Mid-Monroe Water System: Soluble Iron and Manganese Removal via Oxidation & Filtration

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Pennsylvania-American Water Company
Who Is American Water
We are the largest publicly traded water and wastewater utility in the United States

- Broad national footprint and strong local presence
- Services to an estimated 14 million people in more than 1,500 communities in more than 30 states and parts of Canada
- Approx. 6,700 dedicated and active employees
- Treats and delivers more than one billion gallons of water daily
Our Company

- Subsidiary of American Water Works Co. Inc.
- Roots date back to early 1800s, Incorporated in 1904
- Largest regulated water and wastewater service provider in PA
- Serving approximately 2.2 million people in 36 counties
- More than 1,000 employees
- Customer base:
  - 640,000 water customers
    - 92% residential
    - 7% commercial
    - 1% industrial/other
  - 17,000 wastewater customers
Pennsylvania American Water Service Area

Serving 17 percent of the Commonwealth’s population
Our Pennsylvania Infrastructure

Source of Supply
- 92% surface water
- 7% groundwater
- 1% purchased water
- 54 regulated dams
- 121 groundwater well sources

Treatment Facilities
- 36 surface water plants
  - 32 facilities received Directors Award from Partnership for Safe Water
- 6 wastewater plants

Storage & Transmission
- 279 water storage tanks
- 253 booster pumping stations

Distribution System
- 10,115 miles of water and sewer pipe

Water Capacity
- 193 MGD average daily delivery

Wastewater Capacity
- 11.2 MGD permitted
Mid-Monroe Water System

- Middle Smithfield Township, Monroe County, PA
- Small CWS Residential Development
- Provides water service to approximately 600 customers (1,600 projected at build-out)
- Acquired by Pennsylvania American Water in 2002 and is operated as part of our Lehman-Pike District
- System is comprised of four wells, two groundwater treatment facilities, and two storage tanks
- Wells 1&2 combine for treatment into Entry Point 102 (South)
- Wells 3&5 combine for treatment into Entry Point 105 (North).
## Mid-Monroe Water System – Wells

<table>
<thead>
<tr>
<th>Well</th>
<th>Size</th>
<th>Depth</th>
<th>Log</th>
<th>Date Drilled</th>
<th>Safe Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (E.P. 102)</td>
<td>8”</td>
<td>300’</td>
<td>Sand/Gravel: 0-18’ Bedrock: 18’-300’</td>
<td>1990</td>
<td>123 gpm</td>
</tr>
<tr>
<td>2 (E.P. 102)</td>
<td>8”</td>
<td>500’</td>
<td>Sand/Gravel: 0-28’ Bedrock: 28’-500’</td>
<td>1992</td>
<td>40 gpm</td>
</tr>
<tr>
<td>3 (E.P. 105)</td>
<td>8”</td>
<td>753’</td>
<td>Sand/Gravel/Clay: 0-80’ Bedrock: 80’-753’</td>
<td>2002</td>
<td>65 gpm</td>
</tr>
<tr>
<td>5 (E.P. 105)</td>
<td>8”</td>
<td>805’</td>
<td>Sand/Gravel: 0-13’ Bedrock: 13’-805’</td>
<td>2002</td>
<td>65 gpm</td>
</tr>
</tbody>
</table>
# Mid-Monroe Water System – Raw Water Quality

<table>
<thead>
<tr>
<th>Wells</th>
<th>Iron (mg/l) (SMCL = 0.3 mg/l)</th>
<th>Manganese (mg/l) (SMCL = 0.05 mg/l)</th>
<th>Sulfide</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&amp;2</td>
<td>0.18</td>
<td>0.54</td>
<td>ND</td>
<td>7.9</td>
</tr>
<tr>
<td>3&amp;5</td>
<td>0.10</td>
<td>0.076</td>
<td>ND</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Notes:
- Fe & Mn concentrations are approximately 95% dissolved
Customer Water Quality Issues

- Fixture staining
- Fouled point-of-use water filters
- DEP SMCL exceeding levels of Mn recorded at customer’s homes
Previous Approach

• Sequestering via blended polyphosphate chemical addition at both Entry Points
• System wide flushing completed twice a year
• Maximize use of Entry Point 105’s better water quality, and minimize use of Entry Point 102
New Approach Needed

- Entry Point 102 needed to meet system demands
  - Declining yield from EP 105 causing service reliability issues
- Needed to remove secondary contaminants at EP 102 source to effectively meet customer expectations
  - Treatment Target: Although SMCL is 0.05 ppm, Mn concentrations of ~0.02 ppm are typically noticeable to customers
- Alternatives Analysis Completed
  - Membrane Filtration (nano, ultra, micro)
  - Ion Exchange (typically used for softening/demineralizing, and/or nitrate removal)
  - Greensand Filtration (historical precedence)
  - Pressure Filtration w/ Proprietary Media (manufactured greensand)
Oxidation-Filtration w/ Proprietary Media Selected

• Uses portion of applied disinfectant to convert dissolved Fe/Mn to insoluble metal oxides (oxidation) that is catalyzed by pre-precipitated manganese dioxide on media (filtration)

• Benefits
  ▪ Small footprint
  ▪ Higher hydraulic loading rates (5-10 gpm/sf)
  ▪ Does not require long contact time
  ▪ Does not require pre-conditioning (permanganate feed, coagulants, pre-filtration, etc.)
  ▪ No brine or salt required
  ▪ Low head-loss across filters
  ▪ Low operating cost
  ▪ No clearwell storage and/or high-service booster pumping required with pressure filters
Pressure Filter Selection and Specifications

- After competitive bidding process, selected Severn-Trent Omni-Sorb® Media Pressure Filtration System
  - Engineered Omni-Sorb® Media (i.e. manufactured greensand)
  - High catalytic properties allow for activation without the need for pre-conditioning or regeneration (i.e. potassium permanganate)
  - High removal performance over wide range of influent water quality
    - Fe - up to 10 ppm
    - Mn - up to 5 ppm
    - H₂S - up to 3 ppm
    - pH - 6.2 to 8.5
  - Can withstand high differential pressures (+/- 20 psi)
  - Low operating costs
    - 8-10 year life span on media (non-hazardous when spent)
    - +/-$2,900/year (prechlorination, media replacement, power, etc.)
Pressure Filter Selection and Specifications – Cont.

- Performance Guarantee
  Fe <0.1 ppm
  Mn <0.03 ppm
- PLC Operated
  Automated backwashing via pressure differential, run-time, turbidity breakthrough, and/or regular timed intervals.
Plant Specifications

- 0.256 MGD permitted capacity
- Two 6 ft. diameter pressure vessels
  - Flow split 50/50 during normal operation (3.1 gpm/sf each filter)
- 200 psi rated operating pressure
- Pre and post filter chlorine feed
- Blended phosphate corrosion inhibitor feed (post filter)
- 1,500 ft² building footprint
- Fully automated
- 4-log disinfection of viruses achieved via 12.5% sodium hypochlorite and 60’ of 36” contact main
- 22,000-gallon backwash/filter-to-waste tank
Process Control Scheme

- Facility fully monitored and controlled via RTU/PLC with touch-screen & cellular data/voice signal to regional office
- Wells
  - Level/Flow/Pressure
- Chemical Feed Systems
  - Flow Paced
- Cl$_2$ Residual
  - Post-Filter
  - Entry Point
- Pressure Differential
- Turbidity
- Backwash/Waste Tank & Pumps
  - Level/Flow/Pressure
- Security
  - Intrusion/Fire/Smoke/ADT
Effluent Water Quality

- Maintaining 4-log compliant Cl₂ residual through filters
  - ~2.0 ppm pre-feed → ~1.5 ppm post filter

- Typical:

<table>
<thead>
<tr>
<th></th>
<th>Mn (mg/l)</th>
<th>Fe (mg/l)</th>
<th>Color (Pt/Co)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
<td>Δ</td>
</tr>
<tr>
<td></td>
<td>0.54</td>
<td>&lt;0.01</td>
<td>(0.53)</td>
</tr>
<tr>
<td></td>
<td>(0.53)</td>
<td>(0.17)</td>
<td>98%</td>
</tr>
</tbody>
</table>

Mn (mg/l) (SMCL = 0.05) | Fe (mg/l) (SMCL = 0.3) | Color (Pt/Co)
Wastewater Generation & Recycling

- **Typical backwash cycle (each filter):**
  - 12 mins. at 400 gpm to achieve ~50% bed expansion = 4,800 gals.
  - 10 mins. filter to waste at 89 gpm = 890 gals.
  - Total of 5,690 gal x 2 filters = 11,380 gal in WW generation

- **Low pressure public sewer available in system via Township Sewer Authority**

- **Not cost effective to discharge 100% of WW to public sewer**

- **So WW tank equipped with following to facilitate recycling**
  - Dual Submersible Recycling Pumps (15 gpm, VFD Controlled)
  - Dual Submersible Residual Waste Pumps (15 gpm,) w/ air gap
  - Adequate volume to allow for 8 hours of settling time
  - All NSF-61 Approved Materials

- **~94% recycling achieved**
# CONSTRUCTION COST SUMMARY

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Filter System Procurement, Install, etc.</td>
<td>$235,000</td>
</tr>
<tr>
<td>Site Work/Yard Piping/Security Fence</td>
<td>$128,000</td>
</tr>
<tr>
<td>Structural</td>
<td>$370,000</td>
</tr>
<tr>
<td>Electrical/HVAC/Plumbing</td>
<td>$310,000</td>
</tr>
<tr>
<td>Pumps/Controls/Instrumentation(^1)</td>
<td>$120,000</td>
</tr>
<tr>
<td>Well Improvements (two wells)</td>
<td>$70,000</td>
</tr>
<tr>
<td>Start-Up/Testing/Misc. Soft Costs</td>
<td>$17,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,250,000</strong></td>
</tr>
</tbody>
</table>

\(^1\)Excluding filter system instrumentation
Lessons Learned

• Loading of media into 10’ high filters options
  ▪ Bucket Brigade/Scaffolding
  ▪ Escalator/Skilights

• Backwash water supply
  ▪ Finished water recommended versus raw
  ▪ +/- 400 gpm flow may tax small system (stir up system, pressure drop, etc.)

• Backwash protocol
  ▪ Need to vary flow/bed expansion
    Low flow wash for media particulate friction to dislodge stubborn manganese dioxide build-up
    High flow wash for good residual removal/flushing (w/o loss of media)
  ▪ Consider air scour assembly
Wells 1&2 Treatment Facility – Exterior
Wells 1&2 Treatment Facility – Exterior & Well 2
Wells 1&2 Treatment Facility – Dual Pressure Filter System
Wells 1&2 Treatment Facility – Chemical Room
Wells 1&2 Treatment Facility – Backwash Tank
Wells 1&2 Treatment Facility – Sewer Connection
Questions / Comments