Water Sustainability Grants Program
New Projects FY08

WATER QUALITY

Brine Minimization/Salt Management Using VSEP® Technology to Maximize Water Recovery. $49,945. Eric Betterton, Atmospheric Sciences/Chemical and Environmental Engineering, Robert Arnold and Wendell Ela, Chemical and Environmental Engineering, College of Engineering.

Total dissolved solids (TDS) concentrations in Central Arizona Project (CAP) water are more than twice as high as those of native groundwater in the Tucson area. As the region shifts from reliance on groundwater toward use of southern Arizona's full annual allotment of CAP water, necessary for a sustainable regional water supply, RO (reverse osmosis) treatment may be needed to satisfy public preference. If RO is pursued, it will probably be applied to a portion of the region's annual CAP allotment before the RO-treated and untreated fractions are recombined and distributed. However, the efficiency of water recovery during RO treatment is limited by membrane fouling. Without pretreatment for barium ion removal, operational recoveries will be only about 0.75 (the ratio of permeate to influent flows) during RO treatment of CAP water in order to avoid precipitation of BaSO4(s). This project will develop a pilot-scale demonstration of Vibratory Shear Enhanced Processing (VSEP) technology to improve recovery.

Endocrine Disrupters in Wastewater and Biosolids: Occurrence, Fate and Treatment. $50,000. Eduardo Sáez and Wendell Ela, Chemical and Environmental Engineering, College of Engineering, David Quanrud, Arid Lands Studies, College of Agriculture and Life Sciences.

It is estimated that by 2025, it will be necessary to reclaim and reuse approximately 100,000 AFY of wastewater in the Tucson Active Management Area. Observations during the last decade related to residual trace organics in conventionally treated wastewater suggest that advanced treatments are requisite to the kinds of reuse applications that are now being considered. Among the myriad trace organic contaminants present in wastewater effluent, endocrine disrupting compounds (EDCs) are of greatest concern to human and environmental health. Use of reclaimed water to recharge regional aquifers and soil application of biosolids for agricultural purposes raises a concern on the final fate of EDCs. This project will quantify estrogenic activity and EDCs at various stages of wastewater treatment plants in Pima County emphasizing EDC transformations that occur in sludge digestion processes, and fate of EDCs in biosolids and soils treated with biosolids. In addition, advanced oxidation processes commonly used in disinfection operations will be assessed as possible means for destruction of EDCs in WTP effluents.

Fate of Prions in Ground Water, Reclaimed Wastewater and Land Applied Biosolids. $40,262. Charles Gerba, Soil Water & Environmental Science, College of Agriculture and Life Sciences.

Arizona depends both on ground water and reclaimed water to meet its water needs. Arizona applies 95% of the biosolids it produces to agricultural land and additional biosolids from Southern California are transported to Arizona for land application. Prions are infectious proteins that cause fatal brain disease in animals and humans. They are the most stable infectious agents known; however, there is little information on their fate in the environment. Prions present in sewage are not inactivated by chlorine and are believed to accumulate in biosolids and survive mesophilic digestion. The specific objectives of this project are to determine the persistence of prions in water and soils, their transport through soil and survival after composting and lime treatment of biosolids. This will provide information for guidance to utilities and regulatory agencies in Arizona and the Southwest for the control of prions in land applied reclaimed wastewater and biosolids.

Compound Specific Isotope Analysis of Natural Attenuation Activity in Chlorinated-Solvent Contaminated Aquifers in Arizona. $23,834. Mark Brusseau, Soil, Water and Environmental Science, College of Agriculture and Life Sciences.

Chlorinated solvents are the most common contaminants at the state and federal Superfund sites in Arizona and given their myriad toxicological effects, pose a great risk to human health. The remediation of polluted soil and groundwater at the many chlorinated-solvent contaminated sites present in Arizona is of prime importance for enduring a safe and sustainable potable water supply. Monitored natural attenuation (MNA) has recently gained great interest as a low-cost approach for site remediation. The goal of this project is to enhance the viability and effectiveness of MNA for remediation of chlorinated-solvent contaminated sites in Arizona. The specific objective of this project is the development of a characteristic tool (CSI analysis) that will permit rapid and accurate screening of the suitability of using MNA for Arizona sites.

Engineered Reversible and Regenerable, Specific and High Capacity Adsorbents for Sustainable Removal of Arsenic from Contaminated Waters. $49, 877. Roberto Guzman and Jerker Porath, Chemical and Environmental Engineering, College of Engineering.

The contamination of water, air and soils by heavy metal is one of our most important and challenging environmental issues. Heavy metals are toxic, carcinogenic and mutagenic. Chronic arsenic poisoning occurs on a very large scale in many parts of the world and many areas of the U.S. including Arizona. The proposed research aims at the development of removal technologies that allows the removal and capture of arsenic in a highly concentrated form that permits their eventual, easier, encapsulation or disposal as harmless precipitates. The developed arsenic adsorbents and immobilized oxidants are regenerable and thus inexpensive to implement. Metal ions have affinity for many inorganic and organic substances and such affinity is usually preserved but often modulated by immobilization to a solid support. These immobilized metal ions will function as adsorption sites for arsenate and arsenite. The project we propose may serve as a start to develop a workable technology for the solution of a tremendous environmental problem.

Preliminary Evaluation of Metal Contamination Sources in the Colorado River from Measurement of Lead and Uranium Isotopic Ratios. $12, 541. Charles Sanchez, Soil, Water, and Environmental Science, College of Agriculture and Life Sciences and John Chesley, Geosciences, College of Science.

The Colorado River is contaminated with low levels of potentially toxic elements, including uranium (U), lead (Pb), cadmium (Cd) and arsenic (As). The river is used both as a source of drinking water and a source of irrigation water for food crops. Accumulation of these metal elements into food crops is a health concern as potential carcinogens or causal agents of human organ dysfunction. We currently have little or no information on sources of these metals to the Colorado River. In this project, we will gain preliminary information on possible sources of U, Pb, and other metals to the Colorado River. This information is a prerequisite for any possible effort to reduce human exposure to these and other toxic elements.

Tradeoffs between Enhanced Urban Storm Recharge and Water Quality: The Influence of Urban Housing Age and Density on Nutrients, Metals and Organic pollutants. $49,739. Kathleen Lohse, School of Natural Resources, College of Agriculture and Life Sciences, Paul Brooks, Jennifer McIntosh, and Thomas Meixner, Hydrology and Water Resources, College of Engineering.

An increasing number of communities in Arizona, are investigating the potential for enhanced urban ephemeral channel recharge to balance their groundwater consumption and attain sustainable water yields. Currently, water managers and decision makers have limited information on the quality of this

urban storm recharge and almost no information on how housing age and density may impact this quality. We propose to quantify how residential development age and density alter the quantity and quality of storm water runoff. We will use this information to develop best management practices that evaluate the tradeoffs between enhanced groundwater recharge and the increased possibility of nutrients, pathogens, metals and organic pollutants in surface and groundwater. This work will aid in the formulation of sustainable and dynamic water management strategies, planning, and best management practices for Arizona.

IRRIGATION

Salinity and/or Sodium Hazard of Irrigation Water as an Indicator of Rapid Blight Disease Potential in Turfgrasses. $23,845. Mary Olsen, David Kopec, Plant Sciences and James Walworth, Department of Soil, Water and Environmental Science, College of Agriculture and Life Sciences.

Decreasing availability of low salinity water for irrigation has resulted in increased use of reclaimed water and saline well water in large areas of turfgrass. A new problem associated with high saline irrigation water in Arizona is the appearance of a new and unique disease of turfgrasses known as “rapid blight”, caused by the pathogen *Labyrinthula terrestris*. It has become an increasing problem in Arizona causing severe damage to turfgrass and an increase in fungicide use. Elevated salinity of irrigation water enhances disease development, and recent results indicate that sodium chloride may be required for growth of *L. terrestris*. The objective of this project is to determine if salinity and/or sodium hazard of irrigation water can be used to define disease potential in turfgrasses that are differentially susceptible to salinity stress. This information will be used by turfgrass managers to predict and manage rapid blight.

WATER RESOURCES

Stream Aquifer Interactions in Effluent Dominated Riparian Systems. $49,129. Tom Meixner and James Hogan, Hydrology and Water Resources, College of Engineering, David Meko Laboratory for Tree Ring Research and Barron Orr, Arid Land Studies, College of Agriculture and Life Sciences.

In water-limited environments, effluent is an increasingly viable water source for riparian restoration and aquifer recharge. Despite the beneficial uses of effluent, little is known about stream-aquifer interactions in effluent dominated systems. Specifically little is known about the development of a streambed clogging layer which could inhibit stream-aquifer interaction. Our research will focus on the Upper Santa Cruz River where effluent aids in maintaining safe-yield conditions in the Santa Cruz AMA (SCAMA). We seek to determine the spatial extent, regional importance, and temporal impact of effluent on riparian vegetation and groundwater recharge by addressing three questions. First, how important is streambed clogging in limiting stream water infiltration? Second, how important is effluent for aquifer recharge? Third, how has effluent influenced water availability to aquifers and riparian vegetation on decadal time scales?

Estimating Water Use: Monitoring Rural Domestic Wells with Low-cost, Near-real Time Water Metering. $58,970. Susan Pater, Cochise County Cooperative Extension, Sharon Megdal and Susanna Eden, Water Resources Research Center, Kim McReynolds and Cado Daily, Cochise Cooperative Extension, David Quanrud, Arid Lands Studies, College of Agriculture and Life Sciences, Gary Woodard and Ramon Vazquez, SAHRA, Hydrology and Water Resources, College of Engineering.

Lack of information on domestic well pumpage is a source of uncertainty in water policy and planning decisions. Pumpage from domestic wells is significant. There are 95,000 unmetered domestic wells in Arizona and they account for much of the groundwater pumping in many rapidly growing areas, such as the Verde Valley and Upper San Pedro. Without information, policy makers have not been able to judge the magnitude of the problem represented by unmetered domestic wells. In Cochise County specifically, planners have little confidence that the 312 gallons per person per day (gpcd) being used in the county's Babocomari Area Plan is an accurate, defensible number on which to base their decisions. This study will estimate pumping levels and patterns of water use in exempt domestic wells in Cochise County. Data will be collected and analyzed to establish and verify a credible and realistic rural water use value that can be used to resolve water planning and zoning issues and to serve as a model for replication.

PLANNING & POLICY

'Paper Water' Demystified: An Economic Evaluation of CAGRD Spatial Dynamics. $26,434. Paul Wilson, Agricultural and Resource Economics, D. Phillip Guertin, School of Natural Resources, Sharon Megdal, Water Resources Research Center/Agricultural and Resource Economics, College of Agriculture and Life Sciences.

The sizable population growth anticipated in the central corridor between Phoenix and Tucson over the next several decades presents state water managers with a host of challenges related to water sustainability. One such challenge is to ensure that these new developments rely upon renewable water sources. To do so, a system of water accounting through the Central Arizona Groundwater Replenishment District (CAGRD) has evolved to release developers from the costly search for the physical availability of renewable water sources to meet demand. Yet water supply documented on paper ("paper water") does not always match up with physically available water ("wet water"). While state water managers anticipate a policy change related to this issue in the future the short- and long-term economic implications of the spatial disconnect between paper water and wet water remain unclear. Our spatial economic analysis of the CAGRD program over the 2000-2040 time period, will be a timely study for policy makers as they grapple with these important issues. A detailed economic assessment and vulnerability maps, outputs from this project, will provide policy makers with a clearer understanding of the future economic role of the CAGRD in the central corridor of Arizona.

Arizona Drought Monitoring Sensitivity and Verification Analyses $47,343. Christopher Castro, Atmospheric Sciences, College of Science, Michael Crimmins, Soil, Water, and Environmental Science, College of Agriculture and Life Sciences, Gregg Garfin, Institute for the Study of Planet Earth, Arizona Research Laboratories, Francina Dominguez, SAHRA, Hydrology and Water Resources, College of Engineering.

Recent multi-year drought has awakened Arizona decision makers to the possibility of drought-induced water shortages, especially in rural communities. The Governor and the Interagency Coordinating Group (ICG), which advises the Governor on mitigation actions and drought declarations, rely upon drought status reports by the Arizona Drought Monitoring Technical Committee (MTC) to make timely decisions with far-reaching effects on water use. However, the MTC drought status calculations, though vetted through subjective assessment, are a source of uncertainty for the MTC and decision makers. This project aims to evaluate short- and long-term drought indicators, and relate them to quantifiable impacts that affect strategic decisions by Arizona stakeholders. The outcomes include: 1) validation and improvement of the drought status reporting system 2) guidance on the application of drought information to decision-making, and 3) completion of the first stage of developing regional drought prediction capability.

EDUCATION & OUTREACH

Arizona Project WET Evaluation: Examining Impact and Developing a Computer-based Tutorial and Assessment System $49,979. Jerome D'Agostino, Educational Psychology, College of Education and Kerry Schwartz, Water Resources Research Center, College of Agriculture and Life Sciences.

There is a critical need to educate citizens and future citizens about Arizona's water resources and promote the adoption of a conservation ethic and to offer education that is research-based and meets state standards and testing requirements. Project WET is the leading K-12 water education program nationally and internationally and Arizona Project WET has aligned its curriculum to state standards and added state specific relevancy. Numerous studies suggest that high-quality instruction can make a significant difference in student learning. The purpose of this project will be to (1) examine the effectiveness of Arizona Project WET (Water Education for Teachers) under a best case scenario and to (2) create an online tutorial and assessment system to supplement extant Arizona Project WET resources.

Developing a Volunteer-based Automated Environmental Monitoring Network. $29,537. Michael Crimmins, Soil, Water and Environmental Science, College of Agriculture and Life Sciences, Gary Woodard, SAHRA, Hydrology and Water Resources, College of Engineering, and Mark Losleben, National Phenology Network.

Variability in patterns of precipitation and temperature are critically linked to variability in local water resources. Adequate monitoring of this climate variability at the watershed scale is essential to properly manage water and understand water resource dynamics, but current monitoring networks are constrained by limited staff and high instrumentation costs. Rapid growth in high-speed internet access across Arizona has created new and exciting opportunities for volunteer citizen scientists interested in environmental monitoring. Broad public interest in meteorological monitoring and the decreasing costs of environmental sensors is dramatically lowering the potential costs of gathering critical water-related data. This project proposes to explore optimal approaches to developing inexpensive, residence-based hydroclimate monitoring systems important for managing water resources and monitoring drought that provide near-real-time data on precipitation, temperature, and soil moisture.

San Pedro River Volunteer Monitoring, Community Watershed Alliance, Cochise County, AZ. $4,895. Kristine Uhlman, Water Resources Research Center and Phil Guertin, School of Natural Resources, College of Agriculture and Life Sciences.

The City of Benson, within the Benson subwatershed, could see a ten-fold increase in population in coming years. Development of a regional water budget is critical for the long-term welfare of the aquifer that is the sole water supply source and the citizens who depend on it. Volunteers from the Community Watershed Alliance (CWA) will be given training and the instrumentation needed to develop a water budget for their area. This monitoring project will provide important base-line information and long-term records to help with water resource management decisions. Volunteer efforts will include mapping wet/dry reaches of the San Pedro prior to the monsoon, coordinating access permission during the project implementation, continuation of the riparian vegetation monitoring established in 2006, community outreach and training, and data management.