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Water Technology Research at Awwa Research Foundation

Military Applications for Emerging Water Technologies
November 12-14, 2008
Urbana, IL

AwwaRF

Advancing the science of water to improve the quality of life

- **Centralized research program for drinking water utilities**
  - Sponsor research
  - Develop knowledge
  - Promote collaboration
- **Agenda is planned and guided by drinking water utilities**
- **Research covers a broad range of topics including resources, treatment, infrastructure, and management for drinking water utilities**

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Name as of 2009

Water Research Foundation

www.WaterResearchFoundation.org

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AwwaRF Research

- Total research value = $460 million
- 2007 research value ~ $21 million
- > 1,100 research projects
  - > 800 published reports
  - ~ 300 projects currently ongoing

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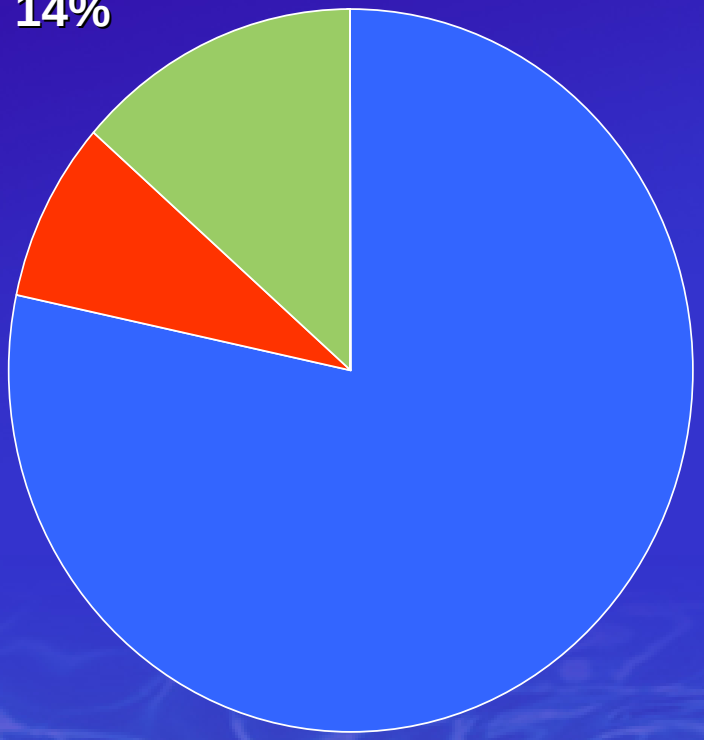
Sources of Funding (2007)



~900 utilities

>50 consultants

16 manufacturers

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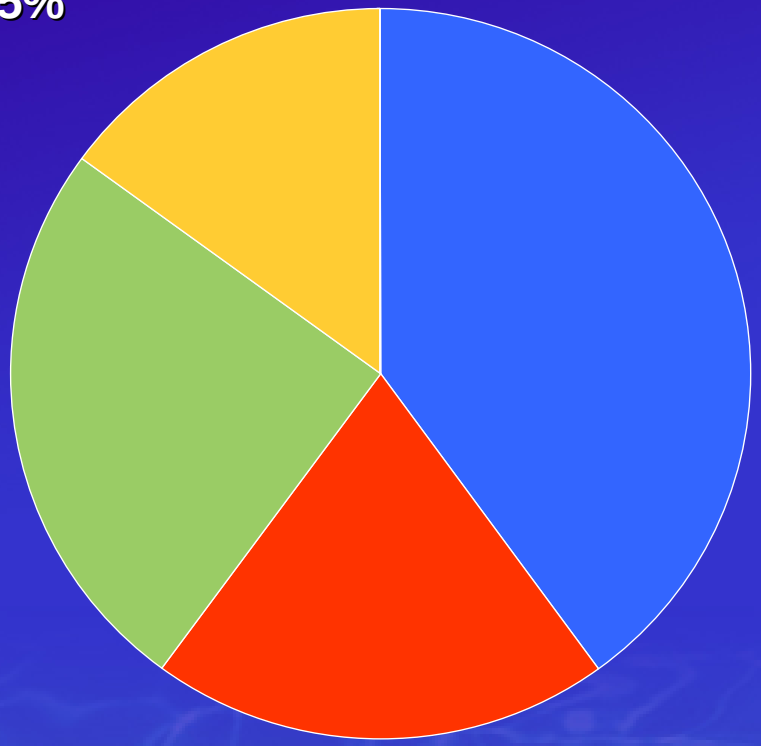
Where Funding Goes



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Water Technology Research

- Perhaps 50 percent of AwwaRF research aims at technology-based solutions
- Of this 50 percent
  - ~80% is application and optimization of existing technologies
  - ~20% is development of new technologies

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Water Technology Research

- Key water technology research focus areas
  - Water resources
  - Water treatment
  - Water quality monitoring
  - Distribution system operations
  - Infrastructure assessment and renewal

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Water Technology Research

- Focus areas for this presentation
  - Water resources

    Alternative water supply
  - Water treatment

    Emerging treatment technologies

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Alternative Water Supply

- Desalination – seawater and inland (brackish groundwater)
- Reuse
- Concentrate management
- Energy efficiency

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Desalination – Example Projects

Project 4148 - Investigation of Vibratory RO to Achieve >99% Water Recovery or Treat RO Brines (Mark Benjamin, University of Washington)

Exploring the performance of a vibratory RO membrane system in treating simulated and real brackish raw waters and brines from first-stage RO systems, with the goal of achieving >99 percent overall recovery combined with excellent solute rejection.

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Desalination – Example Projects

Project 4148 - Investigation of Vibratory RO to Achieve >99% Water Recovery or Treat RO Brines (Mark Benjamin, University of Washington)

- **Vibration improves rejection rate for most major ions in both brackish solutions and RO brines by up to 25%**
- **Improved performance due to reduction in membrane fouling, with associated flux increase**

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Desalination – Example Projects

Project 4201 – Phytoplankton Fouling of Pretreatment and Reverse Osmosis Membranes in Seawater Desalination (Mark Clark, University of Illinois)

Studying the fouling effects of marine algae and algogenic organic matter on integrated membrane desalination systems. Will aid utilities and membrane manufacturers in understanding the fundamental principles involved in phytoplankton fouling so that appropriate technologies can be piloted and implemented.

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Desalination – Example Projects

Project 4201 – Phytoplankton Fouling of Pretreatment and Reverse Osmosis Membranes in Seawater Desalination (Mark Clark, University of Illinois)

- **Mechanical shearing of algal cells leads to increased fouling and associated flux decline in MF/UF pretreatment membranes**
- **Shearing also increases organic matter in pretreatment membrane permeate**
- **Implications for intake and pumping system design/operation**

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Reuse – Example Projects

Project 4150 - A Novel Hybrid Forward Osmosis Process for Drinking Water Augmentation Using Impaired Water and Saline Water Sources (Tzahi Cath, Colorado School of Mines)

Investigating a novel hybrid process (FO followed by RO) that will simultaneously enhance water reclamation and desalination using a forward osmosis membrane process combined with reverse osmosis desalination of saline water. Potential advantages of the hybrid system include reduced chemical use, enhanced water recovery, lower energy use, and multiple barriers to biological and organic contaminants.

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Reuse – Example Projects

Project 4150 - A Novel Hybrid Forward Osmosis Process for Drinking Water Augmentation Using Impaired Water and Saline Water Sources (Tzahi Cath, Colorado School of Mines)

- **Improved rejection of ammonia, nitrate and selected trace organics vs. RO alone**
- **FO membrane fouling propensity appears minimal**
- **Shows particular promise for reuse applications**

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Reuse – Example Projects

Project 3012 – Comparing Nanofiltration and Reverse Osmosis for Treating Recycled Water (Jorg Drewes, Colorado School of Mines)

Evaluates the feasibility of NF and ultra-low-pressure RO ULPRO membranes for rejecting total organic carbon, total nitrogen, and unregulated trace organic compounds under a range of experimental conditions at the laboratory-, pilot-, and full-scale to produce water suitable to augment drinking water supplies. Provides utilities with guidance on selecting membranes and predicting solute rejection during NF-ULPRO membrane treatment. Tailored Collaboration partner: West Basin Municipal Water District.

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Reuse – Example Projects

Project 3012 – Comparing Nanofiltration and Reverse Osmosis for Treating Recycled Water (Jorg Drewes, Colorado School of Mines)

- **Loose NF offers potentially significant energy cost savings but is limited in rejecting ammonia and nitrate**
- **ULPRO offers similar performance to conventional RO with potentially lower operating expenses**
- **Rejection of trace organics (especially hydrophilic ionic species) improved for both NF and ULPRO with increased membrane fouling**

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Concentrate Management – Example Projects

Project 3010 – Zero Liquid Discharge for Inland Desalination (Rick Bond, Black & Veatch)

Describes a process train for zero liquid discharge including primary RO, concentrate treatment process or processes, secondary RO, brine concentrator (thermal desalination), and evaporation pond. Reports the results of a process using five brackish water sources representing a broad range of water quality characteristics.

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Concentrate Management – Example Projects

Project 3010 – Zero Liquid Discharge for Inland Desalination (Rick Bond, Black & Veatch)

- **Fluidized bed crystallization with addition of alum or sodium aluminate provides effective removal of Ba, Ca and Si from concentrate**
- **This process offered significant cost savings versus a benchmark ZLD approach consisting of RO→brine concentrator→evaporation pond**

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Concentrate Management – Example Projects

Project 3030 – Desalination Product Water Recovery and Concentrate Volume Minimization (Sandeep Sethi, Carollo Engineers)

Developed an innovative approach to advance desalination technologies for product water recovery and concentrate volume minimization.

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Concentrate Management – Example Projects

Project 3030 – Desalination Product Water Recovery and Concentrate Volume Minimization (Sandeep Sethi, Carollo Engineers)

- **Assessed 21 different treatment trains and configurations**
- **Developed and tested a concentrate minimization train consisting of RO→chemical precipitation→ electrodialysis**
- **Recovery increases of 10-20 percent versus conventional brackish water RO**

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Energy Efficiency – Example Projects

Project 3056 – Assessing Energy Use and Optimization Potential of Advanced Water and Wastewater Treatment Systems (Yu-Jung Chang, HDR Engineering)

Documents the energy use, cost, and efficiency of water and wastewater unit operations. Includes a comparison with theoretical efficiencies and an identification of the largest energy usages. Conducts a comparison of 12 different plants to include a range of advanced water and wastewater treatment processes including desalination.

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Energy Efficiency – Example Projects

Project 3056 – Assessing Energy Use and Optimization Potential of Advanced Water and Wastewater Treatment Systems (Yu-Jung Chang, HDR Engineering)

- **UV/ozone processes provide significantly lower unit energy costs versus pressure-driven processes**
- **Energy efficiency can potentially be improved by operating systems at near design capacity**

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Energy Efficiency – Example Projects

Project 4038 – Desalination Facility Design and Operation for Maximum Energy Efficiency (Srinivus Vasu, Black & Veatch)

Will compile and analyze data from operating brackish (ground and surface), seawater, and wastewater membrane desalination facilities to result in recommendations for the design and operation of desalination facilities to maximize energy efficiency and reduce energy use and costs. Will also investigate the relationships between plant location, design, operation and maintenance, and energy use and cost.

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Energy Efficiency – Example Projects

Project 4038 – Desalination Facility Design and Operation for Maximum Energy Efficiency (Srinivus Vasu, Black & Veatch)

- **Using case study approach at selected operating facilities worldwide**
- **Just getting underway**

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Emerging Treatment Technologies – Example Projects

Project 4062 – Evaluating Carbon Nanotubes as Adsorbents for Removing Synthetic Organic Compounds (Chip Kilduff, Rensselaer Polytechnic Institute)

Will identify mechanisms of adsorption by carbon nanotubes for a representative selection of synthetic organic chemicals. Will provide a side-by-side comparison with existing adsorbents and a rational basis for selecting and preparing carbon nanotubes. Will evaluate whether recent developments in nanotechnology make sense to pursue for applications in water treatment, and will form the beginning of a database of sorption properties.

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Emerging Treatment Technologies – Example Projects

Project 4139 – A New Water Source: Can Fuel Cells Provide Safe and Cost-Effective Potable Water Sources? (Paul Westerhoff, Arizona State University)

Will assess the viability of integrating fuel cell technologies into the toolbox of options for municipal water providers.

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Thank You!
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