WRC NEWSLETTER

WATER RESOURCES CENTER, TEXAS TECH UNIVERSITY, LUBBOCK

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The Water Resources Center is funding three research projects this year. This issue of the newsletter will focus on two of the projects. The third project: "Evaluating the Presences of Human Pathogens in Lubbock Area Playa Lakes," will be covered in the next issue of the newsletter.

"Potential for In Situ Remediation of Perchlorate Contamination in Sediments and Groundwater," by **W. Andrew Jackson**, Assistant Professor of Civil Engineering and **Ken Rainwater**, Associate Professor of Civil Engineering.

Relavance of the Research

Texas lakes contaminated with perchlorate (PC) supply water for over 400,000 citizens. Treating PC-contaminated water to the probable action level (18ppb) is currently extremely difficult and expensive with reverse osmosis and ion exchange as the only viable technologies. Biological reduction of perchlorate to chloride and bicarbonate is possible under anaerobic conditions. While this method is efficient for treatment of process water (high PC concentration, controlled reactors), the need to supply an organic substrate currently precludes its use in drinking water treatment. As explained by Dr. Andrew Jackson, assitant professor of civil engineering; "Treating the entire raw supply from these reservoirs is highly expensive. It would be much more efficient to treat the PC-contaminated groundwater and land surface water before they enter the reservoirs."

PC is degraded by anaerobic microorganisms in similiar fashion as nitrate or chlorinated solvents, such as TCE. PC is used as an alternate electron acceptor (AEA), taking the place of oxygen as the ultimate electron acceptor. While massive amounts of research has been conducted on chlorinated aliphatic reduction in situ, no current research exists on PC biological reduction in the environment. New knowledge analogous to that available for natural and enhanced chlorinated solvent attenuation should allow the use of this technology for in situ PC remediation. The subsequent protection of major drinking water reservoirs would be achieved at much lower cost than treatment of the entire reservoir volumes.

> "It would be much more efficient to treat the PC-contaminated groundwater and land surface water before they enter the reservoirs."
> --says Jackson

Biological treatment using in situ bioremediation has been demonstrated as a technology capable of contaminant remediation at a significantly lower cost than typical physical/chemical treatment processes. Contaminants utilized as AEAs (e.g. chlorinated solvents and explosives) require anaerobic conditions and electron donors. The main limitation preventing wider use of subsurface bioremediation is the difficulty of effective introduction of acceptable substrates into saturated subsurface systems. Current techniques are limited by the ability to affect hydraulic (pressure) gradients. These techniques suffer from two main problems: 1) inability to transport chemicals through low

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"Evaluation of Brine Extent and Migration in the Brownfield Basin Area, Terry County, Texas," by **Ken Rainwater**, Associate Professor of Civil Engineering, **Susan Barrick**, Doctoral Candidate, Geosciences, **Necip Güven**, Professor of Geosciences, **Harrold Gurrola**, Assistant Professor of Geosciences.

Relevance of the Research

Brownfield Basin occupies a north-south oriented topographic low between the elevations of 3150 and 3200 feet along Lost Draw in eastern Terry County. Its maximum extent is 7.5 miles from north to south and 3.5 miles east to west, based on the Bureau of Economic Geology's Brownfield Geologic Atlas sheet. Rich Lake and Mound Lake lie approximately five miles northwest and two miles northeast, respectively. Two of the smaller lakes occupy the topographic low that closes at 3167 feet elevation in the area's north portion (Red Onion Flats), and the rest occupy a second topographic low that closes at 3152 feet elevation in its southern portion (Brownfield Lakes). Land use in the basin is predominantly range and CRP land, with minor amounts of dry-land cotton.

Salt cedar and mesquite infest lake margins and the Lost Draw channel. A presently inactive sulfate mining operation occupies the south-central portion of the area. Lacustrine clay, silt, sand and gravel with dolomite in uppermost clays, and, most notably, approximately 20 feet of crystalline sodium sulfate have been reported in Brownfield Basin. The lacustrine section is overlain in limited areas by aeolian sand and playa and pond deposits. Brownfield Basin is inset in the Pliocene Ogallala formation. The caprock caliche is absent within the basin, but outcrops about its margins. The Ogallala unconformably overlies the Cretaceous Kiamichi Shale beneath the basin. The irregular Cretaceous erosion surface exhibits approximately fifty feet of relief beneath the basin.

The sodium sulfate deposit has supported a solution mining industry at the site since the late 1930's. A 1975 report estimated that the Brownfield Lakes operation produced one million tons of sodium sulfate between 1957 and 1975, with approximately another one million tons in reserve at that time.

Mining activities continued until

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Potenital for In Situ Remediation . . .

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permeability media; and 2) non-uniform transport caused by heterogeneous flow paths.

Electrokinetic injection is a technology that has been shown to be able to overcome these limitations (e.g. Acar et. Al. 1996). EKI is currently used to remove metals from saturated sediments at a number of sites across the country and has been demonstrated to remove hydrocarbons and solvents from clay. Our initial experiments indicate that this technology is adaptable to allow the transport of organic acids without the limitations of pressure-induced flow to promote the degradationof contaminants in situ.

Anticipated Results, Applications, and Leveraging

Results of this research will provide needed information on the feasibility of using lower cost remediation methods for use at PC contaminated sites in Texas. In addition, the development of EKI could provide a tool that could convert sites that are currently unsuitable for biological remediation. This would lower both treatment costs and duration of remediation operations. Specific results would include:

1) Delineation of redox conditions that favor PC bioremediation.
2) Optimization of organic acid transport in saturated sediments using EKI.
3) Methods to form biologically active zones using EKI.

This research will be immediately useful to remediation efforts currently underway at Lakes Belton, Waco, and Caddo. In addition, sites across the country would benefit from results of this study. If the EKI process is successful, it could be immediately applied on a wide range of contaminants, including chlorinated solvents and high explosives, presently threatening water supplies in the High Plains and Texas. Successful researach in this area will allow the project investigators to compete for site study funds from the military (DOD) and for national funds (DOE, EPA), which should be available in the next few years to develop remediation options on the newly identified wide spread environmental problem.

For more information please contact Dr. W. Andrew Jackson.

Evaluation of Brine. . .

(continued from page 2)

1987. The solution-mining complex has been maintained but inactive since then, and is presently owned by Cooper Natural Resources (CNR). CNR currently produces sodium sulfate at its Cedar Lake Plant, approximately 26 mines south of the Brownfield Lakes plant.

In 1977, operations at the sulfate-extraction plant, then owned by Ozark-Mahoning Campany of Tulsa, Oklahoma, became the subject of a complaint lodged with the (then) Texas Water Quality Board by neighboring landowners whose up-gradient irrigation wells had begun to yield increasingly saline water. In response to a request for a definitive report as well as changes in mining practices at the plant, the (by now) Texas Department of Water Resources undertook an exhaustive review of the relevant groundwater hydrology and chemistry of the basin in 1981. The previous mining, ranching and rainfall history of the area, tabulated historical water levels and analyses are gathered in this limited-circulation report. A conceptual model for the local hydrologic system was developed, including estimates for the amounts of groundwater withdrawn for irrigation and solution mining and for the amounts of water re-injected and discharged by the plant.

The study concluded that irrigation withdrawals, not sulfate extraction processes, were creating the agricultural salinity problems. Heavy seasonal pumping locally reversed the hydraulic gradient and drew naturally saline brine from the lake basin deposits to the irrigation wells. The report emphasized the interdependence of industrial and agricultural operations. Withdrawals by the plant maintained a cone of depression that actually prevented worse contamination of irrigation wells by saline water, while irrigation pumping prevented fresher water from diluting brines utilized by plant operations within the area. It was predicted that the fresh water/saline water interface west of the area would move westward under continued heavy irrigation pumping.

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>
> -- explains Barrick

Since the 1982 TWBD report, conditions at Brownfield Basin have changed in several important respects. Irrigation practices have changed substantially with the utilization of more efficient methods such as LEPA. Various agricultural set-aside programs have taken some parcels out of production in the area. And, as previously mentioned, the sulfate plant has suspended operation.

Susan Barrick explains; "There are approximately 40 saline lake basins within the geographic area of the Southern High Plains. The High Plains aquifer is the lynchpin of the region's economy. Locally high salinity in the aquifers makes it undesirable for municipal or irrigation supplies. The three major sources of salinization are (1) coupled high irrigation application and high evaporation rates, (2) oil field contamination, and (3) naturally saline groundwater and sediments from the vicinity of saline lakes. Since the saline lakes at Brownfield Basin have in the past and may again soon support a mineral extraction plant that will include both groundwater withdrawals and injection, understanding the flow behavior of groundwater in the area has both scientific and economic merit.

Anticipated results, Applications, and leveraging plan

In 1982, TWDR predicted that, in the absence of industrial pumping at the sulfate plant in the south-central portion of the area, the fresh/saline water interface would likely migrate westward, up-gradient, especially if irrigation withdrawals were large. This study will evaluate that prediction. The data gathered for this study will be applied to further work utilizing the U.S. Geological Survey two-dimensional variable density groundwater flow model, MOC dense, and may ultimately help managers recommend safe irriga-tion pumping rates to agricultural users near such saline basins. The Brand Graduate Research Fund in the Department of Geosciences has provided $500 for the installation of several pilot piezometers and mileage from Lubbock to the field site.

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Scholarship Announcement

Sandy Land Water Conservation
Plains, Texas
Research Scholarship

Two $2,500 scholarships will be awarded to deserving graduate students for Fiscal year 2000 (Sept. 1, 2000 - Aug 31, 2001) with funding provided by the Sandy Land Underground Water Conservation District.

Criteria
The recipient must be an enrolled TTU graduated student who has been accepted to candidacy for a graduate degree and who has selected a thesis or dissertation topic centered around water conservation or a closely related area.

How to Apply
* Application forms may be obtained from the Graduate School, 2 Holden Hall, TTU, Lubbock, Tx 79409-1033; Phone (806) 741-2781.
* Application must be received by May 1, 2000. Send to the attention of Allan Headley (pkadh@ttu.edu). The Graduate School, PO Box 41033, Lubbock, Tx 79409.
* Application must include a current, official transcript, a one-page description of the previously selected research topic, and supporting letters from their respective thesis/ dissertation committee chairperson and the departmental graduate advisor or chairperson.

A Texas Tech committee will select and make known the recipients by mid June.

Staff Changes at the Water Resources Center

On December 1st of last year Elizabeth Johnston Vasquez became the new Assistant to the Director of the Water Resources Center. She filled the position of Jan Hudson, who recently accepted the position of Coordinator of Special Projects in the Chemical Engineering Department. Jan worked for the WRC for over a year. She will be greatly missed by staff and frieds of the Water Resources Center and the Civil Engineering Department.

Elizabeth received her B.A. for History in 1997 from Texas Tech University and is currently working on a Masters degree. Elizabeth has been working on campus for three years, with student positions at the Southwest Collection, and a staff position at the Wind Engineering Research Center. She is also busy with a young family which includes her husband, two sons and a step son. All the boys are under the age of 6.

If you have any questions in regards to the Water Resources Center please contact Elizabeth. Her email is Elizabeth.Johnston-Vasquez@coe.ttu.edu. The Center's main phone number is (806) 742-3597, and the fax is (806) 742-3449.

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