HYDRO VISIONS

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GROUNDWATER RESOURCES ASSOCIATION OF CALIFORNIA

Winter 2001

INSIDE

Arsenic in Groundwater Symposium Hits the Mark!

BY TIM PARKER

GRA's Third Symposium in its "Series on Groundwater Contaminants", which focused on the challenges of addressing the problem of naturally occurring arsenic in groundwater, provided a comprehensive overview of this controversial drinking water issue. Over 170 groundwater and environmental professionals, regulators, members from water agencies and private industry attended the Symposium on October 3, 2001 in Sacramento. The Symposium combined discussions of the science of arsenic and the many issues of debate, including risk management and social-political issues. Arsenic has been high on the radar screen since the Bush Administration reversed the earlier Clinton Administration arsenic maximum cleanup level (MCL) of 10 micrograms per liter (ug/L) in drinking water. With Bush Administration's October 31, 2001 ruling of 10 ug/L MCL for arsenic, now we all need to work to combine science, logic, and resourcefulness to meet this aggressive standard.

Richard Shatz, GRA Sacramento Branch President, and Paul Parmentier, GRA Southern California Branch President, co-chaired the program. The Symposium consisted of four sessions that focused on arsenic's characteristics, geochemistry and distribution; risk/toxicology, and regulations; treatment and remediation; and social impacts, political impacts, and legal issues. Individual Speakers' presentations, other arsenic-related literature, web links and information on how to obtain a copy of the Symposium materials are provided on GRA's Web site (www.grac.org).

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

Session 1: Arsenic Geochemistry and Distribution

The first session, on arsenic geochemistry and distribution, included presentations on arsenic geochemical characteristics and natural distribution in groundwater by Dr. Alan H. Welch of the US Geological Survey (USGS), Carson City, Nevada, and Dr. T.R. Hathaway, of the California Department of Toxic Substances Control, Sacramento, California.

Arsenic is ubiquitous in the environment, and occurs in water, soil, animals, minerals and vegetation. Average concentrations of arsenic in the earth's crust range from 1.5 to 5 milligram per kilogram (mg/kg) (Cullen et al. 1989), although higher concentrations are present in some igneous and sedimentary rocks, particularly iron and manganese ores (Welch et al., 1988). Significant minerals containing arsenic include pyrite (FeS), arsenopyrite (FeAsS), realgar (AsS), and orpiment (As^2S^3). Natural concentrations of arsenic in soil range from 0.1 to 40 mg//kg (National Academy of Sciences (NAS)1977). Natural sources of arsenic in the environment include weathering of the earth's crust, precipitation, geothermal and volcanic activity, and forest wildfires.

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President's Message

BY TIM PARKER

War on Terror. Who would have ever thought – how could we have been caught this way?

September 11th Americans were violated – violated like never before. Shocked by the attacks and losses of life and property like we have never before seen on our own soil. And we are striking back – with the rationale that we really have to, that we can't let this sort of horrible violation and loss go, that we need to send back a message of non-tolerance of terrorist acts.

And then came Anthrax – and the potential for other Bio-terrorist acts. So far the human losses to Anthrax have been single digit, albeit this is still unacceptable in our standards. The logistical and economic impacts are mounting, however, as calls come in from across the country of various public offices with mostly false alarms as fear of exposure mounts.

Now I understand that the major bridges in California are the most recent targets. It is clear that things are never going to be the same here in America. These terrorist actions are having a clear effect.

But you know we have to keep going, and we will keep going – that's what makes this country great. All the support that was generated by Americans in response to the losses in New York was and still is phenomenal – yet not unexpected – it's what we are and what we do here in the U.S. And the resources focused on Anthrax will certainly help us to better address that issue. Yes, we march on and continue about our lives with adjustments to address these sick acts known as terrorism.

In spite of terrorism, we continue on through fall, into winter and well into our fourth quarter of 2001 of our tenth year, I am proud to report the GRA continues to perform fantastically! Our organization continues to demonstrate its vitality, viability and sustainability, and also that GRA is the premiere California organization of groundwater professionals. GRA had three tremendously successful events this past two months: "Principles of Groundwater Flow & Transport Modeling" training course at California State University, Sacramento, September 18, 19, 20, 2001 – 24 attended the course (the maximum allowed); Third in the Series on Groundwater Contaminants "Arsenic in Groundwater", in Sacramento, October 5, 2001 - 170 attended the symposium; and "Managing California's Groundwater: The Challenges of Quality and Quantity" was the 10th Annual GRA Meeting & 23rd Biennial Groundwater Conference", in Sacramento, October 30, 31, 2001 – 340 attended.

Thanks to UC Davis Professors Thomas Harter & Graham Fogg, and Peter Schwartzman for providing another excellent groundwater modeling course. This is the sixth or seventh time these folks have done this course, and based on the results of the evaluations, it was very well received. A BIG SPECIAL THANKS to CSUS Geology Professor Tim Horner, whose efforts and resources were responsible for getting GRA the excellent computer facilities and accommodations at CSUS.

I want to extend thanks to Richard Shatz and Paul Parmentier, GRA Co-Chairs of the "Arsenic in Groundwater Symposium", who spearheaded this highly successful event. Thank you to Richard, Paul and all those volunteers, moderators, and speakers who put this tremendously successful event on. GRA and its Executive Director's (Kathy Snelson) meeting management staff coordinated the Symposium, and it went very well in no small part to the efforts of Kathy and her staff.

And special thanks also to Vicki Kretsinger, Carl Hauge, Rita Sudman, Sue McClurg, Andrew Chang, Pamela Dick and the other volunteers, moderators and speakers who helped put on the Annual Meeting. The Biennial and GRA's 10th Annual Meeting was very well received by

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"Perchlorate, NDMA and Other Groundwater Contaminants from Aerospace and Rocket Fuel Facilities"

April 17, 2002

Radisson San Gabriel Valley

The Groundwater Resources Association of California is developing the Fourth Symposium in its Series on Groundwater Contaminants — "Perchlorate, NDMA and Other Groundwater Contaminants from Aerospace and Rocket Fuel Facilities". The Symposium will be held at the Radisson San Gabriel Valley on April 17, 2002.

The investigation of aerospace facilities where rocket fuel has been used has revealed the presence of several highly recalcitrant contaminants in groundwater, particularly perchlorate (ClO_4) and NDMA (N-nitrosodimethylamine). These chemicals have been found to impact drinking water aquifers in California, leading to the closure of numerous municipal water supply wells (refer to the CA Department of Health Services Web site at www.dhs.ca..gov/ps/ddwem/chemicals/NDMA/NDMAindex.htm for an overview of NDMA in California's drinking water). Other sources of these compounds have been identified and include wastewater treatment processes, fertilizer usage, rubber and textile manufacturing, metals refining and finishing and automotive air bag manufacturing.

Information about the use and behavior of these chemicals is not abundant. The Fourth Symposium will showcase experts and offer up-to-date knowledge on the occurrence and potential sources of NDMA perchlorate, their fate and transport characteristics, regulatory status, toxicology and chemical detection challenges. The program will also provide information about the known impact on water resources from these compounds, and current remediation/water treatment options. In addition, the program will address other critical issues surrounding rocket-fuel contaminants in groundwater.

The Symposium will consist of the following four sessions:

SESSION 1: Occurrence and Characteristics: Potential Contaminant Sources, Geochemistry, Fate and Transport in the Subsurface

SESSION 2: Toxicity, Chemical Analysis Methodology and Regulatory Standards

SESSION 3: Perchlorate and NDMA in California

- San Gabriel Valley (Water Supply Impacts, Sources, Responsible Parties Actions, Water Supply Treatment, Agency Activities)
- Sacramento Area (Historical Sources, Regulatory Interaction, Water Supply Impacts, Litigation)
- Remediation and Treatment Alternatives

SESSION 4: Regulatory and Legal Status

- Regulatory Status (Agency Responsibility and Interaction)
- Impacts to Municipal Water Supplies (Regulatory Response, PRP Litigation, Toxic Tort Lawsuits)

GRA will also coordinate a pre-Symposium site visit of a perchlorate water treatment facility in the San Gabriel Valley area the day before the Symposium. For additional information about the Symposium, please contact GRA Executive Director, Kathy Snelson, at 916/446-3626. Updated program information will be posted on GRA's Web site at www.grac.org. If you would like to receive automatic Symposium updates by email, sign up for GRA's announcement distribution list at www.grac.org/joinemail.html.

Chemist's Corner

Perchlorate - This Is Rocket Science We're Talking About

BY BART SIMMONS

Toxicology and analytical chemistry sometimes leap frog each other, generally to lower and lower levels of concern in groundwater. The perchlorate issue has been fueled by major improvements in the analytical chemistry. Earlier, non-specific methods based on gravimetric or colorimetric techniques have been replaced by an ion chromatography method. The refinement of the ion chromatography method by the Department of Health Services and Dionex Corporation, among others, has provided reliable measurement of perchlorate in low total dissolved solids (TDS) water down to the low ppb level, and made it feasible to measure at the action level of 18 ppb. DHS has established a Detection Limit for Reporting (DLR) of 4 ppb. The Ion Chromatography method uses a relatively large injection volume, which leads to potential column overload if the sample is high in TDS, resulting in problems qualitatively (saying that perchlorate is present) and quantitatively (how much is there). When EPA established the Unregulated Contaminant Monitoring Regulation, no method was initially cited for perchlorate, but later published Method 314.0 (based on the DHS and Dionex work) as well as a list of labs approved for perchlorate testing (analysis.www.epa.gov/safewater/standard/ucmr/aprvlabs.html).

Measuring perchlorate in highly contaminated water is problematic because of the interference of other anions such as sulfate. Like any chromatography method, identification of perchlorate is made by comparing the retention time of a peak with the retention time of a standard. Concentration is measured by the peak area. However, large peaks eluting nearby can shift retention times and make it difficult to measure a small perchlorate peak on the shoulder of a large sulfate peak. Reporting limits are likely to be elevated in proportion with the interferences.

An Ultra-Conservative

Perchlorate is a conservative tracer of groundwater contamination. Downgradient of the Stringfellow Site in Riverside County, for example, the size of the perchlorate plume extends far beyond the plume previously defined by TCE. Thus, despite decades of groundwater monitoring, perchlorate has completely changed the assessment of groundwater contamination, and this is not the only site where this is happening.

A study published in Environmental Science and Technology (Vol. 33, no 19, pp. 3469-3472, 1999) claimed that commonly available garden fertilizers contain 0.15% to 0.84% perchlorate. Because of analytical difficulties, the authors used three techniques: ion chromatography, Raman spectroscopy, and capillary electrophoresis. The fertilizer industry disputes the results, and says that perchlorate is not present in fertilizer except for a small volume of products which come from natural products in Chile.

The initial discoveries of perchlorate in 1997 have generated several problems, which will be resolved with additional work. Specifically, there is a need for confirmatory methods, clean-up methods, storage and holding time studies, and more comprehensive inter-laboratory studies. In particular, there is need for methods to measure low level perchlorate in high TDS samples.

Perchlorate has been one more lesson in identifying potential groundwater contaminants, developing methods to measure at levels of concern, and improved risk assessment to establish action levels.

Bart Simmons is the Chief of the Department of Toxic Substances Control's Hazardous Materials Laboratory and can be reached at bsimmons@dtsc.ca.gov. *For information on GRA's 2002 Symposium on Perchlorate/NDMA, please see the program announcement in this issue.*

Technical Corner

Solvent Stabilizer Compounds — Implications for Solvent Release Site Remediation Projects

BY TOM MOHR, SANTA CLARA VALLEY WATER DISTRICT

The widespread release of chlorinated solvents to groundwater from vapor-degreasing operations that occurred from the 1960s through 1980s is well known to GRA's members. University research and consultant ingenuity has brought about a great deal of innovation to the challenge of restoring aquifers impacted with solvents, and indeed substantial progress has been made at many of Silicon Valley's solvent release sites. As the Solvents and Toxics Cleanup Liaison with the Santa Clara Valley Water District, I have had the opportunity to see the progress across the valley and to examine the overall effectiveness of these efforts.

Among the questions I've turned my attention to is, "Are all the contaminants of concern being addressed?" This led me to study the basic composition of solvents and solvent wastes, and to learn that the additives to solvents sometimes have the potential to be as problematic as the solvents themselves. This article explores the subject of solvent stabilizers, focusing on 1,4-dioxane in particular, and discusses recent regulatory action on stabilizers by the San Francisco Bay Regional Water Quality Control Board. A more detailed treatment of this topic, with complete reference listings, may be found in the revised Solvent Stabilizers White Paper, available for download at http://www.scvwd.dst.ca.us/stabilizers.

Numerous additives are routinely included with most industrial solvents to ensure that the solvents perform as needed in their intended degreasing application. These additives are collectively known as solvent stabilizers, or inhibitors, and mitigate or prevent reactions with water, acids, and metals, and inhibit degradation from heat, light, and oxygen. Stabilizers are generally added at volumetrically insignificant proportions, often in the parts per million range, however a few stabilizers are added in the percent range. For example, 1,1,1-trichloroethane (TCA) was stabilized with 1,4-dioxane at 2 to 5% by volume, and some citations list as much as 8%. 1,4-Dioxane is a cyclic ether compound that serves to inhibit reactions with metals, particularly aluminum salts. TCA has been banned for most uses by Clean Air Act amendments, and current formulations use 1,3-dioxolane instead of 1,4-dioxane.

The stabilizers most commonly associated with the four main solvents, TCA, trichloroethylene (TCE), tetrachloroethylene (PCE), and dichloromethane (DCM), are listed in Table 1.

A vapor degreaser consists of an enclosed chamber with a solvent reservoir and a heat source to boil the solvent, and a cooling surface to condense the vapor in the upper section. Metal objects or electronics parts from which grease will be removed are hung in the air-free zone of solvent vapor. The hot vapor condenses onto the cool parts, dissolving oils and greases and providing a continuous rinse in clean solvent. Solvent stabilizers will partition between the vapor phase and boiling liquid phase according to their boiling points. 1,4-Dioxane boils at 101° C while TCA boils at 74°C. Systems designed to handle heavy loads of oil and grease are designed to distill the solvent for ongoing purification.

In such vapor degreasers using TCA, 1,4-dioxane tends to be concentrated in sludges known as still bottoms. Guidance to degreaser operators calls for the addition of fresh solvent after a time to prevent the depletion of stabilizers. While the starting concentration of 1,4-dioxane may be 2 to 5%, the resulting concentration in still bottoms in a continuous distillation vapor degreaser may be considerably higher, particularly after several iterations of adding fresh solvent. Studies of the progressive enrichment of solvent stabilizers in TCA degreasing still bottoms have noted a 68% increase in the mass fraction of 1,4-dioxane. It was most often solvent wastes, which were handled in sumps, vaults, and underground tanks that leaked, rather than the virgin solvents, an expensive raw material handled in drums.

California's regulatory guidance for 1,4-dioxane is a Department of Health Services Drinking Water Action Level (3 ug/L). 1,4-Dioxane is listed as a Class II-B probable human carcinogen, and is known to damage the kidneys.

Once released to the subsurface, the relative rates of migration of TCA and 1,4-dioxane are markedly different, governed by their physico-chemical properties, contrasted in Table 2. 1,4-dioxane is resistant to both abiotic degradation and biotrans formation, and owing to its infinite solubility and low affinity for sorption to soil organic matter, moves through the subsurface relatively unimpeded. Among 123 organic compounds ranked for their subsurface mobility, 1,4-dioxane is ranked first, i.e., it is deemed the most mobile among the compounds ranked (Roy and Griffin's 1985 list, appearing in C.W. Fetter's 3rd Edition of Applied Hydrogeology).

In a laboratory column experiment, the adsorption coefficients for 1,4-dioxane in a clayey soil was measured at 0.17 mL/g, considerably less than toluene, which in the same soil and test configuration was retained at 26 mL/g. Analysis of retardation factors from laboratory column experiments and plume analysis, stated as the ratio of the aver-

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President's Message

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the attendees, had very interesting presentations and sessions, and included the following noteworthy pieces:

Keynote by Celeste Cantu, Executive Director, State Water Resources Control Board;

Lunch Talk by Susan Seacrest, President, The Groundwater Foundation;

Lunch Talk by Steve Macaulay, Deputy Director, Department of Water Resources;

The GRA Kevin J. Neese Award to the American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership; and,

The GRA Lifetime Achievement Award to Carl Hauge, Chief Hydrogeologist, DWR.

I want to once again personally thank all of you for the continued and new support we are receiving – we need your support to keep going as the dues cover less than half the income to support our activities. I also want to extend my sincere thanks to our volunteer and contract staff. These people include our Branch Officers, Statewide Officers, Board of Directors, and contract staff.

I am very pleased to report we have a revitalization occurring in the southern part of the Great Valley. Bill Pipes of Geomatrix is spearheading an effort to re-start an active GRA Branch, to be headquartered in Fresno. Gary Corbell of Welenco, a longtime GRA member and supporter is going to provide assistance. Thanks in advance to Bill and Gary – I look forward to attending a Branch activity in the San Joaquin Valley – and I believe our southern valley groundwater aficionados will see the benefit of an active GRA Branch down there very soon. Our committees continue to charge ahead with lots to report, in spite of the time we are in. And even though we have lots to report, I urge you to please contact any GRA Director or Statewide Officer if you are interested in participating in any of the committees – we can always use more help and more ideas.

So far, the Seminar Committee is planning two additional symposiums in the Series on Groundwater Contaminants next year, with four training classes on the horizon:

Training Classes

- Groundwater Modeling - Southern California, April 2002
- Applied Environmental Statistics -location to be determined, First Quarter 2002
- California Groundwater Management – locations and dates to be determined
- Drinking Water Source Assessment Plans - locations and dates to be determined.

Series on Groundwater Contaminants

- Perchlorate/ NDMA - Southern California, March 5, 2002
- Nitrate or endocrine disrupters – Northern California, third quarter 2002
- GRA's 11th Annual Meeting – Southern California, location to be determined, Fall 2002.

The Legislative/Regulatory Committee, chaired by Scott Slater, GRA Director, continues to provide support to keep our membership apprised on the highly fluid groundwater legislation and regulations. GRA successfully supported and testified on AB599, the Groundwater Monitoring Act of 2001. Find more information on bills in this issue of HydroVisions.

The HydroVisions Committee continues to bring quarterly issues to our membership in a high quality package packed with timely and excellent technical content. The Committee includes Martin Steinpress as Chair, David Abbott, David Von Aspern, Kathy Snelson, and our editor Floyd Flood. Remember that HydroVisions is always looking for excellent technical articles and sponsors!

The Membership Committee, chaired by GRA Director Paul Dorey, is pleased to report that GRA is currently at 742 members, a new high!

Best regards to all of you and yours. I hope to see you at the symposiums, trainings, and branch meetings. Looks like we're through the energy "crisis" for the moment albeit energy conservation is still smart living, and water shortages continue. Conservation mindedness appears to be a requirement for future living!

Tim

Arsenic in Groundwater...

Continued from page 1

Under natural conditions, the most common form of arsenic is arsenate (AsO4 or As(V)), which occurs in oxic waters. Arsenite (AsO3 or As(III)), is generally found under anaerobic condition such as sulfidic and methanic waters (Welch et al 2000). The fate and transport of arsenic is affected by a variety of processes including oxidation-reduction reactions, transformations, ligand exchange, and biotransformations. The factors that affect these reactions include arsenic oxidation state, oxidation-reduction potential, pH, concentrations of iron and sulfides, temperature, salinity, and presence of organics (Welch et al. 1988).

High concentrations of arsenic are generally a result of natural subsurface processes, although anthropogenic effects can locally increase arsenic levels. About 10 percent of 30,000 arsenic analyses of groundwater conducted by the US Geological Survey in the U.S exceeded 10 ug/L (Welch et al , 2000). Arsenic concentrations in groundwater are generally highest in the western U.S. (USGS, 2000). The most common causes of arsenic occurrences in groundwater are release from iron oxide and sulfide mineral oxidation (Welch et al. 2000). Arsenic commonly occurs as an impurity in iron oxide, so desorption of arsenic is an important mechanism affecting arsenic levels in oxic groundwater and can be promoted by increase in pH or the amount of competing ions such as phosphorous. Another source of arsenic in groundwater is in alkaline groundwater in areas of felsic volcanic rock. Additionally, a biologically mediated reaction known as dissimilatory iron reduction, which involves iron oxide along with organic carbon, has implications related to areas of volatile organic compound (VOC) contamination and agriculture. Sulfide minerals (dominantly pyrite (FeS)) contain arsenic at levels up to and exceeding five percent, and the extent of oxidation is generally limited by the amount of oxygen contained in the groundwater during recharge, although nitrate from agricultural activities can also cause oxidation. Another potential scenario can involve exposing the sulfide-bearing material during groundwater decline associated with groundwater extraction,

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23rd Biennial Groundwater Conference

"Managing California's Groundwater: The Challenges of Quality and Quantity"

Conference Summary and Closing Remarks

BY VICKI KRETSINGER

On behalf of the sponsoring organizations, GRA would like to thank the attendees, co-sponsors, planning committee, sponsors and exhibitors of the 23rd Biennial Groundwater Conference and 10th GRA Annual Meeting. During the course of the two-day Conference, we had the opportunity to hear the latest on policy and technical issues for Managing California's Groundwater: Challenges of Quantity and Quality. There were eight sessions covering the broad topics of:

- Quality
- Quantity
- Emerging Contaminants
- Development of Groundwater in Impaired Water Areas
- New Tools for Management
- Watershed Effects on Groundwater
- Groundwater Treatment and Remediation: From Research to Practical Application, and
- GIS for Hydrologic Applications.

As we progress into the 21st century, it is a well-known fact that California must address expanding pressures on its water resources. We have projected population increases of about fifty percent from 33 million to another 15 million in the next 20 years. These population increases obviously translate to increased water demands. It is also obvious that the stress on our water supply is most apparent in our growing urban areas where we are already facing difficult water quantity and quality problems. Questions that are critical to how we address the challenges facing us include:

- How are we defining the current status (quantity and quality) of our resources;
- How are we determining the future availability of our water resources;
- How are we planning for the future distribution of our surface and ground water resources;
- How are we determining the value of our resources for current and future needs;
- How are we protecting the quality of our resources;
- How are we ensuring that we are not only protecting the directly managed resources, but also all elements in our ecosystem intrinsically linked to our water resources; most importantly,
- How do we promote greater awareness, understanding and participation of the public in addressing these challenges?

These basic questions have, in one fashion or another, been on the table for a long time. Have you noticed how Conference themes and session topics for not just the last year but the last 20 or more years are so familiar? This tendency toward topic recycling was also noted in opening comments back in the 1980's. There is a downside and an upside to this time warp. The downside is that we begin to get immune to the subjects and the hyperbole because it begins to seem like "we have been there, done that". The upside is that many of the Conference topics are not just passing fads, but are virtually timeless and command continued investigation and dialog.

A key message at the close of the Conference was: "It is a time for bold action."

We cannot wait for the California water crisis to be among the topics that reinvigorate public attention through drama or fear. It is a particularly daunting reality that unless we move quickly, the water crisis will move front and center into the arena currently occupied by hexavalent chromium, arsenic, endocrine disrupters, and now bioterrorism. The fact is California's water crisis is outpacing the solutions available through science and logic.

We heard at the Conference that we have very serious challenges before us. Our presenters offered us their experiences and knowledge, and new techniques and methodologies to address our water challenges. Our ability to successfully address the state's water challenges will depend on our ability to implement action. Our actions cannot be narrowly focussed. To better identify and define critical long-term problems, it is crucial that we use a holistic approach to hydrologic systems analysis and that this approach couples our solutions for water quantity and quality problems. With new research, tools, and methods, and the application of our toolbox as we discussed during the Conference, these approaches can lead to innovative scientific and technological solutions. However, unless institutional solutions are brought to the forefront, and antiquated legal precedent no longer perpetuates the seemingly endless cycle of trying to resolve water conflict with fragmented laws, our actions based on science and logic will be stifled. Our response will be too slow to curtail the California water crises.

A key message at the close of this Conference was: "It is a time for bold action". How do we link our water challenges to actions? GRA offers the following considerations for furthering our agenda to curtail the California water crisis, and we encourage you to expand upon our action plan. Some action steps include:

- Develop and implement a holistic framework for comprehensive surface and groundwater management;

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Arsenic in Groundwater...

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resulting in a high sulfate, low pH reactive solution.

In Bangladesh, India, nearly half of the wells have concentrations of arsenic in groundwater at concentrations greater than 10 ug/L, and approximately one-quarter of the wells may have concentrations of arsenic greater than 50 ug/L (WHO 2001). The arsenic is natural and one explanation for the source of arsenic in groundwater is the dissolution and release of arsenic containing iron hydroxide in subsurface sediments in combination with the presence of organics. Another possible explanation is the lowering of the water table below organic matter containing authigenic arsenic pyrites and exposure to air in the vadose zone. Subsequent oxidation of the pyrites releases the arsenic to adsorption onto iron hydroxide sediment coatings. Finally, reduction of arsenic occurs with recharge and wetting of the subsurface during the rainy season. These explanations may be applicable to the alluvial deposits in California.

Anthropogenic sources account for a relatively small portion of the arsenic in groundwater and generally represent localized manifestations of elevated concentrations. Arsenic occurs in ore, such as copper ore and is concentrated during the smelting process, and also occurs as a potential groundwater contaminant in mining and mineral refining sites. Arsenic is present in coal and may become airborne during the burning of fossil fuels for power generation. Arsenic also has been utilized historically in pesticides, herbicides, livestock, and wood preservatives, although the consumption of arsenic-containing compounds has generally decreased over the past several decades. Probably the largest amount of arsenic used in the U.S. is for the production of chromated copper arsenate, as a wood preservative (Reese 1998). Small amounts of very pure arsenic are also used to produce the semiconductor gallium arsenide, used in the manufacture of computers and other electronics.

Conclusions of the NDWAC review include: the USEPA estimate was credible; a variety of improvements were offered, with the net result unlikely to significantly change national costs; California may have some significant differences due to hazardous waste determinations being more stringent.

Session 2: Risk, Toxicology, and Regulation

The second session focused on risk, toxicology, regulation, and included analytical testing methodologies. Dr. Bruce Macler, Drinking Water Toxicologist with USEPA Region IX, opened the session with some background on arsenic and the USEPA approach to arsenic risk management and implementation.

The arsenic standard of 50 ug/L was originally set in 1942 by the US Public Health Service. Following enactment of the 1976 Safe Drinking Water Act, an MCL of 50 ug/L was proposed for arsenic by USEPA as part of the National Interim Primary Drinking Water Standards. In 1988, USEPA conducted a risk assessment for arsenic in drinking water, and in 1996 requested that the National Research Council independently review that risk assessment. In 1999, the National Research Council published Arsenic in Drinking Water, and subsequently USEPA proposed an arsenic standard of 5 ug/L in the Federal Register. Following a review by USEPA's Science Advisory Board (SAB) and public comment period, USEPA issued a pending standard of 10 ug/L on January 22, 2001. On March 23, 2001, USEPA published a notice that delayed the effective date of the arsenic rule pending further studies. The additional studies include: the review of health data and risk assessments from 3 to 20 ug/L by the NAS (USEPA 2001b); review of cost and technologies by the National Drinking Water Advisory Committee (NDWAC) (USEPA 2001c); and review of the benefits analysis by the USEPA Science Advisory Board (SAB) (USEPA 2001a).

The World Health Organization (WHO) set a provisional guideline value of 10 ug/L for arsenic for drinking water. The guideline value is restricted by measurement limitations, and if based solely on health criteria the value for arsenic in drinking water would be less than 10 ug/L. The national standard for arsenic in drinking water in Bangladesh is 50 ug/L (WHO 2001).

Arsenic health effects have been studied extensively. A variety of human cancers are associated with arsenic ingestion including lung, bladder, prostate, liver, kidney cancer, and chromosomal repair is inhibited by arsenic, enhancing cancer progression. Arsenic can cause circulatory and neurological damage, as well as diabetes, and high disease levels are evidenced in populations drinking water with arsenic 2 to 20 times higher than the current arsenic MCL of 50 ug/L. New arsenic health concerns include that apparent action as an endocrine disrupter to block glucocorticord action at levels as low as 10 ug/L, and that dimethylarsinic acid promotes bladder, kidney, liver and thyroid cancers.

The NAS conclusions included: data from Taiwan and Chile were appropriate

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Federal Legislative/Regulatory Corner

Current Happenings at U.S. Environmental Protection Agency

BY JUDY BLOOM

Wayne Nastri - New Regional Administrator for Region 9

Wayne Nastri has been designated as the Regional Administrator for Region 9, which covers California, Arizona, Nevada, and Hawaii. For the past 6 years, Nastri has served as the president of Environmental Mediation, Inc. a Southern California firm. He specialized in air and water quality issues as well as hazardous waste investigation and remediation issues. Nastri served as the Governor of California's appointee to the Governing Board of the South Coast Air Quality Management District, was on the external advisory committee for the CA Department of Toxic Substance Control, and he currently serves as the legislative director for the CA Environmental Business Council. Nastri holds a B.S. in biological sciences from UC at Irvine and studies molecular genetics at Cal State University, Long Beach. Some immediate issues that Nastri will face include addressing the threat of bioterrorism and securing the safety of public water supplies, air quality and agricultural facilities in the San Joaquin Valley, improving relations with state agencies, and environmental justice.

Tracy Mehan - New Assistant Administrator for Water

G. Tracy Mehan has been confirmed as the Assistant Administrator for Water. In this position he has responsibility for the management of programs, policies, standards and regulations relating to water matters. Mehan comes to the Agency from Michigan where he was the director of Michigan's Office of the Great Lakes. He previously served in the EPA Administrator's office as the Associate Deputy Administrator and in Missouri as Director of the state Department of Natural Resources — which includes the divisions of environmental quality, parks, recreation and historic preservation, energy, geology, and land survey — from 1989 to 1992. He holds a bachelor's degree and a law degree from St. Louis University.

Region 2 - News from Ground Zero

The US EPA Region 2 office is located a mere five blocks from the World Trade Center. Many EPA employees witnessed the horror of the 9/11 attack from their office windows. Thankfully, all Region 2 employees have been accounted for. Region 2 has been actively monitoring air and water quality near the site as the recovery efforts continue. It will take some time for any semblance of normalcy to resume. As my Region 2 counterpart reports, just about all his co-workers have lost, or knows of someone who has lost, a family member or friend to this terrible tragedy.

Ground Water Pesticide Management Plan Rule

This is not "new" news, however, as a reminder, the Groundwater Pesticide Management Plan Rule, better known as the "Pesticides Management Plan" (PMP) rule, was withdrawn from the Office of Management and Budget last January. The rule is back on the Assistant Administrator's desk for review where a decision will be made to withdraw the rule permanently, revise it, or proceed with the rule as written. The PMP rule, as written, would require states and tribes to develop Pesticide Management Plans for each of four chemicals if they wish to continue the use of atrazine, simazine, metalachlor, and alachlor. The PMPs would include vulnerability assessments, enforcement responses, monitoring, and other components. At issue in California is that these 4 chemicals are not the ones of greatest concern. More to follow as decisions are made...
(Contact Yates.annie@epa.gov)

MTBE Rule

The MTBE Rule is expected to go to the Office of Management and Budget for review in early November. OMB has up to 90 days to review and if all goes well, the Rule will be available for public comment in February 2002 (Contact small.matthew@epa.gov).

Concentrated Animal Feeding Operations

The NPDES Regulations and Effluent Limitation Guidelines that cover Concentrated Animal Feeding Operations (CAFOs) are being revised. Under the proposed regulations (proposed 1/12/01), more facilities, at least those with 1000 animal units (= 700 dairy cows) will most likely be required to obtain an NPDES permit. If the facility is located in an area where ground water is likely to have a direct hydrologic connection to surface water, special conditions could be included in the permit to address potential discharges via ground water. For instance, the waste holding lagoon could be required to be lined. The permitted facility may provide a hydrologist's report to contest the determination of a direct link that could cause contamination of surface water via ground water. These provisions are among those that the Agency has been seeking input. The Agency is under a court-mandated deadline to take action on the effluent guidelines by 12/15/2002.

While the public comment period on the proposed regulation is closed, comment is now being taken on the Notice of Data Availability, which provides additional information and clarifies elements of the initial proposal (http://cfpub.epa.gov/npdes/afo/noda). Public comment for the NODA closes 1/15/02 (contact landy.jacques@epa.gov or bloom.judy@epa.gov).

JUDY L. BLOOM is an Environmental Protection Specialist for the U.S. Environmental Protection Agency, Region 9, and is currently an Animal Feed Operations Coordinator, which includes leading the development of California state strategy and implement strategy for the Central Valley, with focus on ground water issues. Judy is also a GRA Director.

Student/Research Corner

BY VICKI KRETSINGER

Study of Ground Water Dynamics in the Kern Alluvial Fan, California

Investigators:

Jordan Clark
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The Kern Water Bank (KWB) is a 78 km2 recharge ground located in the Kern River alluvial fan at the southern end of the San Joaquin Valley, Kern County, California. As part of the study of groundwater dynamics in an artificial recharge area, groundwater samples were collected at 10 or 13 locations in the KWB in January and August of 2000, respectively. At each location, aliquots of water were extracted from a shallow and a deep monitoring well after they had been flushed with five well volumes. The general chemical characteristics, chlorofluorocarbons (CFC-11/CFC-12) and stable isotopes (^{18}O and ^{2}D) of the water were determined.

The distribution of recharged water in the aquifer is consistent with the recent recharge history at the Kern River Bank.

The distribution of recharged water in the aquifer is consistent with the recent recharge history at the Kern Water Bank. The data indicate that the relatively recent groundwater (>1985) is found in the northern and central regions. An intermediate dated (1985-1960) groundwater component is encountered in the deeper wells of the northern and central regions. The oldest water (<1950) is found in the southern and western areas. At each location, the water found in the deeper layer of the aquifer is usually older. The stable isotopic composition of water and the major ion chemistry did not correlate well with either geography or groundwater age.

A hydrogeologic model was developed using the Visual MODFLOW‰ Software. The model is composed of three layers (total thickness 226 m) representing the aquifer structure and permeability. Each layer is built on a grid consisting of 58 columns and 39 rows; there are 1935 active cells ranging in size from 0.16- 0.65 km2. The model is built with hydrogeologic parameters, monitoring/production well data, and assumed boundary and initial conditions. The California Department of Water Resources hydrogeologic data sets were transferred into MODFLOW file format. Field data entered into the model included: (i) the initial groundwater surface in spring 1994, (ii) the 1994 – 2000 artificial recharge rates at KWB, (iii) 1994 – 2000 hydraulic head records at 26 monitoring wells, and (iv) 1994 – 2000 pumping rates at production wells. The calibrated model was run over a 7-year simulation period (1994 - 2000) in a transient mode, with twelve time steps for each stress period. The root mean squared error between simulated and measured hydraulic heads of monitoring wells in KWB was calculated at 8 m. The DWR numerical flow model used in this study was optimized for an earlier time period, under different recharge and pumping rates. This hydrological model responded well to the more recent hydrological inputs that were integrated in this study.

UC WRC Project Number: W-915
Start: July 1, 1999 Duration: 2 years

Key Project Team and Other Contributors

Jordan F. Clark is an Assistant Professor, Dept. of Geological Sciences, University of California, Santa Barbara; Hugo A. Loaiciga is a Professor, Dept. of Geography, University of California, Santa Barbara. The key student was Laurent Meillier who received his M.S. from the Dept. of Geological Sciences (University of California, Santa Barbara) in June 2001. The study formed the basis of his master thesis. Laurent is now a remedial project manager for the San Francisco Bay Regional Water Quality Control Board in Oakland. Jeff Gamlin also worked on this project before entering graduate school at University of Nevada, Reno. Jeff received his B.S. from the Dept. of Geological Sciences (University of California, Santa Barbara). The project was made possible through a co-operative agreement with the Kern Water Bank and Kern County Water Agency. Jonathon Parker (Kern Water Bank) and Thomas Hasslebacher (Kern County Water Agency) shared important well and water quality data and provided valuable feedback on initial interpretations of the geochemical and modeling results. Finally, Kaylea White (a former DWR employee and currently a graduate student at UCSB) helped by providing the original DWR groundwater MODFLOW modeling code and essential publications that helped in this research.

Editors Note: In this issue of HydroVisions, the Student/Research Corner premiers, in which GRA highlights research focusing on California's groundwater resources. The above investigation summary is from the annual report of the UC Water Resources Center. Submissions for future issues of HydroVisions may be submitted to Vicki Kretsinger at vkretsinger@lsce.com or directly to the editor at editor@grac.org.

Education Corner

"Ask a Groundwater Specialist" Program Premiers, But Needs Volunteers

BY SUSAN GARCIA

One of GRA's goals is to educate the public on groundwater issues and the importance of protecting our water supplies. In the past our educational outreach activities have been predominantly focused on our technical membership. As GRA's 10-year anniversary passes and we look forward to the next ten years, we would like to extend our educational outreach to the general public, including those individuals who will be the future decision-makers of tomorrow, our youth. One step towards this end is to offer our technical expertise to schools by answering questions that students may have on groundwater resources. The program is loosely modeled after NASA's "Ask a Scientist" program, which has students e-mail questions or concerns to central database that transmits the question to a scientist within their organization. The scientist then responds to the question within a few days of receiving a question.

I recently attended the American Ground Water Trust – Ground Water Institute for Teachers in October 2001, and I asked teachers if they would find a program such as this beneficial to their classes. They said yes, they would not only tap the scientists for technical information, but also, career information. They thought it was a great idea to help students realize the importance of water resources and to assist them in exposing them to a variety of resources.

To operate a similar groundwater-focused program, we need to identify a pool of groundwater resource specialists that will commit to respond to student questions within a few days. Student questions are being submitted to GRA's Web site, which directs it to someone within our pool of groundwater resource experts. Individuals will be selected from a pool of scientists on a rotation basis so that this volunteer assignment does not become too onerous. We are notifying teachers from various school districts to alert them of this program for K-12 students.

To volunteer to be a specialist in GRA's "Ask a Groundwater Specialist" program, please email GRA at education@grac.org (with your area of specialization, if any). You can also sign up any time at www.grac.org, where students may now submit questions on groundwater to GRA. Thank you for your assistance, and please spread the word to your local school districts.

Susan Garcia is a GRA Director, GRA Education Committee Chair, and a public school teacher in Southern California.

New Secondary Earth Science Curricula from the American Geological Institute

BY MICHAEL J. SMITH,
AGI DIRECTOR OF EDUCATION

The American Geological Institute (AGI) is producing the EarthComm(tm) and Investigating Earth Systems(tm) (IES) curriculum programs in association with It's About Time Publishing. These innovative series, developed in accordance with the National Science Education Standards and the American Association for the Advancement of Science-Project 2061's Benchmarks for Science Literacy, are designed to help middle school students (IES) and high-school students (EarthComm) understand fundamental Earth Science concepts by the time they graduate.

Field tested and content reviewed, EarthComm and IES are part of AGI's ongoing efforts at implementing effective Earth science education reform. EarthComm and IES provide the teacher and students with a wide selection of content that meets local interests and course objectives. The modules can be used as stand-alone units or as a full course presented in any order. The five modules in the EarthComm curriculum program are Earth's Dynamic Geosphere, Understanding Your Environment, Earth's Fluid Spheres, Earth's Natural Resources (which features a chapter devoted to water resource issues), and Earth System Evolution. The IES program consists of nine modules, including: Investigating Water Resources, Investigating Oceans, Investigating Our Dynamic Planet, Investigating Energy Resources, Investigating Fossils, Investigating Materials and Minerals, Investigating Rocks and Landforms, Investigating Soil, and Investigating Climate and Weather. Each IES module includes six to eight inquiry-based investigations and requires about six weeks to complete. AGI has also developed a comprehensive teacher guide, complete classroom materials kits, and Web sites (www.agiweb.org/earthcomm and www.agiweb.org/ies) for each module.

EarthComm and IES were developed through funding from the National Science Foundation (Grants ESI 9452789 and ESI 9353035) and the AGI Foundation. Development included two rounds of classroom testing and content review, and involved more than 110 teachers in 35 states. In addition to developing the curriculum, AGI and its publisher collaborate to provide professional development training to teachers in schools that adopt the programs, and leadership training (Summer "Curriculum Institutes") for anyone who wishes to work with teachers to help

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for risk assessment and indicate high risks for cancer; a sublinear extrapolation is not justified, but linear approach to extrapolate from 1% cancer risk to 1/10,000 regulator risk level is appropriate methodology; epidemiological studies are unlikely to show effects in the US; quantified cancer risks by NAS were 12-23 per 10,000 at 10ug/L arsenic for bladder cancer, 14-18 per 10,000 at 10ug/L arsenic for lung cancer, and overall 1 per 100 at 5-27ug/L arsenic (USEPA 2001a). Conclusions of the NDWAC review include: the USEPA estimate was credible; a variety of improvements were offered, with the net result unlikely to significantly change national costs; California may have some significant differences due to hazardous waste determinations being more stringent (USEPA 2001c). The results of the SAB review were recommendations to USEPA to quantify certain additional diseases and suggested consideration of the quantification of several added diseases, to provide a net result of a substantial increase in the benefits of the Rule (USEPA 2001b). USEPA Region IX will have substantial direct implementation responsibilities for many tribal water systems, and as a result, will be supporting initial systems testing, identification of cost effective and appropriate technologies, system design assistance, funding source identification, and assistance with operator training.

Dr. Robert Howd, Chief of the Water Toxicology Unit, California Office of Environmental Health Hazard Assessment (OEHHA), provided an overview on the public health goals (PHGs) being developed by OEHHA and their approach on arsenic. The California Safe Drinking Water Act of 1996 (Health and Safety Code Section 116365) requires OEHHA to perform risk assessments and publish PHGs for California drinking water contaminants (chemicals with an established MCL). The PHGs are also developed for chemicals when requested by the California Department of Health Services (DHS) or the Legislature. A PHG is an estimate of a chemical level in drinking water that would pose no significant health risk over a lifetime of exposure. The PHG is the level estimated to cause no more than one cancer case in one million people exposed over a lifetime for protection against cancer, and for non-cancer effects it is the concentration at which no toxic effects are expected. The PHGs are non-regulatory guidance values considering only potential public health effects, and are used by the DHS for setting California drinking water MCLs. The PHGs are designed to be protective of sensitive populations, allow for uncertainty, may be set at zero if insufficient data are available, and are to be re-evaluated and updated every five years. OEHHA develops a PHG for a chemical by completing a comprehensive literature review and scientific evaluation, according to industry-standard risk assessment procedures, and the evaluation is subjected to extensive peer review. The arsenic PHG is currently under development and will be completed soon, at which time it will be posted on the OEHHA website at www.oehha.ca.gov. The arsenic PHG is likely to be based on the Taiwan, Chile and Argentine studies of human lung and bladder tumors, and a cancer risk assessment model, which assumes no threshold for cancer. There will be a public workshop and public comment period following the posting of the arsenic PHG, with responses to comments and final PHG scheduled for late 2002.

Dr. David P. Spath, Chief of the Division of Drinking Water & Environmental Management, DHS, discussed the implementation of PHGs, and future of drinking water standards for arsenic. The DHS sets California drinking water standards as close to the PHG as technologically and economically feasible, considering the best available technology, cost per customer, and aggregate cost of compliance. The governor recently signed into law Senate Bill (SB) 463 (Perata) Drinking Water Standards: Arsenic, which requires that OEHHA develop a PHG for arsenic, and requires the reporting of arsenic at any detectable level above the PHG in the Consumer Confidence Report. SB 493 also requires a California MCL be developed by January 2004. Approximately 30 percent of the groundwater basins exceed a targeted arsenic concentration of 10 ug/L (SKS, 2000). The impact of a new, lower arsenic MCL on public water supply systems will be significant:

	5ug/L	10ug/L
Systems affected:	990	490
Sources affected:	1840	810
Groundwater sources:	1780	790
Surface water sources:	60	20

The numbers of systems/sources affected are rounded to the nearest ten. The small systems are likely to be the most significantly impacted by the ruling and potential costs could be in the $100's of millions. Another issue relates to the handling and disposal of arsenic wastes,

Waterloo Hyrdogeologic pick up page 13

because in California the waste determination process is more stringent and the arsenic residuals generated during the groundwater treatment processes are likely to be considered hazardous, significantly adding to the cost.

Dr. Bart Simmons, Chief of the Hazardous Materials Lab in the California Department of Toxic Substances Control, provided an overview on sampling, analysis, and speciation of arsenic. Sample collection and preservation methodology for arsenic analyses requires careful consideration, especially at low level ambient concentrations. Sampling issues include collection of total and/or filtered samples, sampling technique and cleanliness, containers and preservation that are dependent upon matrix and analytical method. For field testing, there is a visual colorimetric method with asserted detectability level of 10 ug/L, although the method is not USEPA validated, and sulfides appear to interfere. There are a variety of methods for analysis at both the part per billion (ppb) and sub-ppb level of total arsenic in water. At the ppb level, arsenic analytical methods include ICP-AES (EPA 200.7, EPA 6010B, SM 3120B), ICP-MS (EPA 200.8, EPA 6020), AA Platform (EPA 200.9), GFAA (EPA 7060A, ASTM D2972-93C, SM 3113B, 206.2), and Hydride (ASTM D2972-93B, SM 3114B, EPA 206.3, EPA 7061A). At the sub-ppb level, arsenic analytical methods include Cold Trap Hydride Generation (CT-HG-AAS), Hydride Quartz Furnace AAS (EPA 1632), Hydride ICP Mass Spectrometry (HG-ICP-MS), and Liquid-Solid Extraction-Atomic Absorption (LSE-GFAAS). The detection limit for reporting (DLR) arsenic in groundwater is 2 ug/L. An arsenic DLR study is being conducted by DHS; a report summarizing the results of the study is pending. Arsenic extraction methods for mimicking landfill conditions include the well known Federal toxicity characteristic leaching procedure (TCLP) and the California waste extraction test (WET). The TCLP uses an acetate buffer, at pH 4.9 or 2.9 for alkaline wastes, while the WET uses a citrate buffer at pH of 5. The WET is reportedly better correlated with municipal solid waste leachate than the TCLP, which has a much greater tendency to underestimate arsenic concentration. There is a range of extraction test approaches to estimate mass transfer rate and mass release in the environment, including extraction over a range of field pHs, extraction at the natural pH of the material or waste, availability assessment at pH 4 & 8. Speciation of arsenic is necessary in order to understand the role of the solid phase in arsenic fate and transport, to predict arsenic mobility, for treatment system design, and requires selective solid phase sampling ad careful consideration of preservation. Arsenic speciation direct methods for As (III) and As (V) include Ion Chromatography (IC-ICP-MS), Liquid-Solid Extraction (LSE-GFAAS), and indirect methods include Selective Hydride Generation (HG-ICP-MS), and Selective Hydride Generation (EPA 1632, CT-HG-AAS). Based on an USEPA Workshop on Arsenic in May 2001, existing instrumentation appears adequate for speciation and no single preservation and analytical methodology is appropriate for all sample matrices.

Session 3: Arsenic Treatment and Remediation

The focus of the third session of the Symposium was the treatment and remediation of arsenic.

Dr. Steve Reiber, HDR Inc., presented information on arsenic removal mechanisms and conventional treatment technologies, Dr. Joseph Drago, Kennedy/Jenks Consultants, provided a presentation on treatment for arsenic in the context of remediation, Dr. Rula Deeb, Malcom Pirnie, addressed innovations in water treatment processes for arsenic removal, and Jim Rouse, MWH, discussed some of his observations on arsenic behavior during remediation of soil and groundwater.

Arsenic removal efficiency is dominantly a function of oxidation state and charge configuration. Iron (III) or aluminum oxyhydroxide solids provide sorption sites for arsenic and other competing cations and anions. As (III) is neutral in the pH 6 to 8 range and difficult to remove; As (V) is easier to remove due to its ionic charge. Chlorine, ozone, and sodium permanganate can be used to oxidize arsenite. Arsenic controls include redox potential, pH, presence of organics, iron, and sulfides. High pH, high sulfate, fluoride, and phosphate concentrations tend to decrease arsenic removal rates.

USEPA accepted treatment technologies, in order of decreasing removalefficiencies, consist of reverse osmosis, ion exchange, ferric salt coagulation/filtration, activiated alumina, electrodialysis removal, and modified lime softening

Arsenic treatment processes include chemical precipitation by ferric iron and lime (with magnesium present); adsorption by iron oxyhydroxide and activated alumina; and anion exchange. As (V) is generally more strongly sorbed on iron oxyhydroxide than As (III); only As (V) is sorbed on aluminum oxyhydroxide. A key to selection of an appropriate process for arsenic removal is a good understanding of the subsurface hydrogeochemistry. An alternative to core sampling and analysis to provide a good analog to the real subsurface world is with vadose zone sampling and analysis. In one case history, the process of reductive remediation of volatile organic compounds and hexavalent chromium generated a reduced environment conducive to arsenic mobility as As (III), and transient behavior during geochemical modification of the site.

USEPA-accepted treatment technologies, in order of decreasing removal efficiencies, consist of reverse osmosis, ion exchange, ferric salt coagulation/filtration, activated alumina, electrodialysis removal, and modified lime softening. Some of the disadvantages of these

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accepted technologies include the generation of large volumes of brine, large volumes of chemicals required for pH adjustment, fluoridation of finished waste required, and high equipment costs. Emerging technologies currently include coagulation-assisted membranes, iron based/modified disposable sorbants, modified pressurized filters, ferrous oxidation-coprecipitation, and microsand ballasted sedimentation. Advantages of some of these emerging technologies are better removal efficiencies, and lower chemical requirements.

Currently accepted arsenic treatment technologies produce three types of wastes: brines, sludges and spent media. The toxicity criteria for arsenic is 5 mg/L and can apply to all three waste types. The new arsenic rule assumes generated wastes are non-hazardous. However, in California with more stringent hazardous waste requirements, these residuals may be designated as hazardous wastes, which could lead to high disposal costs and additional "cradle-to-grave" long-term implications (USEPA 2001c).

The American Water Well Association Research Foundation (AWWARF), USEPA, and the Association of California Water Agencies (ACWA) funded a research project to assess innovative water treatment processes for arsenic removal at the wellhead. Drivers for the study included smaller quantities of residuals, smaller treatment system footprint, less interference from co-occurring ions, low maintenance, and low costs. The innovative technologies evaluated included:

Microsand assisted oxidation adsorption – fine sand is fluidized in a long column by feed water introduced in an upflow mode; iron (ferrous sulfate) and an oxidant (peroxide) are added to the water at the base of the column, resulting in iron oxide coated sand (IOCS); the IOCS adsorbs arsenic from the water.

Microsand ballasted coagulation sedimentation – rapid mixing of coagulant, polymer, and micorsand; flocculation forms microsand flocs; lamellar settling out of weighted microsand flocs; and separation of microsand from sludge with hydrocyclone, sand is recycled.

Coagulation assisted ceramic filtration – coagulant (iron) and an oxidant (peroxide) are added to the water and agitated using static mixers; after sometime, the water is passed through a filter containing ceramic media consisting of uniformly sized (70-80 mesh) aluminum silicate particles; backwashing is completed when notable filter headloss occurs.

The innovative technologies discussed above were able to lower arsenic levels to 5ug/l or less under optimized operating conditions. The liquid and solid residuals generated by the technologies met the criteria for non-hazardous waste. These innovative technologies are flexible and can be modified to achieve a desired arsenic removal concentration by adjusting the coagulant iron dose.

Session 4: Social, Political, and Legal Impacts

The focus of the final session of the Symposium was an animated panel discussion on the social and political impacts, as well as legal issues of arsenic in groundwater. The panel included a good cross section of views from those of the environmental community, water agencies, consultants, and attorneys.

Janet J. Herring, Ph.D., California Institute of Technology, presented the case of "Social and Political Impacts and Legal Issues" related to the current situation resulting from delaying of the adoption of the arsenic standard. The premise is that

Once lost, the cost of regaining consumer confidence and support is likely to be substantial to the watersupply industry

continuing delays of the adoption of the new arsenic standard jeopardizes public confidence in the safety of municipal water supplies and public support of water utilities. Once lost, the cost of regaining consumer confidence and support is likely to be substantial to the water supply industry. The public has to be the ally of the water industry. Public trust and confidence in water supply is of critical importance. Education is also key to the public for confidence, especially regarding MCLs, the difference between MCLs and PHGs, risk management and what it all means.

The adoption of PHGs as standards in some communities of California set a precedent that is likely to be both economically unsustainable and erode public confidence in drinking water standards. Additionally, attaining sustainable water supplies requires a more integrated approach to monitoring of water quality and consideration of quantity, water conservation and water reuse.

James Goodrich, Water Resources and Environmental Consultant, Chair of the Association of Ground Water Scientists and Engineers, Division of National Ground Water Association, pontificated upon "Life Is A Risky Business." What does risk mean? We need a reality check. Life is not a risk-free enterprise; every minute choices are made relative to actual and perceived risk in our daily routines and rituals. Driving, flying, smoking, drinking, use of chemicals in the home and yard – the list goes on. So the question is why do we as a society go irrationally nuts over risks that are so low they are nearly insignificant, yet we ignore relative risks that are high, for example, exposure to sunlight? The answer may be that we have become so jaded by new contaminants appearing on the radar screen every few months – the contaminant du jour, for example, radon, hexavalent chromium, perchlorate, pharmaceuticals and endocrine disrupters.

Arsenic is one of those irrational health risk issues: in high doses it is an infamous poison (Arsenic & Old Lace), and epidemiological data are at the high dose scale, for example Taiwan in the

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Alliance Corner

BY VICKI KRETSINGER

California Groundwater Association Update

BY MIKE MORTENSSON, CGA EXECUTIVE DIRECTOR

CONGRATS, NPDES PERMITS & REGULATOR TRAINING

My congratulations to GRA on a successful Biennial Groundwater Conference and annual meeting. The tracks offered much for groundwater professionals. CGA and GRA have cooperated on a number of events this year and I look forward to continuing efforts to strengthen relationships with all persons in the groundwater industry who protect and develop groundwater supplies to help meet our state's water needs.

My thanks to Vicki Kretsinger who suggested we begin an exchange of information via HydroVisions. In the coming months, CGA will be exploring ways to minimize impacts on groundwater projects due to changing NPDES permit and stormwater discharge regulations. We are planning to hold a forum on these issues in Southern California in mid-January and we welcome your participation. We'll also be discussing this matter with NGWA officials in Nashville in December. I'd like to hear from anyone who's had experiences with well discharges and NPDES/stormwater permits.

In conjunction with CCDEH and CEHA, CGA has begun development of a well construction training program for regulators. The program will consist of introductory, basic, and advanced courses in water well construction, annular seal installation, water system installation, water well rehabilitation and water well destruction. We'll keep you posted and involved. If you have any questions on these items, give me a call at 707-578-4408 or email: wellguy@groundh2o.org.

National Groundwater Water Association Update

BY JULIE SHAW, NGWA MARKETING & PUBLIC AFFAIRS MANAGER

NGWA Offers Testimony on Terrorism Threat to Water Infrastructure

Dr. Stephen Ragone, science and technology director for the National Ground Water Association (NGWA) has offered testimony to the House Water Resources and Environment Subcommittee addressing terrorism's threat to the nation's water infrastructure. Ragone's statement was submitted in response to an October 10 Congressional hearing on the subject.

"NGWA believes that the United States ground water resources can better be integrated into the country's drinking water infrastructure system to proactively address both natural and man-made disasters," Ragone said in his statement. "Ground water may be the only available resource when a natural or manmade disaster strikes.

"Ground water is protected from immediate contamination by virtue of its location tens to hundreds of feet below land surface, and from long-term contamination by virtue of its slow rate of movement and the probability that biological and chemical agents will be removed as water moves through the subsurface. Unlike surface water supplies, ground water wells are virtually invisible on land surface and are relatively easy to secure," Ragone said. "Additionally, because ground water

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International Association of Hydrogeologists Update

BY LENNY KONIKOW, IAH U.S. NATIONAL CHAPTER CHAIRMAN

IAH's 31st Congress Held in September 2001

The 31st Congress of IAH was held in Munich, Germany, during September 9-14th, 2001. The overall theme was "New Approaches to Characterizing Groundwater Flow." Over 450 scientists, representing 53 different countries, attended the meeting and participated in the lectures, courses, workshops, poster sessions, and excursions. The meeting received good support from government and regulatory agencies in Germany. The technical and institutional challenges arising from the European Union's Water Framework Directive (which reforms the EU legislation and, as of December 2000, introduced a new and innovative model for integrated water management) were much in evidence in presentations and workshops held at the Congress. (For more information on the EU Water Framework Directive, go to its Web site at: europa.eu.int/eur-lex/en/lif/dat/2000/en_300L0060.html)

The technical sessions focused on a variety of ground-water technical and management issues, but special attention was given to the use of tracers in ground-water studies. The spirit of the meeting became quite somber as news of the terribly tragic events of September 11th became known. But participation

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National Groundwater Water Association Update

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movement is typically on the order of feet per year, contaminants injected directly into the ground water through wells will tend to remain in the local area. Terrorist attacks or natural disasters impacting ground water wells will result in little, if any, collateral damage through flooding or other disruptive events."

Ragone also pointed out that the U.S. could do more to conjunctively use ground water and surface water resources to meet the ever-increasing demand for water, particularly during droughts, floods, or other natural or manmade disasters. He cited NGWA's ongoing work with the Federal Emergency Management Agency to help it better respond to drinking water needs following natural disasters, as well as the Association's cooperation with federal and state government agencies in developing the 2002 NGWA conference, Defending the Integrity of Ground Water: Impacts of Natural and Manmade Disasters. Planning for the July 10-12, 2002, event was under way well before the September 11 terrorist attacks. Deadline for conference abstract submission is February 15, 2002. To submit an abstract, obtain a submission form by visiting the NGWA Web site at www.NGWA.org (click on "Events"), or by contacting Dawn Guth at NGWA, (800) 551-7379. Ragone indicated that NGWA will readily share with the U.S. government useful information garnered through the conference.

He also pointed out that NGWA and its membership are available to the government as a resource on water issues. "We look for guidance from you on how to most productively assist you in your decision-making regarding the long-term security of our nation's water infrastructure," Ragone said.

You can view Dr. Ragone's full statement on NGWA's Web site, www.ngwa.org/position/threat.html.

NGWA Executive Director Kevin McCray has also sent a letter to 47 members of Congress and to key agency personnel, such as the new director of homeland security, offering the assistance of NGWA and its membership in discussions on the security of the nation's water supplies. The letter points out the important role ground water resources can play during times of natural disaster or acts of terrorism.

NGWA's Ground Water Information Center has prepared a bibliography on water security for our members. If you would like a FREE copy, please e-mail your full address to astanl@ngwa.org.

International Association of Hydrogeologists Update

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in an international scientific society, such as IAH, is one way to foster international understanding and cooperation, and help break down the barriers that lead to acts of terrorism and war. The spirit of scientific cooperation was clearly evident at the Congress. Those attending the Munich IAH Congress made many new friends from around the world, learned much about how those from other countries approached research and practical applications in hydrogeology, as well as a variety of approaches to management and protection of ground-water resources, and came away with many new ideas applicable and beneficial to their own work. The Conference Proceedings were published by Balkema Publishers (details are available on its Web site: balkema.ima.nl).

The 32nd IAH Congress will be held in Mar del Plata, Argentina, in October, 2002. The theme is "Groundwater and Human Development" and the deadline for submitting abstracts is November 15, 2001. More details are available on the Web site at: www.mdp.edu.ar/exactas/geologia/iah2002/iah2002.html.

The International Association of Hydrogeologists is a member society of the American Geological Institute (AGI). AGI is a nonprofit federation of 37 geoscientific and professional associations that was founded in 1948. AGI provides information services to geoscientists, serves as a voice of shared interests in our profession, plays a major role in strengthening geoscience education, and strives to increase public awareness of the vital role the geosciences play in mankind's use of resources and interaction with the environment. [For more information on AGI, please see article in the Education Corner).

Editors Note: GRA is providing a new dues option for GRA/IAH joint membership in 2002; see page 17 for details.

Organizational Corner

GRA Presents Annual 2001 Awards

GRA recently presented its annual Lifetime Achievement Award and annual Kevin J. Neese Award at its 10th Annual Meeting on October 31, 2001.

The GRA Lifetime Achievement Award is presented to individuals for their exemplary contributions to the groundwater industry and for contributions that have been in the spirit of GRA's mission and organization objectives. Individuals that receive the Lifetime Achievement Award have dedicated their lives to the groundwater industry and have been pioneers in their field of expertise. The 2001 recipient is Carl Hauge, Chief Hydrogeologist for the California Department of Water Resources (DWR).

GRA's Kevin J. Neese Award, which was established in 1999 in the name of the late Kevin J. Neese, a former GRA Director, geologist and attorney, recognizes significant accomplishment by a person or entity within the most recent 12-month period that fosters the understanding, development, protection and management of groundwater. The 2001 awardee is the American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership.

Carl Hauge currently works with local agencies and the public (through the DWR Office of Planning and Local Assistance) providing expertise and information on groundwater, groundwater management, well construction and standards. Carl started his career as a scientific aide at the US Geological Survey. Shortly thereafter, he joined DWR and worked on the State Water Project. When the Project was completed, Hauge was among 100 geologists that were out of work. Carl joined the California Department of Forestry and studied soil erosion, landslides and stream protection zones. He then moved to the California Division of Mines & Geology where he worked on earthquake analysis, urban geology, geologic publications and transitioning the Mineral Information Series into the current California Geology publication of CDMG. Hauge eventually returned to DWR and became involved with studies on water supply and demand, dam site exploration and construction, groundwater and land subsidence, and well construction.

Accepting the Kevin J. Neese award from Tim Parker (center) is Ed Winkler, Executive Director (left), and Carrie Howell, Chair (right), of the Sacramento Groundwater Authority.

Tim Parker, GRA President, (left) awards GRA's 2001 Lifetime Achievement Award to Carl Hauge, Chief Hydrologist, CA Department of Water Resources (right).

Because of Hauge's extensive (and lifetime) career in water resources, his guidance on managing groundwater in California is highly sought after. He is actively involved with the Association of California Water Agencies (ACWA) Groundwater Committee, the California Groundwater Association (CGA), and the American Water Well Association (AWWA) in addition to GRA.

The American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership was selected as the Kevin J. Neese award recipient for significant accomplishments in fostering the understanding and development of a cooperative

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2002 Dues Renewal Notices In the Mail

By now, you should have received a dues invoice to renew your GRA membership for 2002. Please review the invoice and remit your dues payment as soon as possible so that you don't miss out on any membership benefits. On behalf of the GRA Board of Directors and Staff, thank you for your interest and continued participation in protecting and improving California's groundwater.

GRA/IAH Joint Membership Available for 2002

GRA has worked together with the International Association of Hydrogeologists (IAH) to offer a special, one-time discounted GRA/IAH joint membership for 2002 to new members of IAH (to qualify as a new member you must not have been a member of IAH for at least the two previous years). GRA/IAH joint members will receive all GRA and IAH member benefits (including the peer-reviewed Hydrogeology Journal, which is published six times per year). Membership fees are $250 for a GRA/IAH joint business/government membership, which includes three GRA members one of whom can also be an IAH member, or $125 for an individual GRA/IAH joint membership. After the first year of joint membership at the discounted rate, GRA and IAH membership will continue at regular rates.

To take advantage of the GRA/IAH joint membership, please select the appropriate category on the GRA 2002 membership dues invoice that you will receive in early December 2001. For detailed information about IAH, please visit the IAH Web site at www.iah.org.

Solvent Stabilizer Compounds

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age velocity of groundwater to the velocity of 1,4-dixoane, found a range from 1.1 to 1.6. In comparison, retardation factors for 1,1-dichloroethene, an abiotic degradation product of TCA, from the same survey, reported a range from 6 to 11.

To estimate relative rates of migration, 1,4-dioxane and TCA in groundwater were modeled using EPA's BIOCHLOR Natural Attenuation Decision Support System. Using the case study example for the Cape Canaveral Fire Training site for which model parameters have been carefully estimated, migration rates were estimated and compared with all other variables held constant. Input values for 1,4-dioxane included a retardation value of 1.1 and zero biodegradation.

The resulting estimate (Figure 1) shows 1,4-dioxane is expected to exceed its regulatory threshold (3 ug/L) over a distance 2.5 times further than for TCA exceeding its threshold (200 ug/L) for a source releasing 100 mg/L over a 15 year time period.

At actual solvent release sites, 1,4-dioxane has been found to migrate considerably further in groundwater than TCA or its breakdown products. A solvent recovery and recycling plant in Seymour, Indiana was the site of 50,000 drums and 98 large tanks, all filled with organic chemicals, many of which leaked. The average shallow groundwater flow velocity was estimated to be 400 feet per year. Between 1984 and 1990, the plume of 1,4-dioxane advanced 2,000 feet, to a total length of 3,500 feet. Figure 2 displays plume extents for VOCs and 1,4-dioxane.

At a solvent recycling facility in Silicon Valley, California, plume delineation and treatment system design was completed for chlorinated solvents. After operating a groundwater extraction and treatment system for several years, the laboratory reported 1,4-dioxane present as high as 340,000 ug/L. Subsequent investigations determined that the extent of the 1,4-dioxane plume occupied a considerably larger area than the VOC plume (see Figure 3). 1,4-dioxane may have been concentrated through distillation of spent solvents and released, or may have been stored separately to refortify the solvents following distillation. Existing groundwater treatment systems designed to remove chlorinated solvents are generally ineffective for remediation of 1,4-dioxane, due to its KOC and low Henry's Law constant. In El Monte, California, a liquid granular activated carbon treatment system consisting of two 20,000-pound carbon vessels and treating 500 gallons per minute of solvent-contaminated groundwater was ineffective at reducing influent 1,4-dioxane concentrations at 14 ug/L to the treatment target of 3 ug/L. In the City of Industry, California, an air stripper designed to remove 1.2 mg/L chlorinated solvents at 70 gallons per minute was shown to reduce 610 ug/L influent 1,4-dioxane to 430 ug/L in effluent. Conventional activated sludge and other common municipal wastewater treatment technologies have also proven ineffective at removing 1,4-dioxane.

The remedial technologies most commonly employed in the removal of 1,4-dioxane from groundwater ex-situ are advanced oxidation processes (AOP), often in combination with ultraviolet light. AOP processes include ultraviolet light with ozone, hydrogen peroxide with ultraviolet light, ozone and hydrogen peroxide in combination, and Fenton's Reagent (hydrogen peroxide and ferrous iron). Ultraviolet light causes release of hydroxyl radicals from hydrogen peroxide added to influent contaminated water. The hydroxyl radicals can react with 1,4-dioxane to oxidize the molecule to harmless reaction products (water, carbon dioxide, and residual chloride).

Applied Process Technologies Inc. (APT) has developed an advanced oxidation process, called HiPOx, which has been proven effective at removal of 1,4-dioxane from high-volume flows containing elevated concentrations of chlorinated solvents, at line pressures without ultraviolet light. The HiPOx system meters hydrogen peroxide at about 7 ppm through an injection system, while introducing ozone at about 9%. Calgon Carbon markets a medium-pressure peroxide UV oxidation system that does not use ozone, thereby avoiding formation of undesirable bromates. Hydrogeochem, of Tucson, Arizona, has developed low pressure UV-oxidation systems and tools to optimize concentrations and flow rates to minimize energy costs. UV-oxidation technologies are dependent on water clarity. UV light with a transmittance of 254 nanometers is used, and should have 90% penetration for optimal performance. Nitrate interferes with UV light transmittance, even in turbidity-free water.

Biodegradation of 1,4-dioxane in situ is not presently considered a viable remediation option. The ether bond is a highly stable linkage and not readily biodegraded under ambient conditions. Recent research has established that there is promise for engineered bioreactors treating 1,4-dioxane ex situ. In soil microcosm studies of 1,4-dioxane and tetrahydrofuran, no biodegradation of either compound was exhibited when incubated under ambient conditions. When incubated at 35° C, however, complete biodegradation of both compounds occurred in soil previously exposed to 1,4-dioxane, and to which phosphorous and trace minerals were added. In pure culture, an actinomycete was found to degrade 1,4-dioxane. The strain CB1190 was isolated from a 1,4-dioxane contaminated sludge sample after first enriching the culture with yeast extract and tetrahydrofuran, and incubating the culture aerobically. Strain CB1190 was the first reported pure culture demonstrating sustained growth on 1,4-dioxane as a sole carbon and energy source. CB1190 was tested on other ethers, with the fastest growth rate found for tetrahydrofuran, and no growth found on 1,3-dioxolane and methyl tert butyl ether (MtBE).

Dioxane is essentially immune to biodegradation by microorganisms under conditions normally present in conventional industrial and municipal biotreatment processes. No significant aerobic biodegradation was achieved by microorganisms acclimated to municipal wastewater, soils, or to other synthetic organic chemicals. 1,4-Dioxane is also not amenable to biodegradation under anaerobic conditions.

Summary

Where solvents have been released from spills, leaks, and dumping, the presence of solvent stabilizers should be investigated, particularly at facilities whose operational use of TCA extends for decades and where groundwater contamination by

TCA is extensive. Accordingly, site investigations and remedial designs that have failed to account for this class of contaminants are incomplete, and should be revisited with at least sampling and analysis for 1,4-dioxane in treatment system influent and effluent, in the core of the plume, and at the sentinel wells beyond the leading edge of the plume.

The consequence of finding 1,4-dioxane in groundwater, treatment system effluent, recycled wastewater, or water supply wells is made somewhat ambiguous by the lack of a consistent legal standard for human health and other beneficial uses of groundwater. Cleanup criteria are currently issued at restrictive levels, while some toxicologists believe that physiological-based pharmaco-kinetic models support much higher limits.

Much work remains to characterize the patterns of occurrence and migration of 1,4-dioxane and other stabilizers, to develop federal maximum contaminant levels, and to refine treatment technologies to effectively remove these contaminants from groundwater.

Recent Regulatory Action and Policy Issues

The question of solvent stabilizers, and 1,4-dioxane in particular, is not a new one, and EPA, DTSC, and the RWQCB have all dealt with it in the past 10 years. It is only recently, however, that improvements to laboratory techniques have enabled detection to below the California drinking water advisory level. The San Francisco Bay Region has taken a particular interest and has ordered selected sites in Silicon at which concentrations of 1,1,1-TCA have been highest to test for 1,4-dioxane in site monitoring wells. The Santa Clara Valley Water District and the private water company, whose wells draw from the area impacted by the Fairchild Semiconductor and IBM releases in South San Jose, have tested supply wells. 1,4-dioxane was not detected above 0.5 ug/L, to the relief of all concerned.

As many sites near closure or switch over to monitored natural attenuation, the specter of a new contaminant which is very mobile and recalcitrant is raising concerns, particularly since the jury is out on whether the 3 ug/L Drinking Water Action Level is founded in "sound toxicological analysis". At issue is the use of a linear dose-response curve for extrapolation to humans, when laboratory animals display an observably non-linear dose response pattern. The Action Level is advisory in nature, and

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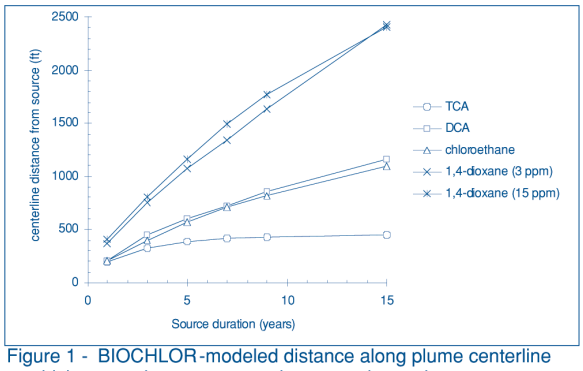

Figure 1 - BIOCHLOR-modeled distance along plume centerline at which contaminant concentration exceeds regulatory thresholds

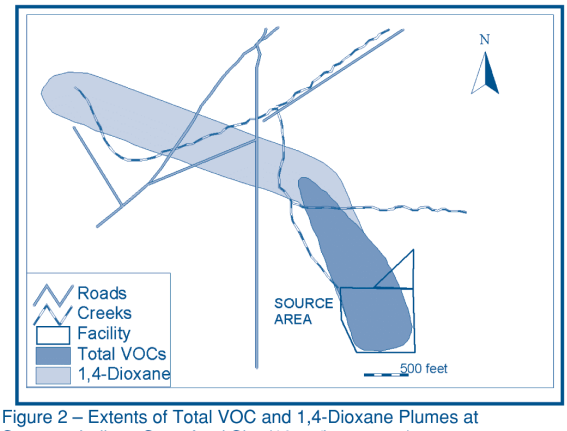

Figure 2 – Extents of Total VOC and 1,4-Dioxane Plumes at Seymour Indiana Superfund Site (10 ug/L contours).

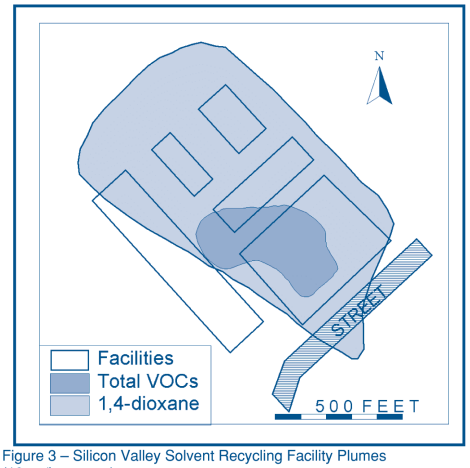

Figure 3 – Silicon Valley Solvent Recycling Facility Plumes (10 ug/L contour).

Table 1 – Solvents and their Stabilizers

TCA	1,4-dioxane	1,3-dioxalane
	nitromethane	1,2-butylene oxide
TCE	1,2-butylene oxide	cresol
	tetrahydrofuran	epichlorohydrin
	diisopropylamine	alkyl pyrroles
DCM	cyclohexane	cyclohexene
PCE	cyclohexene	amines
	butoxymethyloxirane	phenols

Table 2 – Physico-chemical Properties of TCA and 1,4-dioxane

Property	1,4-dioxane CASRN 123-91-1 $C_4H_8O_2$	TCA CASRN 71-55-6 $C_2H_3Cl_3$
Molecular weight	88.10	133.4
H_2O Solubility mg/L @ 20°C	Miscible	1,360
Boiling Pt. at 760 mm Hg	101.1 °C	74.1°C
Vapor Pressure Mm Hg @ 20° C	37 mm Hg @ 25° C	96 mm Hg @20 °C
Vapor Density	3.03	5.45
Henry's Const. atm-m3/mol	3×10^{-6}	1.5×10^{-2}
Log K_{OW}	-0.42	2.49
Log K_{OC}	0.54	2.85
Specific Gravity	1.03 @ 20°C	1.34 @ 20°C

Arsenic in Groundwater...

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100's ug/L range. In low doses, risks are very low, and we want to make the risks even lower. Facts regarding lowering of the arsenic MCL from 50 ug/L to 5 or 10ug/L, based on USEPA studies (USEPA 2000b):

Annual cost for compliance - $200 million to $800 million (assumption dependent)

Cost per cancer case avoided - $4 million to $14 million (assumption dependent)

Number of cancer cases avoided per year is FIFTY. Have we gone mad? Perhaps it is all the arsenic we have been drinking? More money is the only real cure – anything else is just treating the symptom. Put the money where it will do the most good.

One of the challenges is that we are trying to address the problems with treatment solutions one chemical at a time, which is ineffective and cost prohibitive. Then there is the issue of paying for water that is risk-free: the public does not feel obligated, water board members have a high level of risk in raising the rate increase issue, and USEPA is risk-free of the cost issue and political implication. If zero-risk water were really the answer, then perhaps the federal government should: make the recommendation; provide loans to the water suppliers; and increase the water rates, taking the political pressure off the local elected officials and placing it on our congressional leadership. Now there's a solution, - but try to find a federal politician that wants to be exposed to that level of risk. They'd probably sooner drink water laced with arsenic.

Joseph D. Gonzalez, Attorney, Masry & Vititoe, presented on: "Arsenic: No Cost Should be Spared." The expectations begin with the duty government has to protect the public from exposure to toxic chemicals. The government and people who sell water have a duty to provide all persons living in this country with arsenic-free drinking and domestic use water, to keep the public informed at all times of any potential contamination in their drinking water, and to warn and

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- Systematic, comprehensive, and coordinated approaches to data collection, evaluation, and application;
- Encourage outreach and education to improve public understanding of our water resources;
- Disseminate scientific information and encourage practical application of research and new technology; and,
- Facilitate communication between policy makers and scientists and engineers.

We need action now to evolve our political and institutional structure and implement necessary technical analyses, or we will fail to avert California's water crises.

Below are selected points from the Conference Keynote Address.

Groundwater Management – Where Are We Headed?

BY STEVE MACAULAY,
Chief Deputy Director
California Department of
Water Resources

Introduction

I was assigned an interesting topic to cover – where are we headed? Isn't that what all the other speakers are talking about? I'll try my best to look into the crystal ball and see what pops out.

- More aggressive management including specific conjunctive use programs;
- Recharge with reclaimed water;
- Private investment in groundwater banking; and,
- More close integration – on a large scale – between surface water and ground water storage facilities (Greg Thomas told me to say this).

Groundwater management is like a Monet painting – it looks and sounds good from a distance. Implementation of effective management of this underground resource is not easy. Just look at the kinds of problems some of the Conference speakers are dealing with:

Wil Boschman from Semitropic, and his District's very successful partnerships with urban water agencies – pushing the limits on institutional relationships and reaching success;

Marv Shaw from Cadiz, implementing a major private-public partnership;

Vicki Newlin from Butte County, dealing with an untested groundwater ordinance, a valuable and locally important groundwater basin, and an engaged citizenry;

Rick Iger who has lived and breathed the Kern Water Bank for a decade, including surviving those initial years when this was to be a SWP project.

We Have Money – Isn't it great that California voters passed $3 billion in water bonds over the past five years? This helps us survive the era of 15 percent budget cuts and the general tightening of our belts with the downturn in the economy. While this is a great start, it isn't quite like the investment voters supported in 1960 with the Burns-Porter Act, which in present dollar terms represented more than a $10 billion investment in water resources development.

Proposition 204, the Safe, Clean, Reliable Water Supply Act, provided $30 million under the Water Conservation and Groundwater Recharge Subaccount. Of this authorization, $22.1 million was awarded for grants and loans to fund construction of groundwater recharge facilities by local agencies. All the available funding has been obligated; requests for groundwater recharge projects and studies totaled over $40 million.

Proposition 13 provides $230 million for feasibility studies and construction of groundwater recharge and conjunctive use facilities. Last fiscal year, $9 million from the Groundwater Recharge Program and $9.5 million from the Groundwater Storage Program were obligated, with a focus on feasibility and pilot studies. Over $160 million was requested by applicants.

For fiscal year 2001-02, $91 million is available for groundwater storage construction grants and $10.48 million for groundwater recharge construction loans.

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educate potentially impacted members of the public. Beliefs and views of the public include: blaming the government for the problem because government is ineffective, and those that sell contaminated water are only out to make money.

The exposed population issues include: question of harm to family; source of contamination industrial or natural; looking for a guaranteed safe supply; no warning; no government prevention or action; what is the cost and who will pay; can this be fixed; there are no "safe levels" of exposure to arsenic. No cost should be spared. We need a clear-cut policy from the government. Don't feed my family chemicals unless you know it is safe. There are lies and then there's statistics. Regulatory issues, scientific issues, political issues are not the same as people issues. From a social standpoint, people find it unacceptable to knowingly put their families at risk.

The costs associated with preventing exposure to arsenic are deminimus when compared to the costs associated with potential future impacts to peoples' health. From an economic standpoint the extent of additional societal costs associated with exposure to chemicals such as arsenic, e.g. added health care, educational care, etc., probably outweigh the costs associated with paying to make sure that the water that consumers drink is chemical free. We should also take into account the added costs associated with people hiring lawyers to sue industrial polluters as well as regulatory agencies.

Krista Clark, Regulatory Affairs Specialist, ACWA, provided a presentation on "The Political Mess Known As Arsenic." A contaminant by any other name would not have received the political attention that arsenic has garnered this year. Despite years of scientific studies and regulatory motions, it took only "one delay of effective date" by the new administration of the USEPA to make arsenic the topic of every political pundit and late night talk show in America.

Politics and arsenic: Whitman says she wishes she just let the court decide on arsenic. Bush is viewed as anti-environmental, despite last minute adoption of the 10 ug/L "Clinton Rule" last January. An angry Congress reacted with the House adding arsenic 10ug/L language to a bill, and the Senate demanding an immediate MCL. Many states capitalizing on the Bush blunder, including Delaware which has adopted 10 ug/L, California which has passed legislation for an arsenic PHG and subsequent state MCL, and New Jersey and Vermont headed towards similar action.

Lessons learned from hexavalent chromium: public fears spur political action. Health officials caution for patience and deliberation, while California lawmakers introduce a bill for easy "public health" points. Experts determine hexavalent chromium is "not cancer-causing", but the bill passes anyway, with public funds being spent needlessly on a new regulation.

Lessons learned (again): support good science first; use politics only as a last resort. Politics will always win over science. Since politics will always influence science, give politicians a reason to set good policy. Local elected officials are a key due to more budget concern on a local and limited basis. Hexavalent chromium is a good example of how science should have won, but politics did. A sure way to appear anti-environmental is to meddle in something named "arsenic".

John Gregory, Attorney, LeBoeuf, Lamb, Green & McRae, provided a presentation titled "Impacts of Changes in the Arsenic Standard on Contaminated Site Investigation and Cleanup." The setting of a new, lower drinking water standard for arsenic will have potentially significant impacts on compliance with other regulatory programs, including federal and state programs governing the investigation and cleanup of contaminated sites. USEPA did not consider, and the Safe Drinking Water Act specifically excludes USEPA from considering, ancillary costs of compliance in developing a new drinking water standard for arsenic. There are likely to be cascading affects from this new lower MCL as well as legal impacts. The impacts and affects of the new standard may include:

- A lower MCL will be a new ARAR
- Existing supply systems
- Consideration of other hydrogeologic zones
- Re-opening of hazardous substance cleanup sites
- Re-visiting of potentially responsible party agreements
- Diminution of property values
- Property acquisition impacts regarding environmental due diligence
- Impacts on loaners and insurers.

Susan E. Umshler, Attorney, Law & Resource Planning Associates, Inc., presented on " Arsenic Fear and Democracy: How Low Does a Community Want to Go?" Social and legal consequences of a new, lower arsenic MCL will have many implications, including potential alteration of the arsenic natural cycle. And then there are the hazardous waste issues with RCRA implications, the Clean Water Act with National Pollution Discharge Elimination System (NPDES) permit implications, CERCLA and Superfund site cleanup implications, and western water law and water quantity supply implications – issue of losses during treatment and replacing water rights.

Statistics are like a bikini: what it reveals is very interesting, but what it conceals may be the critical parts. The arsenic rule does not evaluate all the costs. Setting a lower arsenic standard for drinking water will effect many other things. Removal from water requires placing the arsenic somewhere else – and then there is the issue of waste generation. NPDES permits will be effected by a new MCL; total maximum daily load values (TMDLs) are going to be in the next war. This is like the rat problem with the mongoose (bad) solution.

There are three alternatives:

- Leave the arsenic standard alone and provide free health care
- Leave the arsenic standard alone until there is more data about actual health threats and harmful levels
- Set the national standard at 30 ug/L and let the communities themselves decide if they want to spend or borrow the money to go lower.

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California Legislative Corner

Senate Bill 221 Signed in to Law

BY MICHAEL FIFE, JD

On October 9, 2001, Governor Davis signed into law Senate Bill No.221, also know as the Kuehl Bill for Senator Sheila Kuehl (D-Santa Monica) the author of the legislation. SB 221 has been described as a landmark in smart growth legislation and is often erroneously summarized as simply requiring developers planning developments of 500 houses or more to demonstrate that an adequate supply of water exists to supply the development. In reality, however, the bill has suffered many amendments in its journey through the legislative process, and the final mechanics of the bill, while providing a useful link between planning agencies and water supply entities, will not likely bring development in California to a halt.

SB 221 is the latest incarnation of the concept of providing a strong link between the decisions of planning agencies to approve development and the availability of water to serve that development. Its predecessors include SB 901, which was authored by Senator Costa (D-Fresno) and passed in 1995. That bill also required an assessment of the availability of water to supply development, but allowed a local agency to approve the development even if the assessment showed that sufficient water was not available.

One of the major proponents of SB 221 was the East Bay Municipal Utility District. Its support stemmed from an incident in which the Contra Costa County Board of Supervisors approved an 11,000-home subdivision, even though the agency protested that it could not guarantee the availability of water to the subdivision in the event of an extended drought. Contrary to the common perception that SB 221 requires a developer to demonstrate that an adequate supply of water exists, it is this dynamic between a county planning agency and a water provider which forms the basis for the procedures mandated by SB 221.

"The adequacy of the determination, whether it finds that sufficient water is available or that sufficient water is not available, will be judged according to a 'substantial evidence' standard."

SB 221 began as Assembly Bill 1219 when Senator Kuehl was a member of the Assembly. Originally the bill was only one sentence long and read: "No lead agency shall approve a development project unless the applicant identifies a long-term, reliable supply of water to serve the proposed project." Since that time the Bill has grown considerably and in its final form stretches to eight pages.

The process described by SB 221 begins when a tentative map application for a proposed subdivision is determined to be complete by the city or county to which it is submitted. Within five days of such determination, the application is sent to the public water supplier that will supply water for the subdivision. The water supplier must respond within 90 days with a "verification" as to whether or not sufficient water will be available to serve the subdivision. If the water supplier states that sufficient water will not be available, then the development agreement "shall not be approved."

The first major qualification to the simple process outline above is that a "subdivision" is specially defined as a residential development of more than 500 dwelling units. This number is a significant compromise in the bill, which originally defined a subdivision as a residential development of more than 200 dwelling units. For water systems that have fewer than 5,000 connections, however, a "subdivision" is defined as any proposed residential development that would account for an increase of 10% or more in the number of the water system's existing service connections.

The other point to note about the definition of a subdivision is that it includes only residential development. Industrial and commercial development is not included within the ambit of SB 221. Some have suggested that this may have the unintended consequence of creating an added force pushing new residential development away from cities' industrial and commercial centers where water supplies are more restricted, thus further promoting increased urban sprawl. However, it is also possible that the bill will encourage mixed use development since a developer can avoid the procedures of the bill by mixing in some commercial development in lieu of some amount of residential development in order to bring the development under the 500 home threshold.

Another qualification in the bill is that it only applies to water suppliers that operate a "public water system" where that term is defined as a system of 3,000 or more connections for the provision of piped water to the public for human consumption. However, this definition should not limit the applicability of the bill since, in the absence of the existence of a public water system as defined, the local planning agency is mandated to make the same findings as would have been required by the water supplier in its verification of the availability of water.

The basic determination to be made by a water supplier concerns the availability of sufficient water supply for the proposed development. The meaning of a sufficient water supply is specially defined as a supply that is available during both normal and "multiple-dry" years. In order to determine whether such a supply is available, the water sup-

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Remaining funding is very limited for feasibility studies. Requests from applicants with good projects are expected to far exceed the available funding for both feasibility studies and construction.

The final funding cycle for these two groundwater programs will be fiscal year 2002-03. There will be $79.5 million available under the Groundwater Storage Program and $8.72 million available under the Groundwater Recharge Program.

Is there enough money to go around? The good news is there is competition for the large amount of money available for groundwater projects. We probably could not say that a few years ago. But there are many good potential projects, and another water bond down the road would really help for groundwater, water use efficiency, and critical water infrastructure.

We Have Implemented Good Projects:

- Semitropic;
- Kern Water Bank;
- Arvin Edison/MWD water banking program;
- Mojave Water Agency.

We Have More Projects Being Proposed or Implemented:

Cadiz/MWD storage of surplus Colorado River water in Fenner Valley. Extraction capacity is up to 150 TAF per year;

Hayfield Valley/MWD – up to 800 TAF of available storage, 150,000 af/yr recharge of Colorado River water $35 million State funding);

Integrated Storage Investigation (ISI) Program – we are emphasizing local development and local benefits as priorities;

Azurix/Madera County – storage capacity of up to 450 TAF. The "Madera Ranch" proposal may look good from a technical standpoint, but there are documented serious implementation challenges – political, institutional, legal AND some technical problems to work out.

We also have the grants to collect groundwater data and conduct groundwater studies, authorized by AB303 (24 grants, $5 million this year).

We Are Investing in Better Institutional Relationships.

Key to ISI is local, local, and local. The ISI emphasizes that plans and projects be comprehensive and integrated.

A foundation of related efforts, such as the Phase 8 Agreement, is also local leadership.

We have more open processes, aimed at collaboration and mutual interests. Only a few years ago DRW was pushing State control of everything – it has not worked as well as the current approach: ISI, the update of the California Water Plan, CALFED. These are all open processes, fostering and promoting closer and more positive institutional relationships.

Let's not forget the AB3030 voluntary groundwater management plans – authorized almost 10 years ago and voluntarily developed by 160 local agencies.

What About Quality?

More aggressive use of reclaimed water needs to be in our future, but there are quality concerns that show up in newspaper headlines weekly – sometimes daily. Our colleague, UCD professor Takashi Asano, recent winner of the international Stockholm Water Prize, has spent his entire career promoting wastewater reclamation and reuse. It is an outstanding achievement that this field is recognized for its critical importance in helping to meet the world's water needs. Quality is a paramount concern – while we have been recharging reclaimed water for decades, a new contaminant or pathogen is discovered periodically that ups the ante on treatment.

No matter what, we cannot afford to waste "wastewater."

No matter what, we need to make it safe and convince the public that it is safe.

And, thinking in the very long term that is typical of Dutch water resources engineers, we need to restore full use of quality-impaired groundwater basins.

Integrated Resources Planning

Water and growth. There's a connection somewhere. As you may know, in January 2002, two new laws go into effect that strengthen the permitting process pursuant to which cities and counties determine the adequacy of existing and planned future water supplies to meet current and planned future demands on those water supplies. Senate Bill 221 specifically prohibits a city or county from approving a residential subdivision of more than 500 units unless there is written verification that a sufficient water supply is or will be available for the development. Senate Bill 610 specifically changes the current process for coordinating water supply planning between local water suppliers and local land use agencies to require additional information regarding water supply reliability and groundwater supplies in Urban Water Management Plans.

These will require much better knowledge of water supply reliability by land use agencies. In recent years a number of progressive urban water agencies have gone through integrated resource planning efforts – IRPs – which take a close look at integration of all available water supplies and water use efficiency measures. So why am I talking about this at a groundwater conference? Groundwater is the largest single source of supply in California, and implementation of more aggressive management of this important resource is essential to California's future. Groundwater management is already a key component of water supply planning in many areas, but it is the integration of groundwater management and use with other sources of supply that needs more attention. For example:

- For any given area, how does the groundwater resource contribute to water supply reliability?
- How are decisions made to use groundwater one day and surface water the next?
- How are decisions made to recharge or extract banked supplies?

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23rd Biennial Groundwater Conference

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- How does reclaimed water fit into the picture?
- Is there an overall entity – or maybe even an overall plan – which integrates all available water resources?
- How do local drought contingency plans deal explicitly with groundwater resources?

Concluding Comments

DWR has never been more optimistic about the future for groundwater management. After decades of inattention – particularly at the State level – we are aggressively encouraging and pursuing opportunities for better management, we are helping to develop workable projects and programs, and we are getting money "out the door" for local implementation.

Every two years at this Conference, we are reminded by Carl Hauge of how little of our planning budget we spend on California groundwater. That is changing. The money has increased. The policy attention has increased. We even have legislators who know about groundwater? Life is good.

It is the full integration of our collective water supplies – especially groundwater – that will be our future.

Watershed and Groundwater Hydrology and Source Water Assessment Methodology Workshop Debuts in March 2002

GRA, in conjunction with the University of California and the California Department of Health Services will offer workshops on Watershed & Groundwater Hydrology and Source Water Assessment Methodology in March 2002. These two-day workshops will be held during the first week of March in Sacramento and the second week of March in Orange County.

The Workshop instructors will be: Graham Fogg, University of California, Davis; Thomas Harter, University of California, Davis; Larry Rollins, University of California, Davis; Anthony Saracino, Saracino-Kirby-Snow; Leah Walker, California Department of Health Services; and Reah Williamson, California State University, Santa Cruz.

The preliminary program, "Understanding Watershed and Groundwater Hydrology", agenda for Day One includes: Overview of the Drinking Water Source Assessment and Protection Program (DWSAP); Watershed Hydrology; Groundwater Hydrology; Legal Control of Water Resources; Surface Water Quality; Groundwater Quality, Sampling and Monitoring; Surface Water Contaminants; and Groundwater Contamination.

The preliminary program, "Source Water Assessment Tools - DWSAP and Beyond", agenda for Day Two includes: Delineation of Surface Water Sources; Delineation of Groundwater Sources; Potentially Contaminating Activities; Vulnerability Assessments; Protecting Water Resources (w/Video); Case Studies; and Use of TurboSWAP.

Additional information will be available in early January 2002 on GRA's Web site, www.grac.org or through the GRA office at (916) 446-3626.

Meet GRA's Staff

KEVIN BLATT, GRA WEB & DATABASE MANAGER

Kevin is a consultant, doing business as iHappi.com, who specializes in establishing successful Internet identities. He has served as the GRA Web and Database Manager for the past two years and recently received the GRA Tribute of Appreciation. Some of his other clients include the California Council of Geoscience Organizations (CCGO), Fast-Tek Engineering Support Services, and Pacific Capital Mortgage.

Prior to becoming a contractor with a primary focus on social benefit organizations, Kevin worked in the private sector (Arthur Andersen (now Andersen) and Pacific Capital Mortgage), as well as the public sector (National Institute for Global Environmental Change (NIGEC) and the City of Vacaville Department of Housing and Urban Development). In 1998, he earned a B.S. degree in Managerial Economics from UC Davis, graduating with honors. Shortly after leaving Davis, he became intrigued by the idea of "Social Enterprise," where nonprofit organizations, such as GRA, adopt an entrepreneurial spirit in order to better fulfill their missions.

Senate Bill 221 Signed in to Law

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plier must analyze availability over a historical record of at least twenty years and must take into account any urban water contingency analyses that have been made by the water supplier pursuant to Water Code section 10632. The determination must also consider any reductions in water demand by specific uses where such reduction is made pursuant to a resolution or ordinance adopted, or a contract entered into, by the water supplier. Finally, the amount of water that the supplier can "reasonably" rely on receiving from other water supply projects, such as conjunctive use, reclaimed water, water conservation and water transfers must also be considered.

The adequacy of the determination, whether it finds that sufficient water is available or that sufficient water is not available, will be judged according to a "substantial evidence" standard. It will likely not be clear for some time exactly what type of analysis will be required in order to meet this standard. For example, the bill does not specify whether the twenty year historical period should be the previous twenty years, or should be chosen to represent a normal fluctuation of normal and dry years, or whether it should include the most severe multiple dry years on record. However, the bill does reference section 10635 of the Water Code, which addresses the assessment of service reliability in normal, dry and multiple dry water years for the purposes of formulating urban water management plans. Water Code section 10635 itself cross-references section 10631 of the Water Code, which describes in detail the findings that must be made by such plans. These Water Code sections will thus play a key role in defining the precise dimensions of "substantial evidence" for the purposes of SB 221.

"We will see to what extent developments of 499 residential units become the industry standard."

If the determination described above relies upon projected water supplies that are not currently available to the water supplier, then to the extent applicable, the determination must be based upon: (1) written contracts or other proof of valid rights to the identified water supply that identify the terms and conditions under which the water will be available to serve the proposed subdivision; (2) capital outlay programs for the financing of the delivery of the water; (3) the successful acquisition of applicable federal, state and local permits for the construction of the necessary infrastructure for the delivery of the water; and (4) necessary regulatory approvals that are required in order to be able to convey or deliver the water to the subdivision.

"It is not clear from the bill what will satisfy this standard…or even how such a determination could be made in an unadjudicated groundwater basin."

The verification must also contain a description of the reasonably foreseeable impacts of the proposed subdivision on the availability of water resources for agricultural and industrial uses within the public water system's service area that are not currently receiving water from the water supplier but which are utilizing the same sources of water, for example, where they both draw from the same groundwater basin. This analysis, however, need only be based upon published records of federal and state agencies, and public records of local agencies, though even based upon this limited source material it may be difficult for a water supplier to formulate a response that is defensible under a substantial evidence standard.

Where the water supply for the proposed subdivision includes groundwater, the water supplier must evaluate, again based upon substantial evidence, the extent to which it or the landowner has the right to extract the additional groundwater needed to supply the proposed subdivision. It is not clear from the bill what will satisfy this standard in this context or even how such a determination could be made in an unadjudicated groundwater basin.

The water supplier is given a 90 day period in which to respond to the request for a verification of the availability of water after which period the local agency "or other interested party" may seek a writ of mandamus to compel compliance with the requirements of the bill. If the water supplier still does not respond, then the local agency may find that sufficient water exists for the development. It is interesting to note that the bill does not say that in this circumstance the local agency is allowed to find that insufficient water exists. However, once again, the finding of the local agency is supposed to be based upon substantial evidence.

Finally, the bill contains exclusions for residential projects that are proposed for sites that are within urbanized areas and have been previously developed for urban uses, or where the immediate contiguous properties surrounding the residential project site are, or previously have been, developed for urban uses, or housing projects that are exclusively for low-income households. Similarly there are other exclusions for residential developments that benefit lower income households, and there is a general exclusion for the County of San Diego to the extent that there is compliance with the previously adopted Proposition C.

While SB 221 is certainly a more forceful attempt to link development to an adequate water supply, the success of the bill will depend upon a variety of as yet uncertain factors. For example, we will see to what extent developments of 499 residential units become the industry standard. More importantly, we will see to what extent the "substantial evidence" standard that is attached to verifications of both sufficient as well as insufficient water supplies makes it impossible for water suppliers to provide any kind of adequate response to verification requests. Ultimately it may be the legal morass created by the inability to meet

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GRA Presents Annual 2001 Awards

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approach to regional planning, protection and management of groundwater.

Water purveyors in southern Placer County and northern Sacramento County formed the American River Basin Cooperating Agencies (ARBCA) to initiate work on implementation of the regional conjunctive use program envisioned by the Sacramento-Area Water Forum. This effort, referred to as the Regional Water Master Plan (RWMP), is the development of equitable, cost-effective water resource management strategies for enhancing water supply reliability and operational flexibility for water users of Folsom Lake, the lower American River and the connected groundwater basin.

Since the groundwater basin underlying the service areas of the American River Basin Cooperating Agencies is under the Sacramento Groundwater Authority's (SGA) jurisdiction, and the RWMP is structured to implement the goals of both the Sacramento Area Water Forum and SGA, ARBCA and SGA formed a "partnership" to develop and implement the regional water resources management strategies identified in the RWMP as cost-effectively and efficiently as possible.

The GRA Board of Directors, Members and Staff congratulate Carl Hauge and the American River Basin Cooperating Agencies and Sacramento Groundwater Authority Partnership on being chosen as the 2001 recipients of GRA's prestigious annual awards.

Encourage your colleagues to join the growing list of new GRA members. Send them to www.grac.org to join!

GRA Welcomes the Following New Members

October 1, 2001 - December 1, 2001

Leo Alvarez	Lowney Associates
William Bazlen	
Timothy Becker	Treadwell & Rollo, Inc.
Douglas Bleakly	SMI, Inc.
William Bourcier	Lawrence Livermore Lab
Megan Bryan	Soilmoisture Equipment Corp.
Joseph Cote	SunStar E.F.S., Inc.
Mike Dryden	Severn Trent Laboratory
Bradley Esser	Lawrence Livermore National Laboratory
Dan Eyde	GSA Resources, Inc.
Sharon Felix	Retec
Daniel Fresquez	Musick, Peeler & Garrett, LLP
Robert Horwath	AllWest Environmental
John Kramer	CONDOR
Peter Langtry	Lowney Associates
Brian Levers	CA SWRCB Division of Clean Water Programs
Kenneth Loy	IT Corporation
Mark Lyverse	Chevron Research & Technology Company
Sherman May	Sherman May Consulting, Inc.
Michael McGuire	Treadwell & Rollo, Inc.
Greg Miller	Daniel B. Stephens & Associates
Kevin Molander	Fusion Staffing Services
Tony Morgan	Layne GeoSciences
Tom Mulder	IT Corporation
Gregory Murphy	Locus Technologies
Karen Peitz	California Farm Bureau Federation
Chris Petersen	Montgomery Watson Harza
Jeff Phillips	
Michael Rafferty	S.S. Papadopulos & Associates, Inc.
Vanessa Reymers	Santa Clara Valley Water District
Henry Rodegerdts	California Farm Bureau Federation
Scott Romine	URS Corporation
Pete Santina	SMI, Inc.
Sam Schaefer	Science Applications International Corp.
Brian Schroth	CH2M Hill
Philip Smith	Treadwell & Rollo, Inc.
David Sweeten	BNC Environmental Studies
Larry Tolman	New Century Water
John Valett	Weiss Associates
Richard White	Soilmoisture Equipment Corp.
Joseph Wong	Black & Veatch
Betsy Woodhouse	Southwest Hydrology
Edward Wosika	SWRCB

Senate Bill 221 Signed in to Law

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the substantial evidence standard to show either the availability or the unavailability of water that limits large developments, rather than the actual lack of water for such developments.

The full text of SB 221 can be viewed online at: www.leginfo.ca.gov.

Michael Fife is an attorney specializing in water law with the law firm of Hatch and Parent. He represents both public and private water supply entities in a full range of water related contexts.

Solvent Stabilizer Compounds

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water purveyors may serve water containing up to 100 times that concentration, yet few would ignore the perceptions of their customers or risk significant liability after the fact. Water purveyors in general prefer not to provide drinking water with measurable concentrations of anthropogenic compounds, regardless of how safe the experts may proclaim it.

From a business perspective, the customer doesn't want it. From a health perspective, the synergistic effects of multiple organic contaminants is difficult to assess, and the incidence of cancer in our society remains unacceptably high. The non-carcinogenic effects of 1,4-dioxane, liver and kidney damage, remain a concern. For these reasons, we continue to call for revisiting solvent sites at which TCA was used in vapor degreasing and released at high concentrations to test for 1,4-dioxane.

Full references for the information presented herein may be found in the Solvent Stabilizers White Paper, in which this subject is treated in greater detail. The White Paper may be downloaded at http://www.scvwd.dst.ca.us/stabilizers.

Tom Mohr is the Solvents and Toxics Cleanup Liaison for the Santa Clara Valley Water District and serves on the Board of Directors of GRA. Mohr is a Certified Hydrogeologist with 17 years experience.

New Secondary Earth Science Curricula...

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them gain the content knowledge and skills needed to implement inquiry-based programs effectively. Professional development for teachers is made possible with support from the American Association of Petroleum Geologists Foundation, the Geological Society of America, and the AGI Foundation. For more information about these programs, including a comprehensive brochure that includes a sample activity from AGI's EarthComm(tm) or Investigating Earth Systems(tm) programs, visit the AGI Web site, www.agiweb.org/education, or contact Dr. Michael J. Smith, AGI Education Director, at msmith@agiweb.org.

Arsenic in Groundwater...

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GRA wishes to thank the speakers, organizing committee, and ooperating agencies: International Association of Hydrogeologists (IAH), Water Education Foundation (WEF), California Groundwater Association (CGA), National Groundwater Association (NGWA), American Groundwater Trust (AGWT), The Professional Environmental Marketing Association (PEMA), Association of California Water Agencies (ACWA), and The Natural Resources Section of the California State Bar. We also wish to thank our sponsors Bookman Edmonston Engineering, Kinetico Incorporated, LFR Levine-Fricke, and Montgomery Watson Harza.

References used for this article are available on GRA's Web site at www.grac.org.

Editor's Note: Due to HydroVisions' publication deadline, the Symposium speakers have not had the opportunity to review the above Symposium summary, which does not necessarily represent the views of the speakers or their organizations.

Letters to the Editor

Confidentiality of Well Completion Reports

BY EUGENE E. LUHDORFF, JR., ELK GROVE, CA

I read with interest, Floyd Flood's editorial on the Confidentiality of Well Completion Reports. Having been a licensed Water Well Contractor as well as an engineer, I thought perhaps I should respond to his article since the topic has always been of interest to me. Let me begin by reviewing my exposure to this topic. I joined my father's business of pump and well drilling in 1957 after leaving the Navy that I had joined in 1953. I had graduated from UCD in 1953 in a water science curriculum. Prior to that period, I had worked in the family business on well construction and pump installations beginning in 1944. I eventually took over the business, and became a licensed well driller in California, Idaho, Arizona, Nevada, and Washington. Additionally, I constructed wells in Montana and Oregon under other's well construction licenses. As a contractor and engineer, I also consulted on well construction methodologies in the Philippines, Japan, Venezuela, Ecuador, Canada, Iran and India. Within the well construction industry, I served as President of the California Well Drillers Association for two years; I was on its State Board for over 10 years. I served on the Board of Directors of the National Water Well Association for two years. I site this experience only to point out my exposure to the subject at hand. In all of my exposure to various State laws, I can honestly say that California has the weakest regulations governing well construction I have encountered.

In Mr. Flood's editorial, he points out that our State Water Code, requiring confidentially, was established in 1949. I can tell you that these requirements were originally proposed by well drillers, not land owners, who felt the knowledge gained by actual well construction was an advantage in learning the basin geology of the area, thereby knowing how deep to drill, what kind of production from a well to expect, as we moved from dry land farming to irrigated agriculture in California. Some drillers in the State refused to submit completion reports because of their beliefs that this information was theirs and did not belong to the State.

How different we are from other States. Arizona and Washington both have tough (but good) regulations governing well construction. They both collect and disseminate well logs gathered from local well drillers. They look at aquifer characteristics to insure that a newly constructed well, if permitted, will not damage existing well performance.

California needs to readdress its State Code regarding the confidentiality of its well logs. We long ago have completed our transformation from a dry land State to an irrigated State. Today, countless bulletins have been published by the USGS and various State Agencies that define our ground water basins. There are no secrets anymore. It is time to release the data. And remember this, the source and quality of the data may not allow one to define a ground water basin's characteristics. It will only be a beginning.

Letters to the editor, Floyd Flood, are welcome and encouraged. Please submit your letter to editor@grac.org

Sacramento Branch Highlights

BY BARBARA HEINSCH,
EVENT CHAIRPERSON

Aerial Photography Interpretation Workshop a Success

On November 10, 2001, the Sacramento Branch of the California Groundwater Resources Association presented their first annual AERIAL PHOTOGRAPHY INTERPRETATION WORKSHOP. It was a huge success as measured by the comments from the participants during and after the workshop. The Sacramento Branch had a goal of 50 participants; at 58 confirmed registrants, the Branch had to turn a few people away. Rest assured, the Branch plans to hold the workshop in the future as further discussed below.

At a recent Sacramento Branch field trip participants stand at the edge of the Missouri Canyon tributary to Greenhorn Creek near the Sierra Nevada foothills town of Colfax in the "You Bet" and "Red Dog" mining districts. In the background, a voluminous amount of sediments carried downstream from just two of the hydraulic mines of the California Gold Rush era can be seen.

The Lead Instructor for the all-day workshop held at the Red Lion Inn in Sacramento was Dr. Brian Hausback, California State University Sacramento Geology Department Chairperson. The workshop started with an Aerial Photography Overview presented by Dr. Hausback, which included a summary of the history of aerial photography, how aerial photography has progressed to its current form, the purposes of aerial photography, a description of the features of aerial photographs, and how to review them.

The main portion of the workshop was hands-on practice sessions for participants to learn how to interpret aerial photographs. All participants were encouraged to either bring their own stereo glasses with them for use during the class or to purchase them prior to the class. (During registration, participants could purchase their own set). The workshop was set up as follows: The classroom was equipped with seven tables, each with a different set of aerial contact prints and a teacher's assistant (TA) to help the participants (eight participants per table). The TAs had each prepared a set of questions to guide the participants' review during the 30-minute photo sessions. When the participants completed their initial review of the photos, the answer key was provided and discussed. This provided the opportunity for the participants to make sure they had a thorough understanding of the information to be gained from the photos. Dr. Hausback circulated throughout the workshop to each table session to answer questions and offer help as needed. The photo sessions and the TAs for the hands-on workshop were as follows:

1. Miners/Secret Ravines: Steve Lofholm, Senior Project Manager, IT Corporation
2. Fault Investigation: David Bieber, Senior Geologist, GEOCON
3. Landfill: John Burgess, Technical Representative, and Kevin Bergman, Project Supervisor, both of Cartwright Aerial Surveys, Inc., in Sacramento, California
4. Gas Station: Patrick Fischer, Senior Engineering Geologist, Blackburn Consulting
5. Phoenix Field (former airfield): Eric Chase, Senior Engineering Geologist, Sierra-Pacific Group
6. Kingsford Charcoal (manufacturing facility): Roy Kroll, Geosciences Manager, Youngdahl Consulting Group
7. Metals Fabrication Shop: David Von Aspern, Director, Site Assessment Group, Wallace-Kuhl & Associates, Inc.

The concluding portion of the workshop was a Digital Aerial Photography Demonstration given by John Burgess, Technical Representative of Cartwright Aerial Survey, Inc. The Digital Demonstration showed how aerial photos could be digitized, then via use of a software program such as Photoshop™, the aerial photos can be enlarged, enhanced, and maneuvered as needed in order to clarify details and better interpret the photos.

Cartwright Aerial Survey, Inc. donated the contact prints used in the photo sessions. Roy Kroll (Youngdahl) and Barbara Heinsch, Yolo County Division of Integrated Waste Management (GRA Sacramento Branch Past President) were the coordinators for the workshop. David Von Aspern, GRA Sacramento Branch and statewide Treasurer, was also instrumental in the success of this workshop.

GRA's Sacramento Branch plans to conduct this workshop on an annual basis. The next class will likely be in the fall of 2002 and include more photos on geologic features such as landslides. Also, we are considering having the first portion of the subsequent workshop be a review section for beginners and the second portion be more advanced with applied problem sets with more detail.

COOL FIELD TRIP

The Sacramento Branch hosted a November 17, 2001 field trip led by Michael P. Hunerlach of the Sacramento Office of USGS. The group discussed the Tertiary river systems, observed tunnel and channel systems related to hydraulic mining, and panned for and found mercury at the Polar Star Mine tunnel. *Thanks Mr. Hunerlach!*

Southern California Branch Highlights

BY PAUL PARMENTIER, PRESIDENT

"Whiskey is for drinking, and water is for fighting over"

and

"Water doesn't flow downhill, it follows money!"

The Southern California Branch tries to keep its members informed on groundwater-related events and news through general-distribution emails. Most members find this periodic inflow of informative emails useful, even if occasionally repetitive. We encourage Branch members to send us interesting email items for distribution by contacting any Branch Officer (see GRA's Web site for email links to each Officer).

In October, the Southern California Branch held an evening meeting arranged by Tony Maggio, where Greg Middleton of the Mojave Water Agency (MWA-see Web site at www.mojavewater.org) presented a unique overview of the groundwater resources of the MWA Mojave river area. Mr. Middleton started with a description of the almost 5,000 square miles making up the agency. Groundwater levels have been steadily decreasing due to overproduction, while the projected increases in the area's population by 2015 highlights a reason for concern in regard to the region's water demand.

The basin is known for its overall low-TDS quality of groundwater, with lower TDS near the southern recharge areas and gradually increasing TDS northward. The Basin has a very diverse hydrogeologic regime, with a wide variety of desert conditions, and a river that flows mostly underground with the occasional daylighted area providing sites where beavers still can be found! Water is used in the basin for drinking water and for agriculture (primarily alfalfa fields — root systems that have been known to reach over 100 ft in depth).

A summary of the water budget illustrated the apparent annual 56,000 acre-feet (AF) excess in usage (108,000 AF/yr) compared to the recharge of the aquifers (52,000 AF/yr). MWA's focus is therefore on gradually reducing the demand on the area's groundwater resources and increasing the recharge into the aquifers. MWA is jointly conducting basin-wide studies with the USGS, focusing initially on groundwater chemistry.

To monitor groundwater extraction, MWA is relying on groundwater extraction reports from private parties. These annual extraction reports — rather than relying on flowmeters, are generally based on annual flowrate test extrapolated into annual pumping rates based on electrical consumption. This practice generated a lot of reaction from the audience who questioned the reliability of this "honor system" practice in an adjudicated basin. Mr. Middleton explained that most of the area's reporting parties were "above reproach" while also explaining that most of the reporting parties also felt "that their neighbors may be fudging their reports a wee bit". Most of MWA's efforts to balance the water supply are currently focused on reducing the overall demand currently being placed on the area's regional and alluvial aquifers. But Mr. Middleton also noted that current emphasis has been placed on augmenting the area's natural recharge by the Agency's General Manager (Mr. Kirby Brill).

To increase the area's net recharge, MWA is proposing experimental pilot tests of controlled surface percolation of water in areas where the region's ubiquitous shallow caliche layer is absent. In the test area washes, the geology allows for the potential of deep percolation of surface recharge water into the aquifers. Mr. Middleton pointed out that a full-scale implementation of such practice could improve the overall water supply, but noted that other potential effects of these activities would not be known until the completion of proposed pilot testing were fully reviewed.

The issue of groundwater storage capacity in the MWA area is also very intense, with a very high potential for such use in the basin. Another topic of high interest is the occurrence of naturally-occurring Chromium VI identified in groundwater in the basin, and the USGS is currently evaluating this issue through isotopic studies.

Mr. Middleton's lively presentation included unforgettable quotes such as:

"Whiskey is for drinking, and water is for fighting over" and "Water doesn't flow downhill, it follows money!"

South San Joaquin Valley Branch Highlights

BY BILL PIPES

Plans are underway to rejuvenate the San Joaquin Valley Branch. The Branch will be home to GRAC member groundwater scientists, engineers, policy makers, and other stakeholders throughout the San Joaquin River and the Tulare Lake hydrologic regions. The aquifers of this area contain about 50% of California's groundwater supply, 90% of which is used for agriculture. The San Joaquin Valley is one of the most important agricultural areas in the world - no single region of comparable size in the U. S. produces more fruits, vegetables, and nuts. Proper management of this very important resource, based on sound science and guided by an educated public, will be critical to the economic well being of the area. The rejuvenated Branch hopes to contribute to these efforts.

Initial Branch activities will be headed up by Bill Pipes of Geomatrix Consultants, Inc. and the Branch will be headquartered in Fresno. Bill is putting together a mailing list with help from GRA and is lining up speakers and other programs. The first meeting is scheduled for January 17, 2002. Please call Bill with any help you can offer. He can be contacted at (559) 264-2535 or by email at wpipes@geomatrix.com.

San Francisco Branch Highlights

BY J. C. ISHAM

Mr. David Rice, of Lawrence Livermore National Laboratory (LLNL), was the speaker at the San Francisco Branch's December 5, 2001 meeting in Oakland. The topic of his presentation was "Subsurface Fate and Transport of Gasoline Containing Ethanol". Mr. Rice is the Environmental Chemistry and Biology Group Leader for the LLNL Environmental Protection Department and the Director of the California State Water Resources Control Board's evaluation of the potential surface and groundwater impacts that may result from the use of ethanol as a replacement to MtBE in gasoline.

Because of Governor Davis' issuance of an Executive Order (D-5-99) on March 25, 1999 calling for the removal of MtBE from gasoline no later than December 31, 2002, significant research has been undertaken to assess ethanol. The result of this research has found that the impacts associated with the use of ethanol are significantly less than those associated with the use of MtBE.

Mr. Rice presented the current results of ongoing research involving groundwater modeling, laboratory studies, and field data. The research examined the following:

- Behavior of ethanol containing gasoline (gasohol) as it migrates through the vadose zone;
- Biodegradation kinetics of the major gasoline components (BTEX) in the presence of ethanol;
- Ethanol related changes in the subsurface bacterial populations that may influence the biodegradation rates of the gasoline components;
- Proper chemical analysis and sampling procedures for ethanol;
- Implications for the cleanup of gasoline releases.

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Dates & Details

2002 Meetings and Other Key Dates

Board & Planning Meeting (All Members Welcome)	**January 19-21, 2002** Santa Barbara
Workshop	**March, 2002** Watershed and Groundwater Hydrology and Source Water Assessment Methodology Sacramento & Orange County
Symposium	**April 17, 2002** "Perchlorate, NDMA and Other Groundwater Contaminants from Aerospace and Rocket Fuel Facilities" San Gabriel Valley
Course	**April, 2002** Groundwater Modeling Southern California
Annual Meeting	**September, 2002** Southern California

HYDRO VISIONS

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Sacramento, California 95814

San Francisco Branch Highlights

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The following are key points about ethanol from Mr. Rice's presentation:

- Lighter than water, but vapors are denser than air.
- Infinitely soluble in water.
- OEHHA developed a draft Health Protective Concentration of 1100 mg/l.
- Degrades very rapidly in soils and water.
- Degradation half-lives of 1.3 to 7 days in groundwater and 3.5 to 10 hours in surface water.
- Increases the solubility of gasoline components in water.
- Preferential degradation of ethanol can impede the degradation of BTEX.
- Benzene plumes may increase by 24 to 33 % in the presence of ethanol.
- Large ethanol spills can increase the production of methane to explosive levels and lower the pH.

Mr. Rice's presentation elicited the audience to ask many questions. As ethanol becomes more commonplace as a fuel additive, it became apparent to most of the audience that they would soon be dealing with ethanol impacts.

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