North Penn Water Authority

- Medium-sized water system
- Serving a population of 80,000 people in 21 municipalities in Bucks and Montgomery County in SE PA
- 48 full-time employees
- Avg. Daily Water Demand = 10 MGD
- 85% surface water/15% ground water
North Penn Water Authority

- One Surface Water Treatment Plant (Forest Park)
- Fifteen Groundwater Wells throughout the system
- Use hypochlorination to maintain chlorine residuals in the water system
- 564 miles of water main
- 33,600 service connections
Asset Inventory

- 14 storage tanks
- 15 operating wells
- 9 booster stations
- 3,563 hydrants
- 12,106 valves
Agenda

- Review of Planning History
- Why the DSOP?
- How are we doing?
- Action going forward
- Questions
History of System Planning

- Water Master Plan, 1998
- Water Distribution System Optimization Plan, 2003
- Updates to Long Range Plan, 2008, 2013
- Water Age Analysis, 2014
- Risk Assessment, 2014
- Water Quality Master Plan, 2015
Resources

- Development of Distribution System Water Quality Optimization Plans, AWWARF, 2005
- Criteria for Optimized Distribution Systems, WRF, 2010
- PfSW Self-Assessment Guide for Distribution System Optimization, January 1, 2011
Partnership for Safe Water

- Formed in 1993, as a result of a cryptosporidiosis outbreak in Milwaukee.
- The *Partnership* is an unprecedented alliance of six prestigious drinking water organizations:
  - American Water Works Association (AWWA)
  - Federal Environmental Protection Agency (EPA)
  - Association of State Drinking Water Administrators (ASDWA)
  - Association of Metropolitan Water Agencies (AMWA)
  - National Association of Water Companies (NAWC)
  - Water Research Foundation (WRF)
Partnership for Safe Water

• The Partnership's mission is to improve the quality of water delivered to customers by optimizing water system operations.

• The Partnership offers self-assessment and optimization programs so that operators, managers and administrators have the tools to improve performance above and beyond regulatory levels.
Partnership for Safe Water

Why Did We Join?
• Natural Progression
• Goals Alignment
• Recognized Quality Improvement Program
• Treatment Plant Optimization
  – Forest Park Water a member since 1997 – Has achieved 10 year Director’s Award and since 2012 has held the Phase IV President’s Award.
  – It all starts with excellent quality source water!
Partnership for Safe Water

Distribution System Optimization Program (DSOP)

- Based on processes, procedures and metrics, resulting in high-performance and improved system integration.
- NPWA is a charter member in 2011 and the first water utility in PA to join the program.
- Completed Phase I and II
- Working on Phase III report toward end of the year and hope to receive Director’s Award in the near future.
Partnership for Safe Water

Distribution System Optimization Program (DSOP)

- Three main components:
  - Chlorine Residual Management
  - Pressure Management
  - Main Break Frequency
What is current DSOP status?

- Fifth round of chlorine residual data submitted in June 2015
- Using data to assess deficiencies
- Evaluating pressure data
- Evaluating main break frequency data
- Completed Water Quality Master Plan
- Developing basis for Phase III Report
So how are we doing?

**Pressure Management Goals**

- 99.5% of locations maintain pressure of 20 psi under normal operating conditions
- 35 psi as a monthly avg. of daily minimum values
Pressure at Maximum Day Demand
Pressure Assessment

- Long Range Plan addresses pressure deficiencies
- Plan is being executed
- More sensors at targeted locations to complete self-assessment
- System meets performance goals
So how are we doing?

Main Break Frequency

- Main breaks (including hydrant and valve leaks but not services) cannot exceed 15 per 100 miles of main.
Distribution System

- Aggressive pipe, service, hydrant and valve replacement/rehabilitation
- Financial and Resource Commitment
- All NPWA System Assets managed using our GIS database
Miles of Active Main

- DIP: 469 miles
- CIP: 81 miles
- AC: 9 miles
- PVC: 2 miles
<table>
<thead>
<tr>
<th>Year</th>
<th>Main Replacement</th>
<th>Service Renewals</th>
<th>Fire Hydrants</th>
<th>Miles of Main Replaced</th>
<th>No. of Services Replaced</th>
<th>No. of Fire Hydrants Replaced</th>
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<td>$181,000</td>
<td>$43,000</td>
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<td>2003</td>
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<td>$20,000</td>
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<td>2004</td>
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<td>16</td>
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<td>2005</td>
<td>$1,500,650</td>
<td>$163,500</td>
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<td>$1,874,937</td>
<td>$43,500</td>
<td>$64,000</td>
<td>1.2</td>
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<td>32</td>
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<td>2007</td>
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<td>2008</td>
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<td>2009</td>
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<td>2010</td>
<td>$1,116,773</td>
<td>$346,000</td>
<td>$32,250</td>
<td>1.2</td>
<td>173</td>
<td>15</td>
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<tr>
<td>2011</td>
<td>$3,260,738</td>
<td>$476,400</td>
<td>$33,050</td>
<td>2.9</td>
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<tr>
<td>2012</td>
<td>$2,789,018</td>
<td>$634,260</td>
<td>$76,053</td>
<td>2.4</td>
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<td>28</td>
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<tr>
<td>2013</td>
<td>$867,386</td>
<td>$512,900</td>
<td>$96,700</td>
<td>1.6</td>
<td>132</td>
<td>10</td>
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<td>2014</td>
<td>$1,350,284</td>
<td>$205,500</td>
<td>$14,000</td>
<td>0.8</td>
<td>137</td>
<td>5</td>
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<tr>
<td>Totals</td>
<td>$19,746,711</td>
<td>$3,695,660</td>
<td>$769,924</td>
<td>28.15</td>
<td>3,070</td>
<td>309</td>
</tr>
</tbody>
</table>

Total of All Renewal Costs: $24,212,295
Number of Main Breaks, per 100 miles of main (1995-2014)

National average = 22 breaks/100 miles of main

DSOP Performance Goal = 15 breaks/100 miles of main

Downward Trend
So how are we doing?

Chlorine Residual Management

Goal: 0.20 ppm free chlorine at 95% of routine samples (coincides with proposed DEP regulations)
Distribution System WQ Management

• Since 2013, 3,272 total samples collected with only 1 Total Coliform positive samples. No samples were *E. Coli* positive:
  – System was always in compliance
  – September 2013 – Free Cl2 residual = 0.71 mg/L
# Chlorine Residual Monthly Data

<table>
<thead>
<tr>
<th></th>
<th>Total # Samples</th>
<th># Samples &lt;0.20</th>
<th>% Samples &lt;0.20</th>
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<tbody>
<tr>
<td>Jan-14</td>
<td>104</td>
<td>5</td>
<td>4.8</td>
</tr>
<tr>
<td>Feb-14</td>
<td>104</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Mar-14</td>
<td>107</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Apr-14</td>
<td>104</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>May-14</td>
<td>105</td>
<td>4</td>
<td>3.8</td>
</tr>
<tr>
<td>Jun-14</td>
<td>97</td>
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</tr>
<tr>
<td>Jul-14</td>
<td>92</td>
<td>21</td>
<td>22.8</td>
</tr>
<tr>
<td>Aug-14</td>
<td>91</td>
<td>17</td>
<td>18.7</td>
</tr>
<tr>
<td>Sep-14</td>
<td>98</td>
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</tr>
<tr>
<td>Oct-14</td>
<td>99</td>
<td>13</td>
<td>13.1</td>
</tr>
<tr>
<td>Nov-14</td>
<td>93</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Dec-14</td>
<td>99</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1193</strong></td>
<td><strong>108</strong></td>
<td><strong>9.1</strong></td>
</tr>
</tbody>
</table>
Chlorine Residual vs. Temperature

Free Cl₂ (mg/L) vs. Temperature (degrees F)

Date: Jan-13, Apr-13, Jul-13, Oct-13, Jan-14, Apr-14, Jul-14, Oct-14, Jan-15, Apr-15

Chlorine Residual

Temperature
Data Analysis  Jan 2013 - May 2015

- 91% of samples taken over last 2.5 years are above 0.20 ppm of free chlorine residual
- 18 out of 57 sites have consecutive months below 0.20 ppm of free chlorine
- Direct correlation between water temperature and chlorine residuals
Action Plan

- Increase free chlorine residuals from 1.1 ppm at Forest Park to 1.6 ppm based on water temperature
- Increase free chlorine residuals at wells, tanks and boosters to 1.3 ppm based on Forest Park water temperature
- Complete water quality modeling and scenario analysis by September 2015
## Chlorine Residual Performance

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Samples</th>
<th>Number of Samples &lt;0.20 mg/L</th>
<th>Number of Total Coliform + Samples</th>
<th>Number of E. Coli + Samples</th>
<th>Average System Chlorine Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1,208</td>
<td>147</td>
<td>1 (Cl₂ = 0.71)</td>
<td>0</td>
<td>0.59</td>
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<tr>
<td>2014</td>
<td>1,193</td>
<td>108</td>
<td>0</td>
<td>0</td>
<td>0.62</td>
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<tr>
<td>2015 YTD</td>
<td>871</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0.76</td>
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<tr>
<td>TOTALS</td>
<td>3,272</td>
<td>256</td>
<td>1</td>
<td>0</td>
<td>0.66</td>
</tr>
</tbody>
</table>
# Chlorine Residual Monthly Data

<table>
<thead>
<tr>
<th>Month</th>
<th>Total # Samples</th>
<th># Samples &lt;0.20</th>
<th>% Samples &lt;0.20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-15</td>
<td>98</td>
<td>1</td>
<td>1.0</td>
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<tr>
<td>Feb-15</td>
<td>98</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Mar-15</td>
<td>100</td>
<td>0</td>
<td>0.0</td>
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<tr>
<td>Apr-15</td>
<td>99</td>
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<td>0.0</td>
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<tr>
<td>May-15</td>
<td>93</td>
<td>3</td>
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<tr>
<td>Jun-15</td>
<td>87</td>
<td>3</td>
<td>3.4</td>
</tr>
<tr>
<td>Jul-15</td>
<td>91</td>
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<td>Aug-15</td>
<td>90</td>
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<td>Dec-15</td>
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<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>877</strong></td>
<td><strong>13</strong></td>
<td><strong>1.5</strong></td>
</tr>
</tbody>
</table>
What about DBPs?

- Higher chlorine dosages coupled with areas of high water age should result in higher DBPs.
- Tank mixing and DBPs
- Chlorine Boosters
Preliminary Findings

• Increased chlorine dosages successful in increasing chlorine levels throughout the system
• Minimal issues with taste and odor
• One problem sample location remains
• Increased Disinfection Byproducts in the system
Water Quality Master Plan

**Decision Variables**

- Validate all sampling locations and data
- Chlorine Booster/Recirculating Stations
- Tank Mixing/Chlorination at all tanks?
- Well and Operations Changes?
- Valving and uni-directional flow?
- Effects of additional storage?
Water Quality Master Plan

- System evaluated with tank mixing
- Model utilizes latest 2015 GIS data
- Model calibrated using chlorine residual data from summer 2014 (highest decay rate)
- Model accounted for two new elevated tanks with 5.5 MG of elevated storage
Water Quality Master Plan Findings

- Current level of WTP chlorine residual at 1.6 ppm and residual of 1.3 ppm at boosters and tanks is optimal
- Reduce residual at wells to 1.0 ppm
- Model indicates areas of low chlorine residual with no further improvement
- Additional capital improvements needed
WQ Master Plan Cap Spend

- Need to eliminate branched areas of system with main tie-in projects at a conceptual cost of $4.6 million
- Need two chlorine booster stations at a cost of $0.83 million
- With tank mixing, total cost is approximately $6 million.
Followup Needed

- Begin working on Phase III report by the end of 2015 and complete in 2016
  - Hire Consultant to assist with Report
  - Determine Optimization Status of Processes
- Study long-term impact of DBPs at higher residual levels
- Update Capital Investment Plan
Phase III Report Outline

- Composed of 6 components:
  - 1.0 Introduction
  - 2.0 Performance Self-Assessment
  - 3.0 Operational Performance Improvement Variables
  - 4.0 Design Evaluation
  - 5.0 Application of Operational Concepts
  - 6.0 Administration
  - 7.0 Implementation Plan
Summary

- Completed Phase I and II of DSOP and working on Phase III self-assessment report
- System is fully optimized in main categories
- Ongoing assessment of chlorine residuals and disinfection byproducts
- Need more pressure sensors and chlorine analyzers at certain locations
- Water Quality must take priority in your decision-making at higher chlorine residual levels.
Acknowledgements

- Lauren Fahnestock, PE, and Christie Ogino, PE, Brown & Caldwell
- Jon Hartzell, Operations Manager, NPWA
- Heidi Palmer, Water Quality Manager, NPWA
Interested in Joining the Partnership?

- John Bartol
  PfSW Representative
  e-mail - jbartolpaawwa@gmail.com

- Gordon Miller
  Operations Supervisor
  Chester Water Authority
  e-mail - grmiller@chesterwater.com
Questions?