Drinking Water Utility Optimization with the Partnership for Safe Water

Barbara Martin - AWWA
Overview

• Partnership for Safe Water
  – Mission and background
  – Program mechanics & self-assessment process
  – Lessons learned
Partnership for Safe Water

• Water utility optimization and recognition program established in 1995 to address Cryptosporidium concerns
Partnership for Safe Water

- Partner organizations:
Partnership for Safe Water

• Partnership for Safe Water mission:
  – To improve the quality of drinking water delivered to customers of community water systems by optimizing operations.

• Two programs
  – Treatment plant optimization
  – Distribution system optimization
Partnership Subscribers

- **Treatment Program**
  - 258 Utilities
  - 477 Treatment plants

- **Distribution Program**
  - 155 Systems

- 40+ States, DC, and 4 Canadian provinces, and Australia represented

- 50% serving <100,000

Partnership Treatment utilities serve a combined population of more than 85 million

Partnership Distribution utilities serve a combined population of more than 38 million
A Collaborative Program

1. Product Quality
2. Customer Satisfaction
3. Employee and Leadership Development
4. Operational Optimization
5. Financial Viability
6. Infrastructure Strategy & Performance Stability
7. Enterprise Resiliency Operational
8. Community Sustainability
10. Stakeholder Understanding and Support

Effective Utility Management

1. Partnership for Clean Water®
2. Partnership for Safe Water®
Treatment Program

- Open to surface water and groundwater filtration plants of all sizes and configurations
  - Focus on applying the multiple barrier approach for turbidity reduction – <0.10 NTU
  - Optimize all unit processes for particulate removal
  - Conventional, direct filtration, membrane, DAF
Distribution System Program
Key Monitoring Parameters

• Disinfectant residual
  – Water quality integrity
• Main break frequency
  – Physical integrity
• Pressure management
  – Hydraulic integrity

Identified in WRF 4109 – Criteria for Optimized Distribution Systems
Distribution System Performance Improvement Variables

- Disinfectant Residual
- Cross-Connection Control
- Customer Complaints
- DBP Control
- Energy Management
- External Corrosion Control
- Flushing
- Hydrant and Valve Maintenance
- Internal Corrosion Control
- Main Breaks

- Nitrification
- Pipe Rehabilitation and Replacement
- Inorganic Accumulation Control
- Pressure Management
- Security and Online Monitoring
- Storage Tank O&M
- Water Age Management
- Water Loss Control
- Water Sampling and Response
Optimization Parameters

Disinfectant Residual
- DBP Compliance
- Nitrification
- Micro Compliance / Sampling
- Security
- Post Precipitation Inorg Accum
- Internal Corrosion Control
- Flushing
- Customer Complaints
- Disinfection: Mains, Repairs
- Water Age
- Storage

Pressure Control
- Main Breaks
- Energy Management
- Cross Connection Control
- Flushing
- Pipeline Rehab/Replace
- Storage/Tank Maintenance
- Water Loss Control

Internal/External Corrosion Control
- Main Breaks
- Maintenance: hydrant/valve
- Pipeline Rehab/Replace
- Storage

Customer Complaints
- Main Breaks

Security
- Emergency Mgmt
Performance Goals

• Disinfectant Residual (>95% of meas.)
  – Free Chlorine: $\geq 0.20$ and $\leq 4.0$ mg/L
  – Total Chlorine: $\geq 0.50$ and $\leq 4.0$ mg/L
  – Chlorine Dioxide: $\geq 0.20$ and $\leq 0.80$ mg/L

• No consecutive residual measurements outside target concentrations at optimized routine sample locations

• DBPs within regulatory requirements
Performance Goals

• Minimum Pressure (≥ 99.5% of meas.)
  – Pressure: ≥20 psi for daily minimum

• Maximum pressure (≥ 95% of meas.)
  – Does not exceed utility specified maximum

• Pressure fluctuations (≥ 95% of meas.)
  – Does not exceed range specified by utility
Performance Goals

• Main Breaks and Leaks
  – $\leq 15/100$ miles of pipe/year - for reported leaks and breaks in utility-controlled distribution and transmission piping

• Or – declining 5-year main break frequency trend demonstrating progress towards optimization
Program Phases

- Phase I – Commitment
- Phase II – Baseline data reporting
- Phase III – Self-Assessment completion
- Phase IV – Demonstrated optimization

Subscribers are required to comply with all applicable regulations, regardless of program Phase.
Phase I - Commitment

• Submission of registration form and payment of subscription fee
• Commitment to participate in the program through Phase III
  – No time limit, self-paced
• DO NOT need to meet goals to join
• DO need to be in compliance with regulations
Phase II – Baseline Data

• Submission of baseline data
  – Treatment – turbidity
  – Distribution – disinfectant residual/DBP

• Why? Measure improvement over time
Phase II – Baseline Data (Treatment)

- **Raw Water**
- **Settled or Clarified Water**
- **Filter Effluent Turbidity (CFE & IFE)**
- **Finished Water (optional)**

*Daily maximum reported.*

*Daily maximum OR 4 hour data reported from individual or combined basins. 95th percentile goal of 1.0/2.0 NTU depending on raw water turbidity.*

*4 hour CFE data, 15-minute IFE data (Phase IV), filter profiles. 95th percentile goal of <0.10 NTU.*
Phase II – Baseline Data (Distribution)

### Partnership for Safe Water

Annual Report Data Collection (v1.3.2) ©
Disinfectant Residual Performance Assessment

**Entry Point Data Entry - Free Chlorine**

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Average Daily Value</th>
<th>Average Daily Disinfectant Concentration for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/12/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/22/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/32/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/42/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/52/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/62/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/72/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/82/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/92/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/102/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/112/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>1/122/2011</td>
<td>0.45</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Secondary Residual Disinfectant - free chlorine or total chlorine or chlorine dioxide

Applicable Routine Sample Goals - free chlorine > 0.20 mg/L and ≤ 4.0 mg/L, total chlorine > 0.50 mg/L and ≤ 4.0 mg/L, chlorine dioxide > 0.20 mg/L and ≤ 0.60 mg/L

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry Points Residual Average (mg/L)</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
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<td>0.45</td>
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<td>0.45</td>
<td>0.45</td>
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<tr>
<td>Number of Routine Samples</td>
<td>730</td>
<td>62</td>
<td>56</td>
<td>62</td>
<td>60</td>
<td>52</td>
<td>60</td>
<td>62</td>
<td>62</td>
<td>60</td>
<td>52</td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>Number of Routine Test Results Not meeting Goals</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>% Routine Test Results Not Meeting Goals</td>
<td>0.41</td>
<td>4.84</td>
<td>0.00</td>
<td>0.00</td>
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</tr>
<tr>
<td>Minimum Daily Residual Value (mg/L)</td>
<td>0.18</td>
<td>0.18</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
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<td>0.40</td>
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</tr>
<tr>
<td>Number of repeat non-conforming sites</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>THM Maximum (μg/L)</td>
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<tr>
<td>HAAS Maximum (μg/L)</td>
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</tbody>
</table>
Phase II – Annual Report

• Annual data is summarized in the Partnership’s Annual Data Summary Report
Phase III - Self-Assessment

- Self-Assessment of:
  - Performance against optimization standards
  - Capacity
  - Unit process performance
  - System operation
  - Administration

Guidance documentation steps utilities through the Self-Assessment process
Phase III – Self-Assessment

• **Team** activity, with objectives to:
  – Identify and prioritize performance limiting factors
  – Develop feasible action plans for improvement
  – Implement plans to realize improvement

*Western Berks Water Authority (PA) – Partnership Team Meeting*
Phase III – Team Approach

• Assessment completed by team that incorporates utility personnel at all levels of the organization
  – Management
  – Operations – field staff participation vital
  – Involve as many staff as possible

Many utilities cite improved communications and teamwork as significant benefits of completing the Self-Assessment process.
# Phase III – Self-Assessment Data (Distribution)

<table>
<thead>
<tr>
<th>Self-Assessment Data Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum daily disinfectant residual for 12 months at distribution system routine sample locations, storage tanks, and entry points. Use Data Collection Software provided by the PSW.</td>
</tr>
<tr>
<td>All TTHM and HAA5 routine test results for 12 months. Annual DBP trending indicating RAA. Use PSW software.</td>
</tr>
<tr>
<td>Daily minimum pressure readings from permanent sensors for the most recent 12 months – ideally at 2 locations in each pressure zone (low and high). Use PSW software.</td>
</tr>
<tr>
<td>Main break records for several years – 10 years is ideal. Use PSW software.</td>
</tr>
<tr>
<td>Records of the annual number of technical water quality complaints. Record of the number of accounts for the utility.</td>
</tr>
<tr>
<td>Flushing velocity, disinfectant residual (before and after), for procedures that are initiated to correct low disinfectant residuals.</td>
</tr>
<tr>
<td>Valve and hydrant exercise (inspection) records with the total number in the system and the number exercised annually.</td>
</tr>
<tr>
<td>Hydrant repair record and calculated time to restore service after detection.</td>
</tr>
<tr>
<td>Internal corrosion testing practices with the number of tests performed annually.</td>
</tr>
<tr>
<td>Free ammonia, nitrate, nitrite, results summary for distribution systems using chloramines.</td>
</tr>
</tbody>
</table>
## Phase III – Self-Assessment Data (Distribution)

<table>
<thead>
<tr>
<th>Self-Assessment Data Requirements (Continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline renewal and replacement rate. The annual miles of pipeline replaced and the miles of pipe in the entire distribution system. The miles of unlined metal pipe and the miles replaced. The miles of pipe more than 75 years old.</td>
</tr>
<tr>
<td>Storage tank cleaning records that show the frequency and any observations</td>
</tr>
<tr>
<td>Water age records at key sites demonstrating the annual maximum water age</td>
</tr>
<tr>
<td>Calculation of the volume of annual real losses, real losses expressed as gallons/service connections/day, and ILI using the AWWA/IWA water audit method.</td>
</tr>
<tr>
<td>Distribution system schematic (map)</td>
</tr>
<tr>
<td>Asset inventory</td>
</tr>
<tr>
<td>Distribution system pipeline type inventory and installation dates</td>
</tr>
<tr>
<td>Storage facility type and installation dates</td>
</tr>
<tr>
<td>Pump type, size, and installation dates</td>
</tr>
<tr>
<td>Valve and hydrant number and installation dates</td>
</tr>
<tr>
<td>Calculations for the following benchmarks (reporting is optional): debt ratio, O%M cost per account, system renewal rate, training hours per employee, interest % of budget</td>
</tr>
</tbody>
</table>
## Phase III Self-Assessment Questions (Hydrant/Valve Maintenance)

<table>
<thead>
<tr>
<th>Self-Assessment Category</th>
<th>Questions for Gauging Optimization Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintaining Valves, Hydrants, and Blowoffs</td>
<td><strong>Location Records:</strong> Does the system have accurate and current records that document the location and attributes for all valves, hydrants, and blowoffs?</td>
</tr>
<tr>
<td></td>
<td><strong>Inspection and Assessment:</strong> Are all valves, hydrants, and blowoffs inspected and evaluated on a schedule?</td>
</tr>
<tr>
<td></td>
<td><strong>Exercise Program:</strong> Are all distribution system main valves and hydrants exercised and tested at least every three years (or more frequently if required by regulation)?</td>
</tr>
<tr>
<td></td>
<td><strong>Hydrant Repairs:</strong> Are all hydrant repairs scheduled within 24 hours of discovery? Are inoperable hydrants identified immediately and is this communicated to the fire protection authority?</td>
</tr>
<tr>
<td></td>
<td><strong>Hydrant Access:</strong> Does the system control access to hydrants and provide training for proper third-party use?</td>
</tr>
</tbody>
</table>
### Treatment Self-Assessment – Performance Assessment Example

<table>
<thead>
<tr>
<th>Self-Assessment Category</th>
<th>Questions for Gauging Whether System is Optimized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Assessment</td>
<td>Do the combined filter effluent turbidities meet the performance goals in Table 1.1?</td>
</tr>
<tr>
<td></td>
<td>Do the settled water or clarified turbidities meet performance goals, either internal or the suggested goals in Table 1.1?</td>
</tr>
<tr>
<td></td>
<td>Do all filters perform equally or are there significant differences in individual filter performance?</td>
</tr>
<tr>
<td></td>
<td><strong>Do changes in raw water quality impact the performance of unit processes, such as the sedimentation basins and filters?</strong></td>
</tr>
<tr>
<td></td>
<td>Do all of the unit processes meet their performance goals, or does filter performance degrade despite consistent sedimentation basins, clarification, high rate clarification, or other pretreatment process performance?</td>
</tr>
<tr>
<td></td>
<td>Do filters (including membranes) meet performance goals despite sedimentation or other upstream processes that do not meet desired goals?</td>
</tr>
<tr>
<td></td>
<td>Do changes in flow to individual treatment processes, implemented to meet demand or during routine operational practices, impact the performance of any unit treatment process?</td>
</tr>
<tr>
<td></td>
<td><strong>Did assessment of the performance of individual filters reveal that some units had been left in service even when they did not achieve the same performance as the other units in service?</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Did assessment of the performance of individual filters indicate that any of the filters had worse or more erratic performance than any of the others?</strong></td>
</tr>
</tbody>
</table>
“All there is to thinking....is seeing something noticeable which makes you see something you weren’t noticing which makes you see something that isn’t even visible.”

-Norman Maclean
Action Planning

“A goal without a plan is just a wish.”

-Antoine de Saint Exupéry
Phase III - Action Plan Development

• Action plans developed for high priority areas that are not optimized/partially optimized
• Utilities should not hesitate to act!

<table>
<thead>
<tr>
<th>Self-Assessment Category</th>
<th>Issue</th>
<th>Short Term Solution</th>
<th>Person(s) Responsible</th>
<th>Target Date</th>
<th>Long Term Solution</th>
<th>Person(s) Responsible</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-line Chlorine Monitor and SCADA Display</td>
<td>Additional online chlorine residual analyzers would provide valuable data</td>
<td>Finalize identification of key areas of distribution system for analyzer placement</td>
<td>Full Team, Consensus Decision Needed</td>
<td>Apr 2013</td>
<td>Install analyzers and connect with SCADA</td>
<td>Dist System Maintenance Supervisor</td>
<td>April 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Budget for and purchase 3 analyzers</td>
<td>Distribution System Ops. Super-Intendent</td>
<td>Jan 2014</td>
<td>Review analyzer data trends for optimization opportunities</td>
<td>Treatment Plant and Distribution System Lead Operators</td>
<td>Ongoing, incorp. Into SOPs</td>
</tr>
</tbody>
</table>
Partnership Tools: Self-Assessment

- Self-assessment guide
- Tracking and prioritization software tools
- Report checklist
- Report template
- Example report
- Assistance and mentorship from utilities and staff
Phase III - Directors Award

Annual Data Submission: Maintain Directors Award status, receive date tags, and become eligible for 5-, 10-, and 15-Year “longevity” awards.

Oak Creek WTP (Wisconsin) General Manager accepts the Directors Award – Distribution at ACE15
Phase III - After Completion

• Monitor progress against plan
  – Partnership for Safe Water annual reporting makes optimization an ongoing process
  – Enhances accountability

• **Adjust action plan as needed**

• Fully optimized systems can apply for Phase IV Partnership for Safe Water status
Phase IV - Optimization

• Phase IV awards recognize utilities for demonstrated optimization.
• You are never too small to improve and optimize!

Aurora Water (CO) staff accepting the Excellence in Water Treatment Award
Lessons Learned: Water Quality Improvements

Long term performance improvement in turbidity and consistency of performance.
Lessons Learned: It Can Change Utility Culture

- Get the entire team engaged (this is the hardest but most important part)
- Develop performance goals, tools, and measures
- Establish unit process operational guidance
- Be Excellent!
Lessons Learned: Changes Don’t Need to be Big to be Effective

• How communication is accomplished
• What data is monitored
• Updating SOPs
  – How ops respond to plant upset
  – Distribution system flushing
• Moving a chemical injection point
• Battling complacency
Lessons Learned: Changes Don’t Need to be Big to be Effective

<table>
<thead>
<tr>
<th>Top Distribution System Self-Assessment Report Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic model calibration/availability</strong></td>
</tr>
<tr>
<td><strong>Pressure monitoring</strong></td>
</tr>
<tr>
<td><strong>Pump efficiency testing</strong></td>
</tr>
<tr>
<td><strong>Optimize flushing</strong></td>
</tr>
<tr>
<td><strong>Asset management</strong></td>
</tr>
</tbody>
</table>
Lessons Learned: Benefits Go Beyond Water Quality
Lessons Learned: Optimization Has No Finish Line

• Focus on continuous improvement becomes part of the culture
• It’s all in the details
• There are always opportunities for improvement!
Questions & Information

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www.awwa.org/partnership