

25th Annual WaterReuse Symposium 2010

**Washington, DC, USA
12-15 September 2010**

ISBN: 978-1-61839-757-7

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2010) by the WateReuse Association
All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact the WateReuse Association
at the address below.

WateReuse Association
1199 North Fairfax Street
Suite 410
Alexandria, VA 22314

Phone: (703) 548-0880
Fax: (703) 548-5085

info@watereuse.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

A1 – HEALTH EFFECTS & RISK ASSESSMENT

Risk Assessment Study Of PPCPS In Recycled Water To Support Public Review	1
<i>Jean F. Debroux, Mark Millan, Laura Kennedy</i>	
Tools To Assess The Risks Of Indirect Potable Reuse Projects	6
<i>Jeffrey Soller, Margaret Nellor, Gretchen Bruce, Peter Fox, Grant Skrepnek, Louisa Flander</i>	
Health Concerns Of The Water Reuse Industry: Prioritizing Research Needs	18
<i>Joseph A. Cotruvo, Richard J. Bull, James Crook, Margaret Whittaker</i>	
Loading Of Pharmaceuticals And Illicit Drugs During A Major Sporting Event	30
<i>Shane Snyder, Rebecca Trenholm, Daniel Gerrity, Yongrui Tan</i>	

A2 – INDUSTRIAL REUSE APPLICATIONS

Water Reuse Comes Of Age In Edmonton Canada	40
<i>Alan Rimer, Hans Wolf, Tim Jantzie</i>	
Electrosorption Desalination Technology For Industrial Wastewater Reuse	50
<i>Hongtao Zhang, Fangqin Xue, Xiaowei Sun, Ke Xu, Chunxu Wu, Tao Ning</i>	
A Review Of A Successful Water Reuse Project Implemented In A Major Petrochemical Plant For 10 Years	59
<i>Joseph M. Wong</i>	
Economic and Financial Evaluation of Industrial Wastewater Reclamation and Reuse System in Taiwan	68
<i>Ya-Chin Chen</i>	

A3 – MEMBRANE TECHNOLOGIES - PART 1

Membrane Bioreactor Effluent Water Quality – Modeling Process Performance For Organic Microconstituents	83
<i>Joan Oppenheimer, Bruce Rittman, Ayla Kiser, Zakir Hirani, James Decarolis</i>	
Choosing Mf Membranes For Expansion Of The GWR System: A Performance-Based Assessment	90
<i>Tom Knoell, Eric Owens</i>	

A4 – MEMBRANE TECHNOLOGIES – PART 2

Oxidation Before Ro For Water Reuse: Effects On Effluent Organic Matter And Ro Fouling	100
<i>Aleksey N. Pisarenko, Benjamin D. Stanford, Dongxu Yan, Shane A. Snyder</i>	
Low Energy-High Efficiency Integrated Coagulation-UF For Reclamation Of Used Water	111
<i>Jian-Jun Qin, Maung Htun Oo, Kiran A. Kekre, Rob Kolkman</i>	
Pathogen Rejection And Peak Flux Performance By Nine Different MBR Systems	120
<i>Zakir Hirani, Geno Lehman, James Decarolis, Joseph Jacangelo</i>	

A5 – REUSE REGULATORY & AMP – INSTITUTIONAL ISSUES

Unintended Consequences: Numeric Nutrient Criteria Will Constrain Reuse Opportunities	132
<i>Albrey Arrington, Kristin Y. Melton</i>	
Water Reuse in Spain prior to the Royal Decree 1620/2007	143
<i>Jesus Yague Cordova, M. Augusta Lopez Martin</i>	
The Recycled Water Quality Management Plan Approach– Learning From The Australian Experience	149
<i>Greta L. Zornes, Emily Jansen</i>	
Assessment Of Approaches To Achieve Nationally Consistent Reclaimed Water Standards	161
<i>Margaret H. Nellor, Roberta Larson</i>	

A6 – PLANNING – A CRITICAL STEP FOR WATER REUSE PROJECTS

Maximizing A Valuable Resource: Demand Management And Planning For A Recycled Water Infrastructure	167
<i>Craig Parker, Sylvie Lee, Amy Jones</i>	
Securing L.A.’S Water Supply Through Water Recycling	170
<i>Paul Liu, John Hinds, Doug Walters, Tom Richardson, Heather Vanmeter, Rob Morrow</i>	
The Expansion of Water Reuse in the Mid Atlantic and Northeastern U.S.: A Review of Drivers, Challenges and Case Studies	181
<i>Richard H. Cisterna, Anni Luck, Cynthia Castellon</i>	

Water Reuse And The Army	186
<i>Richard J. Scholze, Marc D. Kodack</i>	

ALTERNATE PAPERS

Regulatory Drivers And Impacts On Opportunities For Water Reuse In Small Rural Areas Of The Central Valley Of California	191
<i>Colin Moy, Ron Crites</i>	
Water Reuse Strategies To Support Sustainable Water Supplies In Town Of Davie, FL	198
<i>Zuhal Ozturk, Brian Stitt, Everette Lopez, David Ammerman, Bruce Taylor</i>	

B1 – WATER REUSE FINANCE

Water Reuse and Economic Development in Loudoun County	208
<i>Elizabeth G. Sitter, Robyn Bailey, Buddy Rizer</i>	
Economics Of Water Reuse Plans For Urban Areas With Natural Capital Valuation – Getting To The True Value Of Water Reclamation	214
<i>Michael Wilson, Larry Schimmoller, Mary Jo Kealy</i>	
To Recycle Or Not To Recycle Determining A Benchmark For Reuse Expansion	224
<i>Steven A. Friedman</i>	

B2 – GROUNDWATER ISSUES

As Water Becomes Scarce In Desert State, Sedona Seeks To Use Effluent As An Asset	234
<i>Anh Quach, Dave Sobek, Charles Mosley</i>	
An Assessment Of Aquifer Storage And Recovery In Texas	246
<i>Caroline G. Russell, Fred Blumberg, David R. Pyne</i>	
Balancing The Constraints Affecting Reclaimed Water Aquifer Recharge In South Miami-Dade County, Florida	256
<i>Yan Zhang, Lee Wiseman, Harry Cheng, Layla Liewelyn, Virginia Walsh</i>	

B3 – GRAYWATER REUSE

Is Graywater Another Flavor Of Water Reuse?	268
<i>Bahman Sheikh</i>	
The Wra Graywater Policy: Process And Plan Forward	280
<i>Don Vandertulip</i>	
Graywater And The Regulatory Framework - What’s The Real Word?	288
<i>Alan E. Rimer</i>	

B4 – CLIMATE CHANGE AND WATER REUSE

Effects Of Nitrification, Stratification, And Chlorination In The Country’s Largest Recycled Water Reservoirs A Case Study	298
<i>Andy Komor, Michael Anderson, Daniel Feron, Jim Hyde</i>	
New Wastewater Disposal Rules Aimed At Protecting The Environment Could Have Drastic Climate Change Impacts	311
<i>Enrique Vadiveloo, George A. Brown, Gary W. Bors, Janeen M. Wietgreffe, Bert J. Vidal, Vin Morello</i>	
Climate Change And Water Reuse: Expanded Needs, Opportunities, And Values	322
<i>Robert Raucher</i>	

B5 – PUBLIC ACCEPTANCE OF ALTERNATIVE WATER SUPPLIES

Reclaimed Water, Research And Really Good Food—A Recipe For Public Acceptance	330
<i>Jo L. Sullivan, Kristen McIvor</i>	
Hidden In Plain Sight – The Next Generation Of Water Reuse Facility	342
<i>Kelly Comstock, Peter Schuller, Kun Siwanarpa, Paul Williams</i>	
You Want Me To Drink What??	356
<i>Sara M. Katz</i>	
Managing Reclaimed Water Issues: Understanding Environmental Factors And Diffusing Public Perceptions	360
<i>Ted Hartsig, Jenny Fifita</i>	

B6 – INNOVATIVE APPLICATIONS FOR WATER REUSE PROJECTS

Recycled Water Authority Uses Contracting Innovation To Install Screening Facilities	369
<i>Judy Zavadi, Dan Gallagher</i>	

Use Of Reclaimed Water And Regulated Deficit Irrigation: An Alternative To Mediterranean Citrus	378
<i>Francisco Pedrero Salcedo, Juan Jose Alarcon Cabanero, Emilio Nicolas Nicolas, Oussama Mounzer</i>	
A 25,000 GPD Class ‘A’ MBR For Washington State Fire Training Academy Allows Year-Round Training For State, National & International Fire Personnel	390
<i>John C. Wilson, Jeffrey A. Howard</i>	
City Of San Diego, Public Utilities Department Water Purification Demonstration Project	400
<i>Marsi Steirer</i>	

C1 – ADVANCED DISINFECTION TECHNOLOGIES

The Dark Side Of UV Notes From The Field Detailing Realworld Problems And Solutions	406
<i>Andrew Salveson, Craig Riley, David Stoops, Keith Bourgeois, Nicola Fontaine, Jeff Bandy</i>	
Wastewater Utility Resilience Assessment	410
<i>Gary L. Hunter, Leonard W. Casson, Kevin M. Morley</i>	
Development, Challenges And Validation Of A High Efficiency UV Unit For Title 22 Reuse	423
<i>Keith Bircher, Bill Sotirakos, Andrew Salveson</i>	
Combining UV And Free Chlorine For Disinfection: Effects Of Operating Conditions	436
<i>Naoko Munakata, Chi-Chung Tang, Shiaw-Jy Huitric, Jeff Kuo, Phil Ackman, Philip L. Friess, Stephen R. Maguin</i>	

C2 – POTABLE REUSE – CHALLENGES AND OPPORTUNITIES

Potable Reuse In The Permian Basin	448
<i>David W. Sloan, Chris Wingert, Ignacio Cadena</i>	
Recommendations For Future Research In Chemistry And Toxicology For The Watereuse Foundation	455
<i>Erin Snyder</i>	
Advanced Water Reclamation For Indirect Potable Reuse: Examining Sustainability Of Three Different Treatment Schemes	464
<i>James C. Lozier, Larry J. Schimmoller, Jason M. Curl, Robert A. Bergman</i>	
Direct Potable Reuse In California: Strategic Working Plan And Policy Positions	475
<i>Jeffrey J. Mosher, David W. Smith</i>	
Direct Potable Reuse: Are We Ready?	487
<i>Tom Richardson, Dave Smith, Helene Kubler</i>	
Commissioning And Testing Of The Western Corridor Recycled Water Scheme	499
<i>Warren Traves, David Solley</i>	

C3 – WATER QUALITY ISSUES

Challenges Associated With Microbial Methods For Reclaimed Water	507
<i>Patrick Jjemba, Zia Bukhari, Mark Lechevallier</i>	
The Role Of Coagulation And Particle Association In The Removal Of Viruses Through Tertiary Granular Media Filtration	520
<i>Gordon J. Williams, David C. Love, Bahman Sheikh, Kara L. Nelson</i>	

C4 – MICROCONSTITUENTS – PART 1

Manufactured And Anthropogenic Nanoparticle Fouling Of Microfiltration Membranes	532
<i>Jonathan A. Brant, Coleman J. Henry</i>	
Occurrence Of Perfluoroalkyl Carboxylates And Sulfonates In Drinking Water Utilities And Related Waters From The United States	544
<i>Oscar Quinones, Shane Allen Snyder</i>	
Behavior Of NDMA And PPCPs Through A Pilot Scale MBR– Ozone/Peroxide–RO System	556
<i>Benjamin D. Stanford, Aleksey N. Pisarenko, Shane A. Snyder</i>	

C5 – MICROCONSTITUENTS – PART 2

On the Use of Multiple Indicators for Impaired Waters	563
<i>Andrew Eaton, Ali Haghani, Ed Wilson, Walter Hsieh</i>	
The Mabel Approach—Application To Deriving Screening Levels For Micropollutants Inwater	575
<i>Gretchen M. Bruce, Richard C. Pleus</i>	
Occurrence and Variability of Trace Organic Contaminants in Raw Wastewater as a Function of Sewershed Size by Liquid Chromatography-Tandem Mass Sepctrometry	586
<i>Jennifer Teerlink, Jorg E. Drewes, Christopher P. Higgins</i>	
Emerging Contaminants: Establishing Sensible Priorities	592
<i>Shane A. Snyder</i>	

C6 – URBAN REUSE

Retrofits That Make Cents	600
<i>Ken Deck, Dickie Fernandez</i>	
AK-Chin Indian Community Expands Reuse Opportunities With A New Water Reclamation Facility	609
<i>Jayne Long, Roman Orona, Devin Shaffer, Nicole Tomaszewski</i>	
Student Perceptions Of Water Resources And Reuse At A Large University	613
<i>Sridhar Vedachalam, Karen M. Mancl</i>	
Soil Analysis Before and 5 Years after Recycled Water Irrigation	625
<i>Yaling Qian, Sarah Wilhelm, Kory Nickell, Abigail Holmquist, Stephen Lohman</i>	

D1 – DESALINATION 101 – AN OVERVIEW OF DESALINATION PRACTICES

An Integrated Framework For Treatment And Beneficial Use Of CBM Produced Water	635
<i>Jorg E. Dreves, Tzahi Cath, Pei Xu, Nathan Hancock, Katharin Dahm, Katherine Guerra, Dean Heil, Jim Graydon, Jean Debroux, Dawn Taffler, John Veil, Seth Snyder, Bob Raucher, Wayne Buschmann</i>	
Inland Desalination: Current Status And Challenges	643
<i>Mike Mickley</i>	
Seawater Desalination: Current Status And Challenges	653
<i>Nikolay Voutchkov</i>	
Desalination by Reverse Osmosis: How it Began and Where it Is Now	665
<i>Val S. Frenkel</i>	

D2 – MEMBRANE SEPARATION TECHNOLOGIES FOR WATER REUSE

Water Reuse In Australia – Membrane Technologies Make It Happen	676
<i>Dawn Halpern, Anthony Day, Tom Stocker, John Koch, Antonia Von Gottberg</i>	
Antiscalant Capabilities For Mineral Scale Control In RO Reuse Applications	686
<i>Tom Knoell, Eric Owens</i>	
Design, Construction And First Year Operating Results Of The Largest Changi NWater Facility In Singapore	695
<i>Gerry O'Toole, Vasu Veerapaneni, Jimmy Cheng, Chris Johnson</i>	
Performance And Cost Comparison Between MF/RO And EDR Membranes For Reducing The Salinity Of Recycled Water	707
<i>Gordon J. Williams, R. Shane Trussell</i>	
Innovative Membrane Technology For Reuse At A Zero Discharge Power Plant	719
<i>Nathan Kutil, Gordon Criswell, Craig Habben, Jake Ostrander, Ross Schwend</i>	
Combined Organic And Inorganic Fouling Of Forward Osmosis Membranes	727
<i>Yaolin Liu, Baoxia Mi</i>	

D4 – PLANNING FOR DESALINATION PROJECTS

Making New Water: The Design of a Temporary Ocean Water Desalination Demonstration Facility	733
<i>Phil Lauri, John Robinson</i>	
Desalination Decision-Making: Aligning The Board, Staff, And The Community	738
<i>Libby Pischel, Charles Gardiner, Ivy Morrison</i>	
Assessing The Full Costs (And Benefits) Of Desalination	749
<i>Robert Raucher, Janet Clements</i>	

D5 – CONCENTRATE AND BRINE MANAGEMENT

Southern California Regional Brine-Concentrate Management Study	758
<i>Anne Lynch, Greg Krzys</i>	
Ro Concentrate Recovery In The Eastern Us: Results From Bench And Pilot Testing	769
<i>David Macnevin, Sandeep Sethi, Lyle Munce, Ashie Akpoji, Mark Elsner, Huren An</i>	
Concentrate Chemical Softening To Improve The Recovery Of Brackish Water Reverse Osmosis Desalination	780
<i>Scott H. Hekman, Desmond F. Lawler</i>	
A State Of Approach For The Selection Of Best Concentrate Management Technology	786
<i>Ufuk G. Erdal, Jim Lozier, Anne Lynch, Shannon Sweneey</i>	

D6 – DESALINATION CASE STUDIES

A Desalination Challenge: Integrating Your New Source To Meet Cost And Reliability Objectives	792
<i>Alana M. Duncker, Andrew Steere, Jeffery P. Frey</i>	
Improving Energy Efficiency Of Low Salinity Desalination (Wastewater And Brackish Water) Using Energy Recovery Device – Case Studies	804
<i>David G. Argo, Mehul Patel, Shivaji Deshmukh, Srinivas Veerapaneni, Sunny Wang</i>	

Cost Effective Demineralization For Improved Recycled Water Quality In California	811
<i>Michael Thornton, R. Shane Trussel</i>	
Comprehensive Results Of West Basin Municipal Water District's Ocean Water Desalination Pilot Program	820
<i>Phil Lauri, Mark Donovan, Jonathan Dietrich, Shane Trussell</i>	

E2 – REUSE TREATMENT TECHNOLOGIES

Updating Testing Approaches In The NWRI/AWWARF UV Guidelines	830
<i>Brian Petri, O. Karl Scheible, Chengyue Shen</i>	
Ceramic Membranes – A Pilot Evaluation Of An Emerging Reuse Technology	834
<i>Randall S. Brooker Jr., Chamindra Dassanayake, Chris Kaakaty, Randall McIntyre, Brandt Miller, Joseph Husband, Michael Sparks</i>	
Content, Purpose And Need For National Product Evaluation Standards Of Residential And Commercial Water Reuse Technologies	841
<i>Thomas J. Bruursema</i>	

TUESDAY EARLY BIRD SESSION – ENERGY ISSUES RELATED TO DESALINATION

Comparison of Two RO Concentrate Reduction Technologies on Chemical Usage, Energy Consumption, and Life Cycle Environmental Impacts	848
<i>Ke Li, Jing Wan, Charlie He, Zhuang Liu</i>	
Saving Energy and Costs on Microconstituent Removal and Inland Desalination	861
<i>Vijay Sundaram, Robert W. Emerick, John P. Enloe, Jeffrey R. Curtis, Stanley E. Shumaker</i>	

TUESDAY EARLY BIRD SESSION – WATER REUSE

The Multiple Uses Of Reclaimed Water In Spain	871
<i>Jesus Yague Cordova, Cristina Danes Castro</i>	
Tres Rios Constructed Wetlands Support Wetland And Riparian Habitat While Polishing Water From The Phoenix Metropolitan Area	879
<i>Roland D. Wass, Martin Bressor, Dusan Stanistic, Robert Upham, Mike Ternak</i>	

WEDNESDAY EARLY BIRD SESSION – INLAND DESALINATION

Implementation Of An Inland Brackish Groundwater Supply Project From Groundwater Recharge To Reverse Osmosis Treatment Plant And Brine Disposal	890
<i>Dave Kaunisto, Kelly Dinatale, Doug Brown</i>	
Recovering Both Water And Salts From A Saline Inland Groundwater	902
<i>Greg Wetterau, Robert Fowle, Jeremy Anderson, Guy Bralley</i>	

WEDNESDAY EARLY BIRD SESSION – NATIONAL AND INTERNATIONAL PLANNING FOR WATER REUSE

National Water Reuse Plan Of Spain	913
<i>Cristina Danes Castro, Luis Ortega Regato</i>	
Maximizing Interagency Cooperation Maximizes Reuse	919
<i>Steve Hogg, Lou Carella, Kevin Norgaard, Reace Fisher, Lorien Fono, Lydia Holmes, Penny Carlo</i>	
Author Index	