

THE ARIZONA HYDROLOGICAL SOCIETY NEWSLETTER



OFFICIALS CONSIDER THIRD INTAKE FOR LAKE MEAD

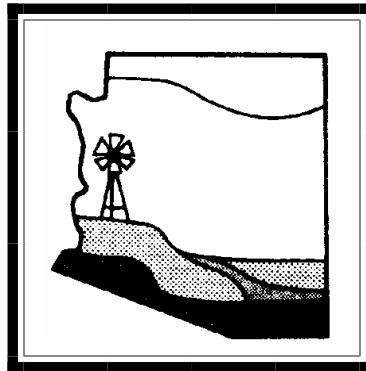
-by Dan Kulin
Staff writer, *Las Vegas Sun*

This article originally appeared in the September 28, 2004, edition of the Las Vegas Sun. It is reprinted with permission. LKB

Southern Nevada Water Authority officials are considering spending tens of millions of dollars on a third intake pipe to draw water from Lake Mead. A third pipe, which would be deeper than the existing two, might be needed to ensure access to drinking water if the lake level continues dropping, officials said.

Water officials said Monday it is too early in the evaluation of a third intake to say how much it could cost or when it would be built. The second intake, which became operational in 2002, cost \$80 million and took two years to construct, water authority spokesman Vince Alberta said.

Water authority board Chairwoman Amanda Cyphers, who is also a Henderson councilwoman, and board Vice Chairman Rory Reid, also a Clark County commissioner, both supported continued study of a third intake for the drought-stricken lake, which provides about 90 percent of the water used in the Las Vegas Valley. The two said they needed more information before deciding whether to support a third intake.



"As the lake level starts to decline, the quality of the water starts to decline," Cyphers said. "The clarity is better at lower levels, and we need to find solutions."

The third intake proposal is "an idea that's being thought through," she said. "It's better to be prepared than to be caught short."

The water authority is the water wholesaler for Las Vegas, Clark County, Henderson, North Las

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2004 AHS SYMPOSIUM WRAP UP

by Gary Burchard
2004 Symposium Planning Co-Chair
Metro Water District

The Tucson Chapter hosted the Arizona Hydrological Society's 17th Annual Symposium on September 15 —18 at the newly-remodeled Radisson Hotel City Center. By all accounts, AHS' 2004 Annual Symposium was a complete success. The AHS 2004 Symposium Planning Committee thanks all the attendees, presenters, sponsors, and exhibitors for making the Symposium such an enjoyable event.

The Symposium officially started with an all-day workshop entitled "Aquifer Test Analysis Featuring AQTESOLV™" presented by Glenn Duffield. Originally scheduled for the 2001 Sympo-

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THIRD INTAKE CONTINUED FROM PAGE 1

Vegas and Boulder City, and it is led by a board comprising elected officials from those local governments.

Reid said the water authority at least needs to study the issue because the continued emptying of the lake creates efficiency and water quality problems for the existing intakes.

"We need to move forward with the study," he said.

During a Monday meeting with a citizens advisory committee looking at future water sources, water authority Director of Engineering Marc Jensen said the water authority will need a new intake to continue drawing as much water as it currently does from the lake. A new intake would essentially replace the first intake, which he said would eventually become inoperable if the water level continues falling.

The first intake, built in 1971, took in water at 1,050 feet above sea level until July, when an extension was completed that brought the opening of that intake down to 1,000 feet above sea level. The second intake also draws from 1,000 feet.

But even with the extension, the first intake wouldn't work if the lake level dropped below 1,050 feet, Jensen said. This is because the pumps the intake is connected to would not work once above the water level.

The water level in Lake Mead is now about 1,126 feet above sea level and has dropped about 90 feet during the past five years.

The third intake would be placed deeper than both of the existing

intakes. In addition to simply being able to get the water out of the lake, a deeper intake would also draw higher quality water from the lake.

Roughly the top 50 feet of water in the lake is in what's called a thermocline, or layer of water that is warmer, thanks to the sun, and home to higher concentrations of pollutants and algae. As the lake level drops, the thermocline comes closer to the existing intakes.

Water authority Deputy General Manager Kay Brothers said the staff will probably have cost estimates, a time line and location for a possible third intake prepared by early next year.

Alberta said the matter could go to the water authority board for a formal presentation soon thereafter. ☐



SYMPOSIUM WRAP UP CONTINUED FROM PAGE 1

sium and delayed due to the events of 9/11, Glenn provided many valuable tips and tricks for computerized aquifer test analyses.

Wednesday continued with the "Application of Isotopes to Common Hydrologic Problems" workshop presented by Chris Eastoe, Brenda Ekwurzel, and James Hoban of, and hosted by, the University of Arizona. In the afternoon, Suzanne Pfister (BJ Communications) presented the well-attended "The Risky Business of Communicating Environmental Information to the Public." Wednesday evening, we were able to renew old friendships and make new ones at an ice breaker at the La Placita Village next to the hotel and to the sounds of a local high-school steel band.

The theme of the 17th Symposium was "The Value of Water." The main Symposium began when two very distinguished presenters opened Thursday morning with the plenary session. Dr. Gary Wolff of the Pacific Institute enlightened us with "Valuing Water for Better Governance;" Dr. Janie Chermak (University of New Mexico) presented an economic perspective of "The Potential Role of Water Markets in the West."

We thoroughly enjoyed geologist and mystery writer Sarah Andrews explanation of the connections between "Murder, Science, and Public Policy." Ms. Andrews exhorted us scientists to not hide behind our science but to apply our expertise to the public process as well.

Our technical sessions (both spoken and poster) on Thursday and Friday (September 16 and 17) included a variety of topics: Recharge, Remedial Investigations, Value and Price Trends for Water in Arizona, Arid Basin Hydrogeology, Drought Conditions and Management, Post-Fire Hydrology, Modeling, Value of Water in the Southwest, Regulatory Matters, Water Management Planning, Hydrologic Impacts of Land Cover Changes, and Emerging Contaminants. We also had a session dedicated as a mini-workshop for students (Careers in Hydrogeology). Many high-quality posters and sponsors' and exhibitors' booths were available for viewing all day, both days.

The annual AHS general membership meeting on Thursday evening was very well attended. With much lively discussion, AHS members delved into much-needed changes to our


**SYMPOSIUM WRAP UP
CONTINUED FROM PAGE 2**

accounting practices and extension of our non-profit status. Dinner Thursday evening, held at the Z Mansion, was quite the party with a Cajun-food buffet, a magician, hurricanes, and a great band.

An all-day workshop for teachers on Water Education was held on Friday, courtesy of Kerry Schwartz and Gail Cordy. The teachers' workshop included both classroom exercises and a panel discussion that updated the teachers on local water issues. Equally important, the workshop introduced water professionals to the teaching arena where they could potentially help with teaching water-related topics to local students. Look for AHS to build on this experience to further our water-education goals.

Lunch on Friday featured AHS's annual awards presentations. AHS honored three college students with scholarships and acknowledged each chapter's current interns. The highlight of the presentations was the announcing of the Lifetime Achievement Awardee, Gary Small. Finally, the Friday lunch crowd was entertained by political cartoonist Fitzsimmons' unique view of Arizona's water issues.

On Saturday, the Symposium hosted two well-attended field trips: one trip traveled both above and within Kartchner Caverns, and the other visited the Upper Cienega Basin and southern Arizona's wine country.

As is our tradition, the Symposium planners believed that the 2004 Symposium should make

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**TIME TO RENEW
YOUR AHS
MEMBERSHIPS**

-by Leilani Bew
Errol L. Montgomery & Associates, Inc.

Well folks, the time is once again approaching for all AHS members to renew their vows of commitment to our fine organization. The way to do that is with your dollars. AHS dues cover any given calendar year, so, it is time for everyone to re-up—almost everyone.

There are three categories of members who do not have to send in their dues for 2005. The first is the elite group of lifetime achievement award winners—you know who you are! If I accidentally send you a reminder, please remind me that you are a member for life. The second group of lucky folks are those who paid registration fees (either one or two days) for the 2004 Annual Symposium; your dues for 2005 were included in your fees. Finally, for those of you who joined AHS during the months of October, November, or December of 2004, you will be current through December 2005.

Everyone else needs to send me a check to continue uninterrupted newsletter delivery. The fee for regular membership is \$40.00 for the calendar year; student rate is \$15.00 with a valid student ID. We are all about to get really busy, so take time now to write out that check (contact information on the bottom of page 4) or visit the AHS website to take care of business.

We truly appreciate the support of each and every one of you. Thanks! ☺


**15-FOOT
HYPODERMIC
NEEDLES PROVIDE
EVIDENCE FOR
VAST OCEANIC
CRUSTAL
BIOSPHERE**

The following is a University of Washington press release from March 18, 2003. It can be found at: http://www.eurekalert.org/pub_releases/2003-03/uow-1hn031703.php. LKB

Teeming with heat-loving microbes, samples of fluid drawn from the crustal rocks that make up most of the Earth's seafloor are providing the best evidence yet to support the controversial assertion that life is widespread within oceanic crust, according to H. Paul Johnson, a University of Washington oceanographer. Johnson is lead author of a report being published March 25 [2003] in the American Geophysical Union's publication *Eos* about a National Science Foundation-funded expedition he led last summer.

Fifteen-foot-long hypodermic needles – strong enough to penetrate the volcanic rocks that make up the Earth's crust – were among the novel devices used to collect samples from sites on the Juan de Fuca plate 200 miles off the coast of Washington and Oregon.

Scientists have known for 20 years of microorganisms that thrive in the acidic iron-, sulfur- and heavy-metal-rich fluid environments in areas where seafloor is being created at mid-ocean ridge spreading centers. These areas are subject to frequent volcanic eruptions and can have fields of hydrothermal vents that pour superheated water as hot as 750° F into the

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CHAPTER NEWS



FLAGSTAFF

-by Nancy Riccio
Plateau TechComm / Plateau
MediaWorks

OCTOBER MEETING

Due to an illness in his family, the previously scheduled presentation by Dr. Allen Shapiro has been postponed until further notice.

NOVEMBER MEETINGS

Thursday, November 18, 2004

Time: 4:00 PM

**Location: NAU Geology Bldg.
Room 203**

There will be a talk at NAU on November 18 in Room 203 of the Geology Building. Linah Ababneh from the University of Arizona will be addressing wet and dry climate periods as predicted from strip-bark bristlecone pines in the Great Basin. Additional details will be announced via email and posted on the AHS website.

Our next symposium planning meeting will tentatively be held on November 4 (or thereabouts) at the Weatherford Hotel, starting at 5:30. Details will be announced via email and posted on the AHS website. We encourage anyone who's interested in helping out with the 2005 Symposium to attend.

RECAP OF SYMPOSIUM PLANNING MEETING

About a dozen Flagstaff Chapter members met on October 14 to

begin planning for the 2005 symposium. The new Symposium Committee discussed possible venues, themes, and formats, and appointed volunteers for most of the subcommittees. We're currently soliciting input from chapter members on a theme and speakers; please forward your ideas to Richard Brose at rjbrose@fourcornersenv.com.



PHOENIX

-by Lee-Anna Walker
Archaeological Consulting Services, Ltd.

OCTOBER MEETING SUMMARY

Dr. Joost de Jong with the Royal Netherlands Meteorological Institute presented his paper "Challenges of Climate Change for Water Management in the Netherlands" to the Phoenix Chapter on October 12.

The Netherlands is a small country located in northwestern Europe along the North Sea. The lowest part of the country lies 7 meters below mean sea level and the highest regions reach 320 meters above mean sea level, with 65 percent of the country prone to flooding. To help fend off floodwaters, dikes and pumping stations provide protection during high sea and high river levels. Approximately 11 million people are currently living in the floodplain, creating a need for a well-developed water management plan.

While a water management plan may help with current issues, the plans should incorporate predicted climatic trends for fu-

ture generations. It is widely known that the industrialization boom of the 20th century has been linked to global climate changes, primarily due to the production of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) found that the average global temperature has increased by 0.6°C, which may be linked to higher frequencies of natural disasters occurring worldwide. Scientists have also been monitoring the rate at which glaciers are melting and sea levels rising as a result of the increasing temperatures. Rising sea levels will have dramatic impacts on flooding and water quality issues in the Netherlands. As a result of the 1993 and 1995 floods, the government decided to expand major river channel widths to increase the discharge capacities to the sea. Pumping capacities have been doubled, and dikes and floodplains adjusted in an attempt to minimize water and erosion damage in the sensitive areas of the country.

However, climatic changes are not restricted to just the Netherlands. It is becoming evident to the countries bordering the Netherlands that international cooperation is vital to the success of developing an effective water management plan on a regional level. Climate change is a global issue and even conservative predictions show that the temperatures will continue to escalate well into the foreseeable future.

The Phoenix Chapter would like to thank our speaker for an interesting presentation.

2005 MEMBERSHIP DUES

Dues, payable to AHS (\$40.00, \$15.00 for students) should be sent to:
Leilani Bew, AHS Newsletter Editor, Errol L. Montgomery & Associates, Inc.
1550 East Prince Road, Tucson, Arizona 85719 Phone: (520) 881-4912

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CHAPTER NEWS



PHOENIX NEWS
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NOVEMBER MEETING

Tuesday, November 9, 2004

Time:

5:30 PM Social Hour

6:30 PM Dinner

7:15 PM Presentation

Location:

**Macayo's Depot Cantina
300 S. Ash, Tempe**

Topic: "A Unique Technique for Rehabilitating a Poorly Producing Well" presented by Basil J. Boyd Jr., R.G., Water Resources Hydrologist, City of Tempe and Marvin F. Glotfelty, R.G., Principal Hydrogeologist, Clear Creek Associates

**Cost: \$12 members, \$17 non-members, \$5 students
Please RSVP by Friday, November 5 to Beth Proffitt by phone at (602) 437-0330 or by email at:
eproffitt@transgeo.com.**

Abstract: In May 2003, the City of Tempe completed a new production well. During the initial pumping test this well produced only about 150 gallons per minute (gpm). This was surprising, since a similarly constructed well only 1,700 feet away produces about 2,500 gpm. The City tried a unique rehabilitation method and eventually managed to increase the production to 2,000 gpm. Our experience with this well was quite instructive in terms of hydrogeologic variability between wells, well design alternatives, well devel-

opment techniques, and rehabilitation alternatives. This presentation will include our theory (or theories) as to what may have caused this well to have such poor initial groundwater production, and a description of the well rehabilitation procedure. This is intended to be an open "lessons learned" discussion, and the audience is encouraged to contribute to the discussion with their own stories of well rehabilitation.

LOOKING AHEAD...

In December, Mark Raming of SWCA will present "Do we need to learn to live with drought?"

The 2005 Annual Kickoff Meeting will be held in January at a location to be announced.

Dr. Phil Christensen with ASU will be discussing the Mars program in March.

February, April, and beyond are open for presentations. Please contact a Phoenix Chapter officer if you are interested in sharing your work and ideas. ☐



TUCSON

-by Anne Kramer-Huth
UofA, Hydrology & Water Resources

OCTOBER MEETING

The Tucson Chapter was eagerly anticipating Dr. Allen Shapiro's presentation at our October dinner meeting. However, due to an illness in his family and his inability to travel right now, his visit has been postponed until further notice. We assured Dr. Shapiro that we

sympathize with him and understand his circumstances and would welcome him back any time. We are considering re-scheduling this event sometime in the next year, but do not have any firm plans for this yet.

NOVEMBER MEETING

Tuesday, November 9, 2004

Time:

7:00 PM Social Half Hour

7:30 PM Presentation

Location:

**Water Resources
Research Center
350 S. Campbell Ave.**

Topic: "An Overview of Project WET" presented by Kerry Schwartz, Project Wet Coordinator, Water Resources Research Center

Project Wet Coordinator Kerry Schwartz will be talking about Project WET (Water Education for Teachers). Project WET is a nonprofit water education program and publisher for educators and young people ages 5-18. The program facilitates and promotes awareness, appreciation, knowledge, and stewardship of water resources through the dissemination of classroom-ready teaching aids and the establishment of internationally sponsored Project WET programs. Kerry will also discuss the workshop that was held at the 2004 Annual Symposium to integrate scientists and science teachers.

LOOKING AHEAD...

Our last meeting for 2004 will be

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**TUCSON NEWS
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held on December 14. At the time of printing, details were still being finalized. Watch next month's newsletter for more information.


**CRUSTAL BIOSPHERE
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oceans.

As visually spectacular as such areas can be, they represent only a tiny area of the seafloor. Far more of the seafloor is tens of millions of years old.

"The types of seafloor environments we sampled last summer are found everywhere in the ocean. This argues, although it doesn't prove, that oceanic crust may be a microbial incubator of global proportions," he says. Scientists still haven't sampled widely enough to say for sure, and it was just Jan. 3 when the first report of microbes living in 3.5 million-year-old crust was published in the journal *Science* by Johnson and co-authors from University of Hawaii, Oregon State University, and University of Illinois.

Now Johnson and another group of scientists report in *Eos* that they retrieved and are actively growing microbes from both old and young seamounts – "old" being 3.5 million years in age and "young" being new enough to be volcanically active. They also are culturing microbe samples from similarly old and young seafloor that is unaffected by the growth of seamounts or disturbed by fracture zones or tectonic forces – what Johnson refers to as "normal" seafloor.

Ninety percent of the world's

seafloor consists of normal seafloor or has seamounts similar to the types of crust recently sampled, Johnson says. And most of that – even seafloor that's much older, 100 million years or more – is similar to the 3.5-million-year-old sites sampled as far as porosity of the rock, the sediment cover and rock temperatures of between 100 and 160° F, he says. The rocks at the sites on the Juan de Fuca plate are at the higher end of the range for 3.5 million-year-old crust because sediments covered them at a very young age.

University of Washington doctoral student Julie Huber and her advisor, John Baross, are working with samples of live microbes from the expedition. Some UW laboratory work shows bacteria extracted from seamount flanks grow best at hot temperatures, 190° F, which is considerably higher than the 68° F fluid they were collected with and the 140° F temperature of the rocks in that area. This means that the fluid and microbes are coming from deeper within the ocean crust, perhaps as deep as half a mile below the seafloor.

Cell counts at most of the sites are higher than cell counts from normal seawater, a strong indication the scientists were sampling a crustal environment and that their samples were not contaminated with bottom seawater. Another important concern involves possible contamination from the process of drilling. This is a critical question even for a hole drilled by the International Ocean Drilling program in 1997 that has been gushing copious crustal fluids since then. There is a chance that drill hole, sampled for work reported in

both the *Science* and *Eos* articles, was contaminated during drilling or that microbes being collected for these studies were growing in the artificial environment of the steel drill pipe in the bore hole.

To try to avoid this, Johnson and engineers with the UW's Applied Physics Laboratory designed probes that look remarkably like giant hypodermic needles. The 15-foot-long stainless steel probes were driven into the summit of a 3.5-million-year-old seamount. Two of the hollow probes immediately began venting warm crustal fluid.

The successful insertion of the probes and the development of a new barrel sampler meant scientists could take very large samples, 25 gallons at a time, of uncontaminated fluid to measure extremely dilute organic compounds that would tell how long the fluid was within the crustal rocks. These quantities are 200 times larger than normal hydrothermal fluid samples and the scientists may have accidentally spilled more hydrothermal fluid than is collected during other expeditions, Johnson says. Woods Hole Oceanographic Institution's new remotely operated vehicle Jason II was used for the seafloor work. All 24 scientists on the expedition are named as co-authors on the *Eos* paper. In addition to the UW, they represent NOAA's Pacific Marine Environmental Laboratory in Seattle, University of Victoria, Oregon State University, University of Chicago, Field Museum of Chicago, University of California Santa Cruz, University of South Carolina, Dartmouth University, and Woods Hole Oceanographic Institution.


**CRUSTAL BIOSPHERE
CONTINUED FROM PAGE 6**

While work continues on the chemical and microbiological analyses, Johnson and his colleagues have been intrigued by research reported by Andrew Fisher of the University of California, Santa Cruz, and 12 co-authors in the Feb. 6 issue of *Nature*.

That work describes how two seamounts in the North Pacific appear to share the same underground plumbing so that cold seawater being taken in at one seamount is venting as warm hydrothermal fluid at another – and the two are 25 miles apart. The seamount at the venting end of this system is the one where Johnson and his team drove their hypodermic needles and found abundant microbial life.

“If crustal fluid can flow over large distances in old oceanic crust and can nurture these large microbial populations,” Johnson says, “then the chances are good that there is a global-scale biosphere living within the upper oceanic crust. This oceanic crustal biosphere would live at a wide range of temperatures and fluid flow rates, have different chemical environments, have unique entrance and exit ports and would have been exposed to completely different formation histories.”

“It’s like finding an undiscovered world.”

For more information contact Johnson, (206) 543-8474, johnson@ocean.washington.edu. Reporters can obtain a copy of the *Eos* report from Emily Crum,


**THE VIEW INSIDE THE
INDUSTRY–
HERMAN BOUWER INTERN
SCHOLAR REPORT**

–by Josh Coyan
2004 Herman Bouwer Intern Scholar

Before I started my internship program, I was inexperienced in real world practices. I was excited to remedy this, but in reflection I was also very unaware of the efforts and money invested to produce clean water, clean up dirty water, and plan for future water needs. The people that provide water for a wasteful society do so by working long hours. These people take pride in their work without the recognition they deserve. Phoenix is located in an arid environment that has suffered drought longer than we all wish. The individuals that provide these services turn a dry, brown desert into a green, lush oasis full of resorts, swimming pools, and fast growing neighborhoods.

I spent five weeks observing and participating with three water resource entities in the valley: Arizona Department of Water Resources (ADWR), Brown and Caldwell, and Clear Creek Associates.

Following my OSHA training, I began interning at ADWR. The internship promised gravity and GPS studies. For two weeks, I simultaneously probed the deep earth with extremely exact and sophisticated gravity equipment while receiving messages from space, which pinpointed our location within millimeters. This didactic experience intrigued me. I was amazed to learn how efficiently the ADWR team worked. They worked nonstop throughout the day acquiring sensitive data and ultimately ac-

quired hundreds of data points. These data will be used to determine the availability of water for future needs.

From ADWR I went to Brown and Caldwell. I was allowed to perform a series of activities and tests with their staff. These activities included site characterization, and water and soil sampling, as well as the opportunity to monitor some drilling operations. I performed bail down tests and reduced data to determine aquifer properties of a remediation site. Not only did they send me to Willcox, but also to the White Mountains where I assisted in a soil-sampling program. I surveyed and investigated several remediation sites, including the exploration of new remedial techniques. I learned in what situations thermal oxidation units, internal combustion engines, and activated carbon are appropriate. I was invited to a colloquium in which I learned about the future of soil and surface stabilization technology. In addition, I spent a sweltering 112-degree day at a dairy assisting in site characterization and soil sampling.

I finished my internship at Clear Creek Associates. While at Clear Creek, I was sent out to observe drilling in progress. I was fascinated from beginning to end. The drilling techniques, logging of the core, and installation of the future sparge system provided a nice supplement to past classroom learning. I was also able to apply what I had learned in classes by reducing modeling equations, producing a potentiometric surface map, and working with water chemistry data for a project in Tucson. A well inventory study reminded

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**INTERN SCHOLAR
CONTINUED FROM PAGE 7**

me why I chose geology for my degree, to be in the field.

Throughout the entire internship program, people welcomed me into their group and treated me as an equal. I would like to thank: Dr. Herman Bouwer and the Arizona Hydrological Society, Dr. Peter Kroopnick, Dave Christiana, Steve Acquafredda, Maurice Tatlow, Paul Ivanich, Brian Conway, Tekla King, Pejman Eshraghi, Derek Foehr, Darren Curtis, Mike Orcutt, Doug Bartlett, Marvin Glotfelty, Todd Cruse, David Wrzosek, Rochelle Destrampe, and Barry Halterman. Thanks to everyone for letting me tag along. I would also like to thank the Arizona Department of Water Resources, Brown and Caldwell, and Clear Creek Associates for allowing me to be a part of their family for a short time. ☐



WHAT IS A STORM SURGE?

With this year's very active hurricane hopefully winding down, I found the following discussion very interesting. I hope you do too. It was downloaded from the National Oceanic and Atmospheric Administration website at <http://www.noaa.gov/>. LKB

Q: What is the most damaging hazard from a hurricane?

A: The greatest potential for loss of life and property related to a hurricane is from the storm surge—water pushed ashore by the force of the winds accompanying a hurricane. Although hurricanes are usually described in terms of their wind speeds, historically storm-surge flooding has claimed more victims (nine of 10) than wind. During the past 30 years, however, inland

flooding has caused most hurricane-related deaths.

Specifically, storm surge forms when hurricane force winds push water up into a mound. When a storm is at sea, the water easily flows away. However, as a hurricane crosses the continental shelf and nears land, the water piles up creating a storm surge, which can inundate coastal areas. Generally, for a hurricane that crosses perpendicular to the coastline the highest part of the storm surge will be to the right of the eye where the strongest winds eventually blow “on shore.” The height of the storm surge depends on the wind speed. The stronger the wind speed, the higher the storm surge. In powerful Category 4 and 5 hurricanes, storm surge maximums of 20 to 25 feet are possible for many locations along the U.S. Gulf and Atlantic shorelines. This surge also combines with the normal astronomical tides to create the hurricane “storm tide,” which can further increase the water level. Lastly, at the shore line, 5 to 10-foot high wind driven waves are often superimposed on top of this “storm tide.” These storm surge components can cause severe flooding and damage in coastal areas—often many miles inland depending on the terrain—particularly when they coincide with normal high tide.

Storm surge normally does not arrive as a “wall of water,” but instead more like a quickly rising VERY high tide. Its destructive forces are immense. Water weighs an impressive 64 pounds per cubic foot and ocean waves can be as powerful as battering rams. Currents associated with storm surge also cause extensive damage.

As the water begins rising in advance of the storm, high water and pounding waves create currents, eroding beaches and carrying away sand under sea walls, buildings, and roads. When Hurricane Eloise hit the Florida Panhandle in September of 1975, it carried away an average of 45 cubic yards of sand for each yard of beach front along nine miles of the coast. Even buildings that can withstand hurricane force winds have little chance if their foundations are weakened and fail due to eroding sand under and around them. Likewise, boats are often ripped from their moorings; trees and utility poles are uprooted. Worse yet, the destruction accelerates when the storm surge—now laden with large debris loosened by the storm—reaches further inland.

Not only does storm surge cause damage along ocean front beaches, but adjacent bays and rivers are also vulnerable. In fact, water levels may even rise higher inland when winds channel storm surge waters into narrowing bays and rivers. For example, when Hurricane Carla (a Category 4 hurricane) hit the Texas Coast near Lavaca Bay, between Corpus Christi and Galveston in September 1961, the storm tides along the outer coast were measured at 10 to 12 feet. The value at the head of Lavaca Bay was 22 feet. Even inside Galveston Bay, approximately 150 miles to the right of the eye, values of 14 to 16 feet were reported. Storm tides, waves and currents in confined harbors severely damaged ships, marinas and pleasure boats. In estuarine and bayou areas, salt water intrusion endangers public health and forces wildlife (e.g., poisonous snakes and alliga-


**STORM SURGE CONTINUED
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tors) to take refuge in urban areas.

One contributor to the height of the storm surge is determined by the slope of the continental shelf. In general, the worst storm surges hit places where the ocean floor slopes gradually (e.g., around the Gulf of Mexico). Communities with a steeper continental shelf, on the other hand, will not see as much surge inundation (although large breaking waves will present major problems). Hurricane forecasters consider New Orleans, La., to be the U.S. city most at risk from storm surge. A major hurricane could drive 20 feet of water into this city, which is already below sea level. Southwest Florida (from Tampa Bay south to the Everglades) is considered the next most vulnerable because of the large number of people living along its coasts and the shallow slope of the adjacent ocean bottom. On the Atlantic coast, areas north and south of Savannah, Ga., are also considered more dangerous for the same reason. When you consider that much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, the potential for danger from storm surge becomes apparent. ☐


**SYMPOSIUM WRAP UP
CONTINUED FROM PAGE 3**

as much money as possible, be inclusive of many topics, encourage student participation, be planned early, include aggressive fundraising, and build on the website created last year. I believe the 17th Annual Symposium fulfilled all of these

goals. Look for articles in upcoming Newsletter issues and on the AHS website to give you the final numbers for attendance, survey results, and fundraising.

Thanks again to all the planners, sponsors, exhibitors, presenters, moderators, and student volunteers who made possible yet another successful Annual Symposium. We look forward to seeing you next year in northern Arizona!

Editor's note: AHS would like to thank both Gary Burchard and Peter Livingston for co-chairing the symposium, Mike Block for leading the fundraising efforts, and all of the many volunteers who helped make the symposium. You folks are terrific! LKB ☐


**2004 ANNUAL REPORT
AVAILABLE ONLINE**

At the 2004 Annual Membership meeting our Corporate Treasurer, Michael Geddis, presented a comprehensive annual report. It described the Society's business for the year and included a detailed budget analysis along with other information. The report is available on our website at www.AzHydroSoc.org. The easiest way to get to the report is to use the new "search" feature, found in the upper left of the screen. Simply type in "annual report" and you will go right to it. We would like to thank Michael for all of the time and energy spent serving as our treasurer and for preparing this report. ☐


**EMPLOYMENT
OPPORTUNITIES**

Arcadis currently has openings for project and staff level Engineers, Scientists or Geologists. Further information is available at <http://www.arcadis-us.com/>,

or feel free to contact Dr. Peter Kroopnick at pkroopnick@arcadis-us.com.

Title: Project Engineer/Scientist/Geologist

ARCA Number: arca-00002017

Location(s): Phoenix AZ
Project, account and client management support for site evaluation and remediation projects for EPA and state lead Superfund projects. Responsibilities include project planning, project costing, CPM scheduling and schedule management, track / status project financial status, project re-planning, client and client account management. Excellent interpersonal communication and organizational skills, and ability to perform in a fast-paced environment required.

Desired years experience:
5 - 10 yrs

Discipline/Education preferred/required: B.S. Science, Engineering, Business or related field.

Title: Staff Engineer/Scientist/Geologist

ARCA Number: arca-00002018

Location(s): Phoenix AZ
Technical and regulatory support for site evaluation and remediation projects for EPA and state lead Superfund projects. Responsibilities include task management of site investigation and remediation activities (sample collection, chain of custody, QA/QC) and office support (data analysis, interpretation and data management) for Superfund projects. Emphasis will be placed on drill rig supervision, logging/soil classification and well construction.

Desired years experience:
3 - 5 yrs

Discipline/Education preferred/required: B.S. Geology or related field. ☐

ARIZONA HYDROLOGICAL SOCIETY
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Leilani Bew
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AHS NEWSLETTER SUBMITTALS

Submittals and comments should be addressed and faxed to Leilani Bew at Errol L. Montgomery & Associates, Inc. by the **15th** of each month. If you learn of something timely after the deadline has passed, call me, and we can discuss it.

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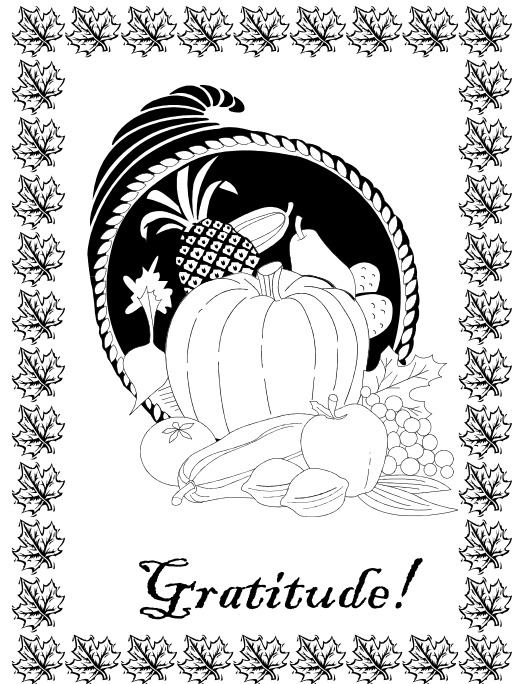
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MANY THANKS EVERYONE



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