

# Research Related to Water Reuse

## Funding Sources

This paper presents a brief overview of research related to water reuse sponsored by the following entities:

American Water Works Association Research Foundation (AwwaRF)

National Water Research Institute (NWRI)

Water Environment Research Foundation (WERF)

WaterReuse Foundation

The U.S. Environmental Protection Agency (EPA) also sponsors a wide range of water-related research. While their activities are not included within this summary, information concerning EPA's research activities can be found on their webpage ([www.epa.gov/ebtpages/research.html](http://www.epa.gov/ebtpages/research.html)). The EPA and the U.S. Agency for International Development have contracted with Camp Dresser & McKee (CDM) to update the *Guidelines for Water Reuse*. The update is anticipated to be available around January 1, 2004.

## American Water Works Association Research Foundation (AwwaRF)

The AwwaRF is the research arm of the American Water Works Association (AWWA). Both AWWA and AwwaRF are located in Denver. Their webpages can be found at [www.awwa.org](http://www.awwa.org) and [www.awwarf.org](http://www.awwarf.org).

## National Water Research Institute (NWRI)

The NWRI is located in Fountain Valley, California. Their webpage can be found at [www.nwri-usa.org](http://www.nwri-usa.org).

## Water Environment Research Foundation (WERF)

The WERF is the research arm of the Water Environment Federation (WEF). Both organizations are located in Alexandria, Virginia. Their webpages can be found at [www.wef.org](http://www.wef.org) and [www.werf.org](http://www.werf.org).

## **WateReuse Foundation**

The WateReuse Foundation is the funding and research arm of the WateReuse Association. The foundation sponsors an annual research conference devoted to research related to water reuse. Information about the organization is available on the WateReuse Association's webpage ([www.watereuse.org](http://www.watereuse.org)).

## **Cooperation Among the Funding Organizations**

The NWRI convened a workshop in 1999 to identify and prioritize research needs related to non-potable water reuse activities. The AwwaRF, NWRI, WERF, and the WateReuse Foundation have used the summary report resulting from that workshop in developing priorities for research associated with non-potable reuse. These four organizations have formed somewhat of a collaborative effort to address research needs associated with non-potable reuse and a number of projects have been jointly funded by these four organizations.

## **Research Projects**

The tables that follow present summaries of key research projects funded by AwwaRF, NWRI, WERF, and the WateReuse Foundation. While most of the projects listed are ongoing, several past and planned projects also are included.

## **Credits**

This summary was assembled by David York, Water Reuse Coordinator, Florida Department of Environmental Protection ([david.york@dep.state.fl.us](mailto:david.york@dep.state.fl.us)). Appreciation is extended to the following individuals who provided reviews and inputs to this summary: Bonnie Bailey (WERF), Bob Bastian (EPA), Gina Melin (NWRI), Jami Montgomery (WERF), Jeff Mosher (WateReuse Foundation), and Stephanie Passarelli (AwwaRF).

# **AwwaRF Research Projects**

## **Protocol for Developing Water Reuse Criteria with Reference to Drinking Water Supplies (2968)**

Will document and evaluate existing standards and guidelines, will identify knowledge gaps, and will develop a rationale for setting standards based on risk assessment. [Contract with CREH Analytical, Ltd. Co-funded with UKWIR and WateReuse Foundation]

## **Options for Inland Disposal of Brine (2971)**

Convene a workshop to identify research related to this issue. [Co-funded with WERF and WateReuse Foundation]

## **Understanding Public Concerns and developing Tools to Assist Local Officials in Planning Successful Potable Reuse Projects (2919)**

Develop a better understanding of public concerns and potential opposition to indirect potable reuse. Will develop a tool kit for use in working with stakeholders. [Co-funded with WaterReuse Foundation]

## **Investigation of Soil-Aquifer Treatment for Sustainable Water Reuse (487)**

Establish the efficacy of wetlands and soil aquifer treatment leading to indirect potable reuse. [Contract with Arizona State University. Co-funded with SROG, LACSD, and EPA]

## **Pharmaceuticals, Endocrine Disrupting Compounds, and Personal Care Products – Where Do We Go From here? (2972)**

Will organize an international workshop and deliver an expert report that synthesizes results from recent and ongoing studies related to these compounds. [Contract with Foundation for Applied Water Research (Netherlands). Co-funded with GWRC and WERF]

## **Strategies for Identifying Emerging Drinking Water Contaminants and Communicating to Address Public Concerns (2776)**

Will develop proactive strategies and tools to identify and track these compounds and will frame strategies to enable utilities to proactively and effectively communicate information to the public. [Contract with the George Washington University]

## **Endocrine Disruptors and Pharmaceuticals in Drinking Water (2598)**

Examines endocrine disruptors and pharmaceutically active compounds in drinking water and wastewater. Provides an overview of the health effects, occurrence, and treatment options. [Contract with University of Iowa. Co-funded with WERF and WateReuse Foundation.]

## **Impact of UV and UV Advanced Oxidation Processes on Toxicity of Endocrine Disrupting Compounds in Water (2897)**

Evaluate UV and UV-based oxidation processes for removal of endocrine disrupting compounds. Will employ multi-tiered toxicity assays to assess these processes. [Contract with Duke University.]

## **Evaluation of Conventional and Advanced Treatment Processes to Remove Endocrine Disruptors and Pharmaceutically Active Compounds (2758)**

Determine removal efficiencies for a range of conventional and advanced treatment processes for removal of these compounds. Ultimately will develop predictive models for the range of treatment processes. [Contract with Southern Nevada Water Authority]

## **Beneficial Reuse of Lime Softening Residuals for Flue Gas Desulfurization (179)**

Advances an alternative method for disposal of softening plant residuals by demonstrating its application at a coal-fired electric generation station as a limestone makeup reagent for flue gas desulfurization. Provides data to confirm the merit of reuse as a realistic strategy and addresses attributes for the acceptance and application of the option. Published in 1997. (Out of print but available to AwwaRF subscribers.)

## **Augmenting Potable Water Supplies With Reclaimed Water (371)**

Gives technical guidance regarding the use of treated municipal wastewater as a potable water source. Provides regulators and utilities with guidance to assess the feasibility and desirability of potable reuse projects as a means of supplementing water supplies. Includes recommendations for future research. Research partner: NAS. The NRC published this work in 1998 as Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies With Reclaimed Water (ISBN 0-309-06416-3). This report is available from the National Academy Press (telephone: 800-624-6242).

## **Current Management of Membrane Plant Concentrate (498)**

Characterizes membrane reject water and defines parameters for possible reclassification or reuse of these waters within state and federal regulatory guidelines. Published in 2000. (Out of print but available to AwwaRF subscribers.)

## **Membrane Treatment of Waste Filter Washwater for Direct Reuse (2568)**

Will investigate the feasibility of using membrane technology to treat filter backwash water for direct reuse. [Co-funded with New York City Dept. of Environmental Protection]

## **Water Quality Requirements for Industrial Applications of Reclaimed Water (2697)**

Assembling water quality requirements for a range of industrial activities that could use reclaimed water from domestic wastewater treatment facilities as their water source. [Contract with Boyle Engineering]

## **Research for 2004**

The following is a list of research projects identified by the AwwaRF's Research Advisory Council for possible funding during 2004:

1. Strategies for Communicating in an Uncertain Environment.
2. Concentrate Disposal by Deep Well Injection Assessment.
3. Design, Operation and Maintenance Considerations for Sustainable Underground Storage Facilities.
4. Characterization and Control of Biofouling in High-Pressure (RO and NF) Membranes: Detection and Control.
5. Comprehensive Review of Methods, Occurrence, and Treatment of Pharmaceuticals, Endocrine Disrupting Compounds, and Personal Care Products in Drinking Water.
6. Detection of Infectious *Cryptosporidium* in Filtered Drinking Water.
7. Development of an Infectivity Assay for Human Calicivirus (HuCV) in Cells.
8. Cross-Connection and Backflow Vulnerability: Monitoring and Detection.
9. Identification of Health Impacts Associated with Cross-Connection Events.

## **NWRI Research Projects**

### **Rejection of Pharmaceuticals by Reverse Osmosis Membranes: Quantitative Structure Activity Relationships (QSAR)**

This research involves the evaluation of several membranes to remove a wide range of pharmaceutically active compounds. Models will be developed for prediction of removal of compounds based on the compound's quantitative structure activity relationship (QSAR) properties. [Contract with Orange County Water District, CA]

### **Optimization of Filtration Flux Rate for Production of Title 22 Disinfection Tertiary Recycled Water**

This study will evaluate performance of filtration systems at loading rates above the 5 gal/(ft<sup>2</sup>\*min) maximum allowed by California regulations. The pilot-scale study will enable collection of data for turbidity, solids, indicator organisms, and viruses before and after filtration. Chlorination studies also are proposed. [Contract with University of California, Berkeley]

### **Novel Membrane Biofilm Reactor for Groundwater Treatment and Remediation**

This study will evaluate treatment of several oxidized inorganic and organic compounds using a hydrogen-fed membrane bioreactor. [Contract with MWH & Northwestern University]

### **Enhancement of MF Performance via Membrane Stretching**

This study will evaluate the possible enhancement of membrane performance (rejection of materials and flux) that may result from stretching the membrane to control the aspect ratio of pores on the membrane surface. [Contract with the University of Texas]

### **Rate of Bromate Reduction in the Human Stomach**

In Phase I of this study, possible transformations of bromate in the human stomach will be evaluated using synthetic gastric fluids. If significant reductions in bromate are observed, this may provide a means for moderating the drinking water standard for bromate. Given that many states have adopted the drinking water standards as their ground water standards, this also could influence reuse and land application projects. [Contract with Joseph Cortuvo & others]

## **Bacterial Adhesion and Transport in Groundwater Systems**

This study examines molecular level interactions between bacterial cells and collector surfaces that influence bacterial adhesion and transport. [Sharon Walker, NWRI Graduate Fellow, Yale University]

## **Attenuation of Pharmaceutically Active Substances During Bank Filtration and Artificial Recharge**

The occurrence and concentrations of several pharmaceutically active substances will be monitored in the Santa Anna River and in Anaheim Lake. The fate of these compounds during riverbank filtration and artificial recharge will be evaluated. [Dr. Tragott Scheytt, International NWRI Fellow]

## **Analysis of Biocide/Biofilm Interactions by Attenuated Total Reflection Fourier Transform Infrared Spectrometry [Orange County Water District, CA]**

## **Colloidal Fouling in Reverse Osmosis Membranes [UCLA]**

## **Dean Vortex Instabilities for Reducing Concentration Polarization and Fouling and for Developing New Membrane Module Designs [RPI]**

## **Dean Vortex Instabilities for Tubular Membrane Module Design [RPI]**

## **Development and Testing of New Nanofiltration Membranes for Application to Water Treatment: An Integrated Polymer Chemistry/Engineering Approach [University of North Carolina]**

## **Influence of Molecular Conditioning Films on Microbial Colonization of Synthetic Membranes Determined by Internal Reflection Spectrometry [Orange County Water District]**

## **Survey of U.S. Costs and Rates for Desalination and Membrane Softening Plants [Leitner & Associates, Inc.]**

## **Demonstration for Biological Denitrification of Drinking Water for Rural Communities [University of Colorado]**

## **Development and Application of Molecular Techniques to Detect Indicator and Pathogenic Microorganisms in Treated Wastewater [Orange County Sanitation District]**

## **Field Experiments and Modeling of Viral Transport in Groundwater [Texas A&M University]**

**Investigation of Design Parameters and Biological Factors Influencing Vapor-Phase Biotreatment of Volatile Organic Contaminants in Groundwater** [Orange County Water District]

**Organic Carbon Characterization of Advanced Treated Wastewater at Water Factory 21, Orange County** [Stanford University]

**Ozone-Induced Biodegradability of Disinfection By-Product (DBP) Precursors** [University of Colorado]

**PCR Detection and Assessment of Viability Methods for the Detection of Legionella Species in Potable Water Supplies** [Perkin-Elmer Applied Biosystems]

**Potential for Genetic Enhancement of Bacterial Degradative Processes in Wastewater** [University of California, Irvine]

**Quantitative Detection of Injured or Non-Culturable Microorganisms by Signature Lipid Biomarker Analysis** [Microbial Insights, Inc.]

**Virus Transport in the Vicinity of a Pumping Well** [University of Montana]

**Collaborative National Study Using Molecular Techniques to Detect Hepatitis A Virus and Virulence Factor Genes in *E. coli*** [Orange County Sanitation Districts]

**Deposition Mechanisms and Long-Time Scale Factors Influencing Virus Transport in Porous Media** [University of California, Irvine]

**Groundwater Transport of Viruses** [University of Colorado]

**Microbial Risk Assessment for Reclaimed Water** [University of California, Berkeley]

**Transport and Transformation of Antibiotics and Hormones in the Aquatic Environment** [University of California, Berkeley]

**Water Quality and Wildlife Enhancement in Prado Wetlands** [University of California, Berkeley]

**A Comparative Study of UV and Chlorine Disinfection for Wastewater Reclamation** [Montgomery Watson]

**Development and Characterization of UF Membranes and Relation of Membrane Properties to Absorptive Fouling**

**Soil Treatability Pilot Studies to Design and Model Soil Aquifer Treatment Systems** [Co-funded with AwwaRF]



**Contaminant Transport in Ground Water for Environmental Performance Assessment**  
[University of California, Davis]

**Effects of Physical and Geochemical Heterogeneity of Porous Media on Macroscopic Virus Transport** [University of California, Davis]

**Gene Probe Spectroscopy: A New technology for Detecting Microorganisms in Water Supplies** [University of California, Davis]

**Mass Transfer and Kinetics Study of the Ozonation of Refractory Organics in Wastewater**  
[University of California, Davis]

**Monooxygenase Catalysis for Conversion of Trace Hydrocarbon Contaminants** [UCLA]

**Stochastic Transport and Risk Assessment in Regional Aquifers** [University of California, Davis]

## **WERF Research Projects**

### **Water Reuse: Understanding Public Perception and Participation (00-PUM-1)**

Provided guidance for successfully incorporating public input into the planning for non-potable and potable water reuse projects. [Resolve, Inc.]

### **Reductions of Pathogens, Indicator Bacteria, and Alternative Indicators by Wastewater Treatment and Reclamation Processes (00-PUM-2T)**

Evaluation of the removal of pathogens (viruses, Giardia, Cryptosporidium) and indicator organisms by full-scale wastewater treatment facilities. Seven treatment facilities that employ a range of treatment, filtration, and disinfection processes will be evaluated. [Contract with Michigan State University and the University of South Florida]

### **Membrane Treatment of Secondary Effluent for Subsequent Use (01-CTS-6)**

Improve understanding of membrane technologies for various uses of reclaimed water. [Contract with CDM]

### **Removal of Endocrine Disrupting Compounds in Water Reclamation Systems (01-HHE-20T)**

Couples bioassays with chemical analysis to evaluate removal of endocrine disrupting chemicals by a range of treatment technologies. [Contract with Wisconsin State Laboratory of Hygiene. Co-funded with AwwaRF, NWRI, WateReuse Foundation, and CUWA]

### **Innovative DNA Array Technology for Detection of Pharmaceuticals in Reclaimed Water (01-HHE-21T)**

Evaluation of DNA arrays to rapidly screen changes in gene response to aquatic pharmaceutical exposure. [Co-funded with AwwaRF, NWRI, WateReuse Foundation, and CUWA]

### **Workshop: On-Line Toxicologic Methods for Evaluating Potential Chemical Risk Associated with Potable Reuse (01-HHE-4)**

Workshop evaluated various state-of-the-art toxicologic techniques for on-line monitoring of reclaimed water. [WERF organized & ran this workshop]

## **Online Methods for Evaluating the Safety of Reclaimed Water (01-HHE-4A)**

Will identify and develop an on-line method for evaluating and assessing the potential risks, if any, to human health from reclaimed water. [Contract with University of California, Riverside]

## **The Use of Reclaimed Water and Sludge in Food Crop Production (92-HHE-1CO)**

Evaluated the benefits and risks associated with land application and water reuse practices related to production of edible crops. [Cooperative effort with NAS/NRC]

## **Water Reuse Assessment (92-WRE-1)**

Evaluated existing technologies, examined planning and management issues, and reviewed guidelines for a range of water reuse applications.

## **Nonpotable Water Reuse Management Practices (97-IRM-6)**

Provided examples of diverse water reuse systems from around the world and developed case studies addressing the management practices employed. [Metcalf & Eddy, Inc.]

## **Cryptosporidium Removal, Occurrence, and Inactivation Methods for Wastewater (98-HHE-1)**

Developing methods to detect and quantify Cryptosporidium removal by wastewater treatment and disinfection processes. [Contract with Clancy Environmental Consultants, Inc.]

## **Impact of Storage on Nonpotable Reclaimed Water: Seasonal and Long Term (99-PUM-4)**

Evaluated changes in water quality resulting from storage of reclaimed water. [Recently completed. Contracted with Black & Veatch.]

## **Study Installed State-of-the-Art WWTP Sensing and Control Systems and the Applicability of Industrial Process Control Methods to Wastewater Treatment Systems (99-WWF-4)**

Evaluated the relative success and applicability of monitoring and automation technologies used in the wastewater industry and in the manufacturing sector. [EMA, Inc.]

## **Workshop on Pharmaceuticals and Personal Care Products in the Water Cycle (03-HHE-6CO)**

This refers to a project jointly funded with AwwaRF (Project 2972). Will convene a workshop to evaluate these issues. [Co-funded with AwwaRF]

## **Endocrine Disruptors and Pharmaceutically Active Compounds in Drinking Water – A Workshop (00-HHE-7-CO)**

This workshop examined the implications of these compounds in drinking water and wastewater. [Co-funded with AwwaRF – also listed under AwwaRF as Project 2598]

## **Analytical Method for Endocrine Disruptors in Sewage Sludge (02-HHE-1CO)**

Development of methods for identifying and quantifying hormones in residuals (biosolids). Procedures developed will be used to evaluate the survival of endocrine disruptors in soil/residuals mixtures under conditions following land application. [Recently completed. Co-funded with UKWIR]

## **Detection Methods for Endocrine Disruptors in Environmental Matrices (03-HHE-4CO)**

Evaluation of analytical methods for these compounds. [Co-funded with GWRC]

## **An Assessment of the Occurrence and Ecological Significance of Endocrine Disrupting Chemicals in Watersheds (99-ECO-3)**

Will assess the temporal and spatial variability of endocrine disruption biomarkers and evaluates the chemical quality of aquatic ecosystems. [Golder & Associates, Inc.]

## **Long-Term Study on Landscape Irrigation Using Household Graywater (03-CTS-18CO)**

This proposed study will evaluate the safety of using graywater for landscape irrigation.

## **Emerging Treatment Technologies for Water Reclamation (98-CTS-5)**

Explored the feasibility and application of membrane bioreactor (MBR) technology to reduce costs and increase practicality of water reclamation for use. Summarized advantages and limitations of MBR process, and addresses the potential of MBRs for water repurification, configuration issues for full-scale development, compliance and preliminary cost estimates. [Completed. MWH.]

## **Overcoming Molecular Sample Processing Limitations: RNA and DNA Extraction Strategies (00-HHE-2A)**

Readers will learn about several strategies for pathogen nucleic acid detection that are relatively rapid, reasonably priced, and reproducible by individuals without extensive training in molecular biology techniques. [Completed. USDA]

### **Overcoming Molecular Sample Processing Limitations: Quantitative PCR (00-HHE-2B)**

The researchers developed promising methods for rapid (<8 hours) real-time quantitative PCR detection of *Cryptosporidium parvum* and infectious enteroviruses in wastewater samples. [Completed. AWWWS, Inc.]

### **Overcoming Molecular Sample Processing Limitations: Fiber Optic Biosensor (00-HHE-2C)**

Explores the application of a commercially available fiber-optic biosensor for the detection of bacterial pathogens. [Completed. University of South Florida]

### **Development of Practical Monitoring Techniques to Identify the Probability of the Presence of Pathogens in Receiving Waters (97-HHE-1)**

Develops a practical, low cost, easily administered monitoring technique, not presently used for compliance, for detecting bacterial pathogens in a variety of receiving waters. [Contract with Los Angeles County Sanitation District]

### **Applications of DNA Microarray Technology for Wastewater Analysis (01-HHE-1)**

Prepares a white paper describing microarray technology and needs for industry-wide application of this technology. Will evaluate the applicability of this technology in water and wastewater treatment analysis. [Contract with Biotechnology Research Institute]

### **Molecular Detection of Pathogens and Indicators: Real-Time PCR (01-HHE-2A)**

Will examine feasibility of more rapid and specific detection methods (quantitative polymerase chain reaction) for pathogen and indicator monitoring. This could lead to near real-time analysis of human health risk. (Contract with University of California, Riverside)

### **Molecular Detection of Pathogens and Indicators: Microarray Technology (01-HHE-2B)**

Will compare a more rapid and specific detection method (microarray technology) for pathogen and indicator monitoring with existing U.S. EPA methods. This could lead to near real-time analysis of human health risk. (Contract with Battelle-PNL)

### **Development of Molecular Methods for Detection of Infectious Viruses in**

## **Treated Wastewater (99-HHE-5-UR)**

Will develop a sensitive and specific assay for the detection of viruses in treated wastewater.  
[Contract with University of North Carolina]

# **WaterReuse Foundation Research Projects**

## **National Database on Water Reuse Projects (WRF-02-004)**

Development of a searchable database (inventory) containing information on water reuse projects in the U.S. [RFP expected in fall 2003]

## **Develop a National Salinity Management Clearinghouse and Five-Year Research Program (WRF-02-005)**

Development of a clearinghouse for information related to salinity management (brine disposal and long-term salinity impacts within ground water basins). The initial five years of an ongoing research program is included. [RFP expected in late fall 2003]

## **A Protocol for Developing Water Reuse Criteria with Reference to Drinking Water Supplies (WRF-02-011)**

Development of methodologies for establishing criteria for augmentation of indirect potable reuse systems. [Co-funded with UKWIR]

## **Water Reuse Research Needs Workshop (WRF-03-010)**

The Foundation will sponsor a workshop in January 2004 designed to identify and prioritize research needs related to water reuse.

## **Rejection of Wastewater-Derived Micropollutants in High-Pressure Membrane Applications Leading to Indirect Potable Reuse: Effects of Membrane and Micropollutant Properties (WRF-02-001)**

Evaluation of the ability of high-pressure membranes to reject trace organics. This will include development of methods for predicting removal efficiencies. [Contract with Colorado School of Mines]

## **Optimization of Filtration Flux Rate for Production of Title 22 Disinfected Tertiary Recycle Water (WRF-02-003)**

Development of guidance on optimizing filter loading rates to meet California's Title 22 high-level disinfection criteria. Study will be done at the Monterey, CA water reclamation facility. [Contract with Monterey regional Water Pollution Control Agency]

## **Concentrate Disposal in Landlocked Cities (WRF-02-006)**

Options for disposal of brines in major landlocked cities (Phoenix, Las Vegas, Tucson) will be evaluated. [RFP expected in fall 2003]

### **Study of RO and UV and Reclaimed Water (WRF-02-009)**

Investigate the effectiveness of UV and reverse osmosis in removing biological and chemical constituents (including the emerging pollutants of concern). The Southwest Florida Water Management District has contributed funds for this project. [Expect RFP in early 2004]

### **Reclaimed Water Aquifer Storage and Recovery: Potential Changes in Water Quality (WRF-03-009)**

Evaluate changes in water quality during storage in an ASR system. This will include evaluation of trace contaminants (NDMA, disinfection byproducts, EPOC, etc.). [Contract award expected in October 2003]

### **Develop Low Cost Analytical Method for NDMA (WRF-01-001)**

Development of a reliable, low-cost method for analysis of NDMA. [Contract with Long Beach Water Department]

### **Removal and/or Destruction of NDMA in Wastewater Treatment Processes (WRF-01-002)**

Evaluation and optimization of treatment processes for removal of NDMA. [Contract with Malcolm Pirnie, Inc.]

### **Characterizing Salinity Contributions in Sewer Collection and Reclaimed Water Distribution Systems (WRF-01-005)**

Evaluation of salinity contributions received through the wastewater collection system and identification of salinity issues in reclaimed water distribution systems. [Co-funded with AwwaRF]

### **Characterizing Microbial Water Quality in Non-Potable Reclaimed Water Distribution System to Optimize End Uses (WRF-01-006)**

Evaluation of changes in microbial quality in reclaimed water storage and distribution systems. [Co-funded with AwwaRF]

### **Use of Bioassays and Chemical Measurements to Assess Removal of Endocrine Disrupting Compounds in Water Reclamation Systems (WRF-01-007)**

Evaluation of the removal of endocrine disrupting chemicals by unit processes used in wastewater treatment facilities. [Joint project administered by WERF]



## **Evaluation and Testing of Bioassays for Pharmaceuticals in Reclaimed Water (WRF-01-008)**

Evaluation of DNA arrays to rapidly screen changes in gene expression in response to aquatic pharmaceutical exposure. [Joint project administered by WERF]

## **Investigation of NDMA Fate and Transport (WRF-02-002)**

Evaluation of the fate and transport of NDMA in soil and in the ground water system. [Contract with West Basin Water District]

## **Comparative Study of Recycled Water Irrigation and Fairway Turf (WRF-02-007)**

Evaluation of turf grass irrigated with reclaimed water under several prescribed irrigation regimes. [Co-funded project]

## **Study of Reclaimed, Surface, and Ground Water (WRF-02-008)**

Will characterize and compare reclaimed water with surface waters (pristine and impacted) and ground waters (pristine and impacted) for a wide range of constituents (including microbials, EPOC, endocrine disrupters, etc.). The Southwest Florida Water Management District has contributed significant funding. [RFP expected in fall 2003]

## **Pathogen Removal and Inactivation in Reclamation Plants (WRF-03-001)**

Development of a detailed study design for a future research project to evaluate pathogen removal by various unit processes. [Contract award expected in October 2003]

## **Understanding Public Concerns of Indirect Potable Reuse Projects (WRF-01-004)**

Evaluation of example indirect potable reuse projects (successes and failures) aimed at identifying key issues and strategies. A “tool kit” for successful implementation of this type of reuse project will be developed. [Contract with Resource Trends]

## **Marketing Strategies for Non-Potable Recycled Water (WRF-03-005)**

Development of marketing strategies to be used by utilities in increasing the demand for reclaimed water for non-potable purposes. [Contract award expected in October 2003]

## **Economic Analysis of Sustainable Water Use – Benefits and Costs (WRF-03-006)**

Development of approaches for considering total costs and benefits (economic and non-economic) associated with water reuse projects. [Contract award expected in October 2003]