites in Green Bay and Oak Creek, Wisconsin, and he led the development of criteria for ASR projects in the direct implementation state of Minnesota.

**POSTER PAPER PRESENTERS**

**Al Aikens, CH2M HILL**

Mr. Aikens earned a B.A. in Geology from Thiel College, Greenville, PA in 1980 and an M.S. in Hydrology and Water Resources from the University of Arizona, Tucson, AZ in 1986. He has been employed with CH2M HILL from January 1986 to the present serving as a project hydrogeologist and a project manager on water resource planning and development projects, and contaminated site investigation and clean-up projects.

Mr. Aikens is the project manager and principal investigator in the SJRWMD Central Florida Aquifer Recharge Enhancement Program – Phase I, Artificial Recharge Well Demonstration Project that is the topic of the poster session. The purpose of the project is to measure and evaluate groundwater quality for microbial and chemical changes that result from long-term operation of stormwater recharge wells in Central Florida, identify if supplemental treatment would be beneficial, and measure groundwater quality changes if treatment is implemented.

**Thomas L. Dobecki, SDII Global Corporation**

Thomas L. Dobecki is Principal Geologist with SDII Global Corporation of Tampa, Florida. This follows an extensive career in engineering and environmental geophysics including employment with Sandia National Laboratory, several international engineering firms, as well as the geophysics faculty at the Colorado School of Mines. Dr. Dobecki is currently President-elect of the Near Surface Geophysics Section of the Society of Exploration Geophysicists (SEG). He is a Professional Geophysicist/Geologist licensed in Florida, Texas, and Tennessee. He has recently completed a FDEP/FGS funded study using electrical methods to map the boundary between fresh and saline waters at various depths around Central Florida.

**William C. Hutchings, HSA Engineers & Scientists**

William C. Hutchings, M.S., P.G. is a Hydrogeologist with HSA Engineers & Scientists. He obtained B.S. (1981) and M.S. (1986) degrees in Geology from the University of Florida. He subsequently attended the University of South Florida (USF) and received a Graduate Certificate in Advanced Studies in Hydrogeology in 1992. He is currently pursuing a M.S. degree in Hydrogeology at USF with thesis research in the effects of aquifer heterogeneities and variable density on aquifer storage and recovery systems. His interests are in numerical modeling of groundwater recovery systems, contaminant transport, and seawater intrusion.

**Gregg Jones, Southwest Florida Water Management District**

Gregg Jones has been with the Southwest Florida Water Management District since 1986, first as manager of the Water Quality Monitoring Program and later as director of the Resource Conservation and Development Department. The main function of this department is water supply development, minimum flows and levels establishment, and resource assessment.

Mr. Jones has a B.S. in geology from Florida Atlantic University, an M.S. in geology from the University of South Florida, and is currently working on his Ph.D. in geology at the University of South Florida.

**Eberhard Roeder, Florida Department of Health**

Eberhard Roeder recently took a position as Environmental Health Program Consultant with the Bureau of Onsite Sewage Programs in the Florida Department of Health after holding postdoctoral positions related to groundwater modeling and hydrogeology in Finland, South Carolina and Florida. His research interests are in the area of subsurface transport processes, now with particular emphasis on septic tanks. He received a Diplom in Civil Engineering from the Technical University of Braunschweig (Germany) and graduated in 1998 with a Ph.D. in Environmental Systems Engineering from Clemson University.

**Catherine J. "Cat" Shrier, Golder Associates, Inc.**

Catherine J. "Cat" Shrier is a Senior Water Resources Engineer with Golder Associates, Inc. in Denver Colorado. Her professional experience primarily involves conjunctive management of water resources and water policy. She completed a nationwide survey and analysis of ASR practice and regulations for the American Water Works Association in 2001, and began the North Carolina Division of Water Resources review of regulations pertaining to that states first ASR project in 1998. Dr. Shrier holds a Ph.D. in Civil Engineering (Colorado State University), masters degree in Environmental Sciences and Engineering (UNC-Chapel Hill), and bachelors degrees in Government (Dartmouth) and Geology (NCSSU).

**Michael Sukop, Florida International University**

Michael Sukop, Ph.D., R.G., C.Hg., is a professor in the Department of Earth Sciences at Florida International University. His current research is focused on applications of lattice Boltzmann modeling in hydrogeology – particularly karst, solute transport, and density-driven flows. He teaches field methods in hydrogeology and ground water, solute transport, and lattice Boltzmann modeling. Dr. Sukop worked in traditional ground water modeling for 8 years as a hydrogeologist with CH2M Hill in Redding, California. He has extensive experience including: injection well solute transport and related aquifer chemical reactions; large-scale planning, field testing, and solute transport modeling associated with Arizona’s largest recharge project; large water reclamation and water resources projects in California, Oregon, and Nevada; and numerous Superfund, Department of Defense, and private soil and ground water contamination sites.

**POSTER PAPER ABSTRACTS**

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**EFFECTS ON FLORIDAN AQUIFER WATER QUALITY IN EAST-CENTRAL FLORIDA FROM LONG-TERM STORMWATER RECHARGE THROUGH WELLS - A PROGRESS REPORT**

**Alan W. Aikens, CH2M Hill, 225 E. Robinson St., STE 505, Orlando, FL 32803**

Management of stormwater through recharge wells is a practice in the Orlando, Florida area that has been employed and effective since the early 1900’s. Nearly 500 recharge wells were recently inventoried in Central Florida. The wells divert an estimated average of 30 to 50 million gallons per day of stormwater to the Upper Floridan aquifer. The wells are of two types: direct urban runoff wells and lake-level control wells. The St. Johns River Water Management District is sponsoring a program, with local cooperators, to quantify changes to chemical and microbial quality of groundwater resulting from this practice. This is applicable to proposed aquifer storage and recovery (ASR) applications of surface water in the Floridan aquifer in that these recharge systems have been in place and operating in the Orlando area for 50 to 100 years. Monitoring these systems will provide valuable insight to the potential success of applying ASR to surface water management techniques.

The on-going project is at two sites, one for each type of recharge well system: Festival Park in Orlando – direct urban runoff, and Lake Orienta in Altamonte Springs – lake-level control. The project has six phases: dry-period characterization (corresponding with a prolonged drought during the late 1990’s), baseline characterization, groundwater tracer test, operational characterization, enhanced treatment evaluation and possible implementation, enhanced treatment effectiveness evaluation. Water flowing into the recharge wells and groundwater from monitoring wells is sampled for an extensive list of inorganic and organic chemical parameters and selected microbes (bacteria, protozoa, and a virus).

This paper presents a progress report of the current results of the program. To date, completed activities at Festival Park are the groundwater tracer test, baseline sampling, and four of the six operational characterization samplings. Results for Festival Park indicate connection between a recharge well and two monitoring wells indicate rapid groundwater transport between these wells, indicate 3 to 4 orders-of-magnitude reduction of coliform concentrations from the recharge well to the monitoring wells. This reduction occurs over distance of 250 to 450 feet and a duration as short as two weeks. Very few detections of organic chemicals with no concentration greater than Maximum Contaminant Levels were encountered. The inorganic chemical data indicate a shift in the character of the groundwater from the stormwater recharge. The potential for mobilizing arsenic and other trace elements from the aquifer matrix is present. Site activities at Lake Orienta began January 2004 with the installation of the four monitoring wells. Baseline sampling and a groundwater tracer test are scheduled for the summer of 2004. Operational characterization sampling is scheduled from fall 2004 through spring 2005.

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**GEOPHYSICS AS AN INTEGRAL PART OF THE AQUIFER STORAGE AND RECOVERY PROCESS**

**Thomas L. Dobecki (1) and Jennifer L. Hare (2)**

- 1 - SDII Global Corporation, 4509 George Road, Tampa, FL 33634**
- 2 - Zonge Engineering & Research, 3322 E. Ft. Lowell Rd. Tucson, AZ 85716**

Aquifer storage and recovery (ASR) has very many basic similarities, unknowns, and needs as compared with a variety of in situ processes that have been investigated in the past. These include, among others, pumped storage, secondary and tertiary petroleum recovery (hydraulic fracturing, CO<sub>2</sub> flooding, brine flooding), and in situ combustion processes (coal gasification, oil shale retorting). A central concern to each of these as well as ASR is an accurate depiction of how/where the process develops (process monitoring). Geophysical surveying techniques, principally methods relying on the electrical resistivity contrast between native and stored waters, are viewed as the most probable means for mapping the shape and progress/growth of injected water during ASR activities. Model studies are presented using typical ASR depths, formation (ambient) water and injected water resistivities, which indicate that electrical resistivity-based surveys (e.g., controlled source audio magnetotelluric profiling [CSAMT] and transient electromagnetic sounding [TEM]) have the potential to track growth and shape of the ASR injected waters.

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**THE EFFECTS OF HETEROGENEITY OF THE UPPER FLORIDAN AQUIFER ON ASR SYSTEMS**

**Bill Hutchings (1), Vacher, H.Len (2), and Budd, David (3)**

- 1 - HSA Engineers & Scientists, 4019 East Fowler Avenue, Tampa, FL 33617**
- 2 - Geology Department, University of South Florida, 4202 E. Fowler Ave., Tampa, FL 33620**
- 3 - Department of Geological Sciences, University of Colorado, Campus Box 250, Boulder, CO 80309-0250**

The matrix permeabilities of approximately 1200 meters (m) of the Upper Floridan aquifer (UFA) in the southern SWFWMD area were measured from cores in eight wells with a minipermeameter at one-foot intervals and classified by depositional texture. A wide range of lithologies ranging from permeable grainstones to low-permeability high-mud packstones are present. The bulk of the intrinsic transmissivity is contributed from the grainstones and dolostones, although they represent a minor percentage of the thickness of the aquifer.

We selected a 200-foot interval from the Suwannee Limestone as a representative section to study the effects of bed-scale, layered heterogeneity on a theoretical Aquifer Storage and Recovery (ASR) well. The wide range of permeabilities at the core scale was modeled with a highly discretized (200-layer), three-dimensional flow (MODFLOW) and solute-transport (MT3D) model to ascertain the distribution, storage, and recovery of injected water. The models reveal that units of high permeability facilitate the depth of penetration of injected water into the aquifer. The domain of injected water is not at all like a bubble, but instead much like a bottle brush. Taking into account the effects of buoyancy, which we did not do in this study here, one can easily picture the inverted Christmas tree proposed by Missimer and associates for the geometry of the invaded domain.

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**THE RELATIONSHIP BETWEEN PYRITE STABILITY AND ARSENIC MOBILITY DURING AQUIFER STORAGE AND RECOVERY IN SOUTHWEST CENTRAL FLORIDA**

**Gregg Jones (1) and Thomas Pichler (2)**

- 1 - Southwest Florida Water Management District, 2379 Broad St. Brooksville Fl, 34609**
- 2- University of South Florida Geology Department 4202 East Fowler Ave SCA 532 Tampa, Fl 36620**

Elevated levels of arsenic are common in water recovered from aquifer storage and recovery (ASR) systems that store oxygenated surface water in southwest central Florida. Mineralogical investigations of the Suwannee Limestone, the preferred storage zone for ASR systems, have shown that the highest concentrations of arsenic are associated with framboidal pyrite in zones of high moldic porosity.

This investigation employed geochemical modeling to examine the stability of pyrite in limestone during simulated injections of oxygenated surface water. Injections were simulated for 20 wells with intervals in the Suwannee Limestone with known chemical composition. The goal was to determine if aquifer redox conditions could be altered to the degree of pyrite instability. Increasing amounts of injection water were added to the formation water in a series of steps and the resulting reaction paths were plotted on pyrite stability diagrams. The pre-mixing formation water in the wells plotted within the pyrite stability field indicating that redox conditions were sufficiently reducing to allow for pyrite stability. Since arsenic is immobilized in pyrite, its concentration in the formation water should be low. This was corroborated by actual analysis of arsenic in water samples; none of the 20 wells sampled had concentrations above 0.1 µg/l. During simulation, however, as the ratio of injection water to formation water increased, redox conditions became less reducing and pyrite became unstable. As a result, arsenic would be released from the aquifer matrix. The simulation also showed that the ratio of injection water to formation water necessary to cause pyrite instability was highly variable and seemed to be controlled by the chemical composition of the formation water.

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**ARSENIC AND AQUIFER STORAGE AND RECOVERY IN SOUTHWEST FLORIDA: SOURCE, ABUNDANCE, AND MOBILIZATION MECHANISM, SUWANNEE LIMESTONE, UPPER FLORIDAN AQUIFER**

**Roy E. Price and Thomas Pichler, University of South Florida Geology Department 4202 East Fowler Ave SCA 532 Tampa, FL 36620**

Recent analyses of recovered water from two aquifer storage and recovery (ASR) facilities in west-central Florida showed arsenic concentrations in excess of 100 µg/L, more than 10-times the current EPA drinking water standard. Detailed mineralogical and chemical analyses of the Suwannee Limestone, the primary storage zone for ASR in west-central Florida, indicates that, while arsenic is ubiquitous throughout the Suwannee Limestone, it is highly concentrated in framboidal pyrite. Elevated levels of arsenic in pyrite were documented by scanning electron microscope and electron probe microanalysis with energy dispersive and wavelength dispersive x-ray capabilities, respectively, showing greater than 1000 ppm arsenic. The pyrite containing the arsenic is normally stable in the reducing environment of the aquifer, but the artificial recharge of oxidized surface water during ASR changes the redox conditions and is believed to cause the framboidal pyrite to become unstable, thus releasing the arsenic.

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**AQUIFER STORAGE AND RECOVERY - EXPERIMENTS IN THE LOWER HAWTHORN GROUP AQUIFER, LEE COUNTY: PREVIOUS SIMULATIONS AND ILLUSTRATION OF A DUAL-POROSITY APPROACH**

**Eberhard Roeder, 6854 Hanging Vine Way, Tallahassee, FL 32317**

High recovery efficiency of aquifer storage and recovery (ASR) systems requires that the injected water interacts little with ground water in place. The existence of preferential flow paths influences the extent of interaction between injected and resident water and thus can be expected to affect recovery efficiency. Most past numerical models of ASR in Florida have considered preferential flow paths in the storage zone indirectly, by using a calibrated low value for effective porosity, or as explanation for residual error. An alternative, the dual-porosity approach, divides aquifer porosity into a mobile fraction wherein advective transport occurs and another stagnant or immobile fraction in which concentrations change in response to diffusive mass transfer from the mobile fraction.

In this modeling study, I revisit the injection, storage and recovery experiments in the Lower Hawthorn Aquifer in Lee County described by Fitzpatrick (1986) and illustrate differences between single and dual-porosity approaches. Quiñones-Aponte and Wexler (1995) previously simulated these experiments using a single-porosity approach with a version of SUTRA. The simulator used in this study to represent the density-dependent transport of Chloride in single and dual-porosity aquifers is a slightly modified version of the compositional FDM simulator UTCHEM.

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**GUIDELINES FOR AQUIFER STORAGE AND RECOVERY REGULATION IN THE UNITED STATES**

**Catherine Shrier, Senior Water Resources Engineer, Golder Associates Inc., 44 Union Boulevard, Suite 300, Colorado 80228**

Regulatory concerns and state and federal regulatory practices have been among the most pressing issues impacting the development of aquifer storage and recovery (ASR) facilities in the United States. With at least 26 states having developed or investigated the development of ASR facilities, a wide range of regulatory issues have been raised by state, federal, and some local or regional agencies. Issues have included the regulation of recharge and storage practices, primarily to protect groundwater aquifers; recovery, treatment, and use of stored water, particularly for potable uses; and water rights or other water resources management laws and programs. With multiple agencies involved in ASR regulation, several states have also investigated or implemented regulations to streamline the permitting process. This paper reviews the major regulatory issues that have been considered in 20 states with operating or pilot ASR facilities, as well as federal regulatory issues pertaining to ASR. This paper also highlights issues for regulatory agencies and water managers to consider for future ASR facility development.

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**LATTICE BOLTZMANN MODELING FOR AQUIFER STORAGE AND RECOVERY SYSTEMS**

**Mike Sukop and Danny Thorne, Florida International University, Dept. of Earth Sciences, PC 344, 11200 SW 8th Street, Miami, FL 33199**

Lattice Boltzmann models of fluid flow and solute transport readily handle several well-known and important challenges that limit the ability of Darcy's law-based models to accurately simulate flows and solute transport in aquifer storage and recovery (ASR) systems. In particular, we simulate flows in any complex cave/conduit/pore spaces over a broad range of Reynolds numbers leading to complex flow phenomena such as vortex streets that have never been incorporated into ground water models but undoubtedly play a significant role in solute transport and the recovery of stored water – especially in karstic aquifers. The principal strengths of lattice Boltzmann methods in these areas are the ease of incorporating the details of complex geometry and the direct computation of Navier-Stokes flow solutions in the complex space. Solute transport is intimately coupled to the flows so that eddy diffusion, for example, becomes an integral part of the transport process. Concentration-dependent density-driven flow is important in ASR systems and is a highly non-linear process that has proven difficult to solve with standard finite element and finite difference approaches; lattice Boltzmann methods are at least as good as the most advanced standard approaches and have numerical advantages that could make them far superior for these problems.