Distribution System Water Quality (DSWQ) Strategic Initiative (SI) at the Water Research Foundation

PNWS Annual Meeting
Tacoma, Washington
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WATER RESEARCH FOUNDATION™
ADVANCING THE SCIENCE OF WATER®

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What is the Water Research Foundation?

- Originated in mid-1960s as a division of AWWA
- Independent mid-1980s
  - American Water Works Association Research Foundation (AwwaRF)
  - Separate Board of Trustees (BOT)
  - Separate funding source
- Name change January 2009 to Water Research Foundation

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New Name, Same Mission

Advancing the science of water

to improve the quality of life.

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Foundation's Contribution to the Water Community

- Practical applications to help utilities optimize operations and ensure customer satisfaction.
- Early alert and proactive solutions on future issues.
- Direct, immediate benefits to utility subscribers.

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Sources of Funding

- Voluntary Subscriptions from Water Supply Community - Subscribers
- Partnerships / In-kind contributions
- Congress

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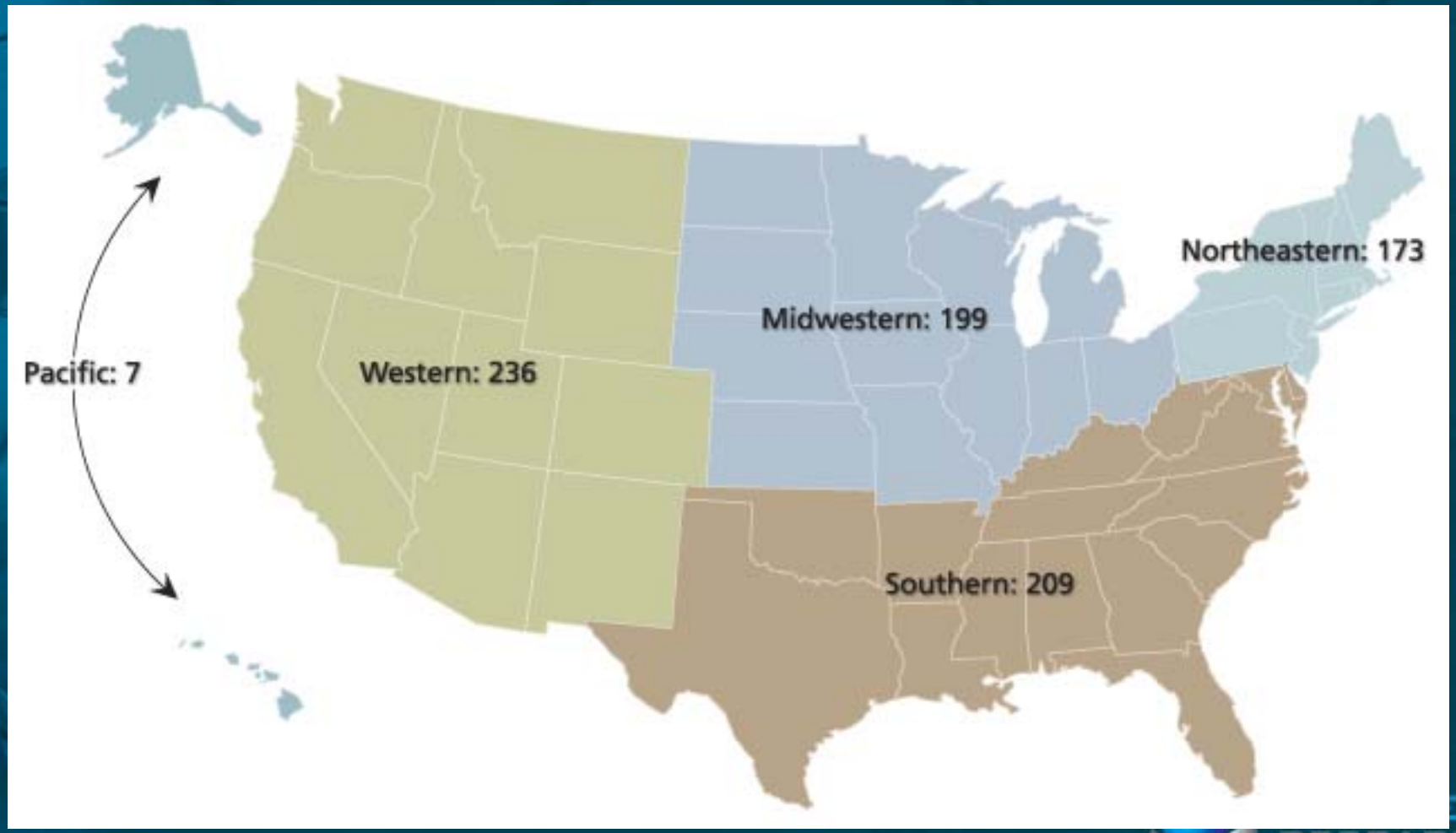
Our Subscribers by Region



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Foundation Overview

- Over 1,000 projects
- Four Technical Areas for Research
  - Water Quality/Treatment
  - Infrastructure
  - Water Resources & Environmental Sustainability
  - Management and Customer Responsiveness
  - Opportunity cost results in some lack of focus on a given topic – pre-SI
- Five Funding Programs (w/SI)

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With 20+ Years of Research & Research Planning, Why an SI?

- Research Strategy Committee suggested
- BOT decreed it
  - Solve specific, pressing, water community problems through sustained and coordinated research
  - Establish the Foundation as a recognized leader on critical issues
  - Provide opportunities for shared funding, obtain federal funding

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Strategic Initiative Overview

- Expert Panel (EP) provides focus & direction, same panel, same focus
- Expert workshop to inform EP, held in May 2007
- Funding up to $1M/year
- 5+ years min. duration
- EP must identify specific technical goals for SI
- 2007 Start, first funded projects 2008
- Annual review by EP of accomplishments, next steps

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DSWQ SI Goals

- **Goal 1: Understanding Premise Plumbing Water Quality Changes**
- **Goal 2: Define and Measure Multiple Barriers to Ensure Distribution System Water Quality**
- **Goal 3: Chloramination – Filling in the Gaps**

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DSWQ SI Goal 1

Goal 1: Understanding Premise Plumbing Water Quality Changes:

Although drinking water utilities are not responsible for water quality degradation caused by premise plumbing, these changes can reflect negatively on customer perception of tap water quality and utility performance, and are an important issue for utilities. Work on this objective will produce new and specific understanding of premise plumbing water quality impacts, a new set of forensic tools to determine causes of the changes, and an improved ability to positively impact water quality at the tap. This knowledge will enable drinking water utilities to take appropriate action in helping customers improve water quality at the tap.

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DSWQ SI Goal 2

Goal 2: Define and Measure Multiple Barriers to Ensure Distribution System Water Quality:

Secondary disinfection is a key component of distribution system management, but the quantitative value of this barrier as well as other barriers to water quality degradation are not measured. The DSWQ SI will develop tools and approaches to evaluate the benefits and costs of multiple barriers used to ensure distribution system water quality. This work will enable water utilities to quantitatively evaluate the value of different barriers, and substantially increase the ability of utilities to measure the "health" of their system.

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DSWQ SI Goal 3

Goal 3: Chloramination – Filling in the Gaps:

The use of chloramines as a secondary disinfectant by drinking water utilities has been increasing, and this trend is expected to continue. Although the use of chloramines for secondary disinfection has been studied extensively, considerable knowledge gaps remain. The DSWQ SI will develop additional guidance and understanding to help address these gaps. Water utilities will benefit from a more comprehensive understanding of chloramines and how to monitor and manage chloraminated systems, as well as improved tools to prevent or control negative impacts from the use of chloramines.

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DSWQ SI Overview of Projects

- Projects funded 2008, 2009, will be in 2010 (Request for Proposals out)
- Total projects counting 2010: 15
  - Premise plumbing goal: 4
  - Measuring multiple barriers: 6
  - Chloramination: 5
- A number of “targeted unsolicited” projects started to encourage thinking on DSWQ

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Premise Plumbing Accomplishments

- Three projects substantially underway out of four
  - Some valuable guidance for new building premise plumbing is under preparation
  - Some useful findings on lead oxide formation and stability, some specific recommendations can be made to manage lead oxide dissolution
  - Have determined that:
    - Fluxes a major issue – including water soluble ASTM B813 compliant
    - Inadequate flushing of flux can lead to Cu, Pb, and Cl levels above limits/guidance levels, contribute to degradation of disinfectant residual
    - 4 fps flushing found to readily remove metal debris
    - 50 – 200 mg/l shock chlorination was not found to damage plastic or copper piping - if not required by plumbing code then it is not recommended

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Premise Plumbing Accomplishments (cont'd.)

- Three projects substantially underway out of four
  - Have determined that:
    - Lead carbonate and dissolved inorganic carbon (DIC) can play an important role in accelerating lead oxide formation and form
    - Lead oxide can be formed in absence of DIC
    - Lead oxide dissolution will be higher when disinfectant is changed from chlorine to monochloramine
    - Have a good summary of sulfate reducing bacteria concerns, with ten specific follow-up research needs identified
  - More results coming as projects reach completion

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Quantifying Value of Multiple Barriers Accomplishments

- Two projects substantially underway out of six
  - DS microbial ecology studies appears to hold promise for improved biofilm management
  - Pressure management is a prime factor in DS optimization that can be considerably improved
  - Assessing the risk of waterborne disease outbreaks associated with pipe breaks and intrusion is currently impossible
  - Have determined that:
    - 454-pyrosequencing allows for high throughput sequencing in a single sequencing run, and provides better taxonomic ID of the bacterial population in the DS
    - Bacterial community composition and structure can vary considerably from region to region in the DS with different metabolic potential
    - DS bacterial groups also commonly found in freshwater and soil
    - While focused on effective bacterial management and ecology, still getting started with detailed analysis and evaluation

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Quantifying Value of Multiple Barriers (cont'd.)

- Two projects substantially underway out of six
  - Have determined that:
    - Preliminary optimized pressure management requirements have been identified, and will be further tested in case studies
    - Improved understanding of DS pressure wave propagation needed
    - Further study of risk factors in pressure management is required
    - Risk assessment methods applicable to individual pipe breaks need to be explored/developed
  - Much more quantification of multiple barriers is under development in ongoing or new projects

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Filling in Knowledge Gaps on Chloramine Use Accomplishments

- One project substantially underway out of five
  - Have determined that:
    - Development of a microbial identification and diversity method based on high density microarrays for DS nitrification studies is complicated
  - A number of chloramine projects are getting started that should yield useful data

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DSWQ SI Coordination with Research and Information Collection Partnership (RICP)

- Follow-up to TCRDS Advisory Committee Agreement in Principle of Sept 2008
- Partners are USEPA and the Foundation
- Fifteen month effort with dozens of people involved
- Seven Technical Topics analyzed
- ~Completed April 2010
- Research plan “Priorities Document” will shortly be posted to EPA website
- Excellent plan to better quantify problems, and identify solutions, with DS water quality
- Ten high priority project research areas identified
- DSWQ SI Expert Panel and RICP Steering Committee have common members

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DSWQ SI Coordination with Criteria for Optimized Distribution Systems (Project 4109)

- Project 4109 is developing a roadmap for expansion of Partnership for Safe Water (PSW) into distribution system excellence
- PSW co-funded this work
- Three metrics identified that are easily measured and in which optimization drives optimization of many other DS factors
  - Disinfectant residual (chlorine and chloramine only)
  - Pressure measurement and management
  - Main break/leak measurement and management
- DSWQ SI Expert Panel and 4109 researchers have common members

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DSWQ SI Coordination with Criteria for Optimized Distribution Systems (Project 4109) (cont'd.)

- PSW will expand into DS optimization
  - February 2011 roll-out of a full-scale program
  - Adopting all three recommended metrics
  - May not adopt all suggested details for pressure management
- DS optimization programs also a requirement of the TCRDSAC AIP
- Final Report on Project 4109 should be out shortly

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DSWQ SI Summary

- About half way through five funding years
- Research will easily run to seven years
- Some concern SI will be self-perpetuating
- EP members – if value not achieved in five years it SHOULD be shut down
- EP has remained consistent in vision and focus on goals
  - Chosen not to fund projects insufficiently aligned with SI
  - Annual re-alignments consistent to achieving goals/tools for utility use

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DSWQ SI Summary (cont'd.)

- Fifteen projects identified to date, not close to half complete
- Considerable focus and value already created by consistent EP decisions
  - Specific findings applicable to premise plumbing water quality management
  - Specific findings on optimization and management of DS
  - Considerable value likely to be created in multiple barrier measurement work and on chloramine knowledge gaps
  - The combination of different efforts seems of most value
- Value metrics discussed April 29 meeting, but substantial work remains to be done
- Value metrics will be revisited in an October

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Thank You!
Questions?

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DSWQ SI Projects Started, 2008

- **Solicited Project 4164 – "Lead and Copper Corrosion Control in New Construction" –** Dr. Marc Edwards, Virginia Tech.
- **Solicited Project 4165 – "Characterizing the Components of the Microbial Community Responsible for Nitrification" –** Dr. Greg Harrington, University of Wisconsin-Madison.
- **Solicited Project 4166 – "Water Industry Contribution to Epidemiological and Health Effects Studies Involving DSWQ" –** Dr. Mark Borchardt, Marshfield Clinic Research Foundation.
- **Project 4220 – DSWQ SI Targeted Unsolicited Project Award 1: John Woolschlager of Arizona State University** on the Chloramine objective, specifically on water quality modeling (chloramine loss and nitrification) and evaluation/calibration of the Comprehensive Disinfection and Water Quality (CDWQ) model for this application.
- **Project 4219 – DSWQ SI Targeted Unsolicited Project Award 2: Paolo Scardina of Virginia Tech** on the Premise Plumbing objective, specifically on sulfate reducing bacteria impacts on premise plumbing water quality and possible control guidelines.
- **Project 4218 – DSWQ SI Targeted Unsolicited Project Award 3: Dominic Boccelli of University of Cincinnati** on the Chloramine objective, specifically on water quality modeling (chloramine loss, DBP formation and nitrification) and evaluation of MSX-EPANET for this application).

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DSWQ SI Projects Started, 2008 (cont'd.)

- **Project 4116 – DSWQ SI SOQ for Singapore Partnership, "Microbial Ecology of Drinking Water Distribution Systems" –** University of Illinois, Carollo Engineers and others were selected as the U.S.-based half of a research team that will partner with researchers from the Singapore Public Utilities Board.

- **Unsolicited Project 4211 - "Lead (IV) Oxide Formation and Stability in Drinking Water Distribution Systems: Rates and Mechanisms of Processes at the Solid-Water Interface,"** – Dr. Daniel Giammar, Washington University.

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DSWQ SI Projects Started, 2009

- **Solicited Project 4259 - Role of Biofilm on Fate and Transport of Waterborne Pathogens in Distribution Systems and Premise Plumbing** – Dr. Aaron Packman, Northwestern University.
- **Solicited Project 4251 - Relationship Between Biological Organic Matter and Pathogen Concentrations in Premise Plumbing** – Dr. Marc Edwards, Virginia Tech.
- **Project 4266 - Research and Information Collection Partnership with the USEPA (Follow-up to TCRDSAC Agreement in Principle)** – Dr. Yakir Hasit, CH2M Hill.
- **Project 4303 – DSWQ SI Targeted Unsolicited Project: Dr. Howard Weinberg, University of North Carolina at Chapel Hill** on the Chloramine objective, specifically on Evaluating Water Quality after Chloramination through Measurements of Cytotoxicity and Organic N-containing Disinfection Byproducts.

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DSWQ SI Projects Starting, 2010

- RFP 4307 – Effective Microbial Control Strategies for Main Breaks and Depressurization.
- RFP 4320 – Assessing Potential Short-term Impacts of Chloramination.
- RFP 4321 – Pressure Management: Baseline to Optimized Utility Case Studies.

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