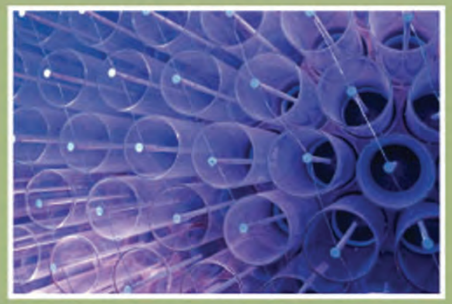
PENNSYLVANIA
AMERICAN WATER



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

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Pennsylvania-American Water Company

# Who Is American Water

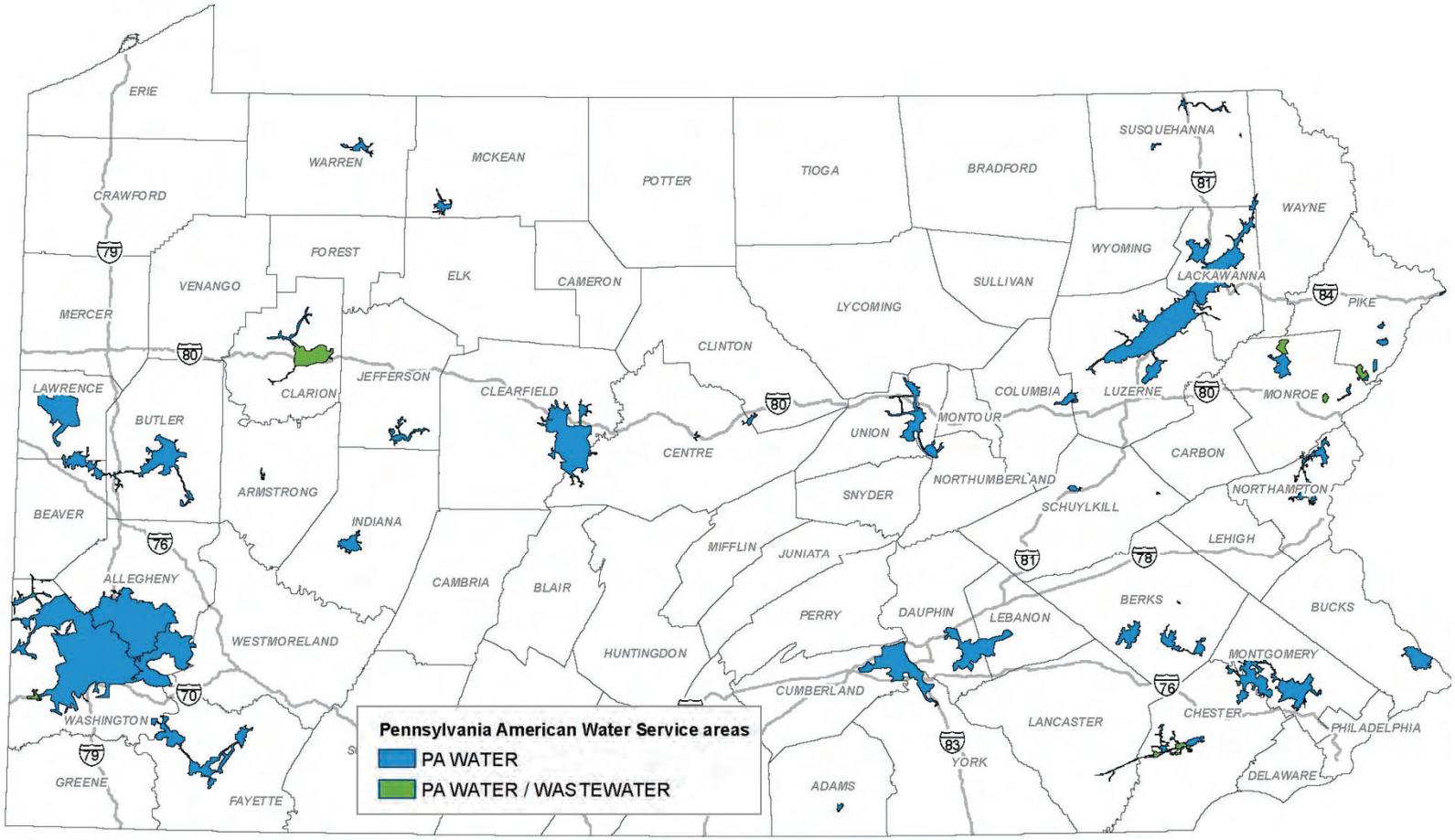
## We are the largest publicly traded water and wastewater utility in the United States

- 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

| Well | Size | Depth | Log | Date Drilled | Safe Yield |
|---|---|---|---|---|---|
| 1 (E.P. 102) | 8” | 300’ | Sand/Gravel: 0-18’<br>Bedrock: 18’-300’ | 1990 | 123 gpm |
| 2 (E.P. 102) | 8” | 500’ | Sand/Gravel: 0-28’<br>Bedrock: 28’-500’ | 1992 | 40 gpm |
| 3 (E.P. 105) | 8” | 753’ | Sand/Gravel/Clay: 0-80’<br>Bedrock: 80’-753’ | 2002 | 65 gpm |
| 5 (E.P. 105) | 8” | 805’ | Sand/Gravel: 0-13’<br>Bedrock: 13’-805’ | 2002 | 65 gpm |

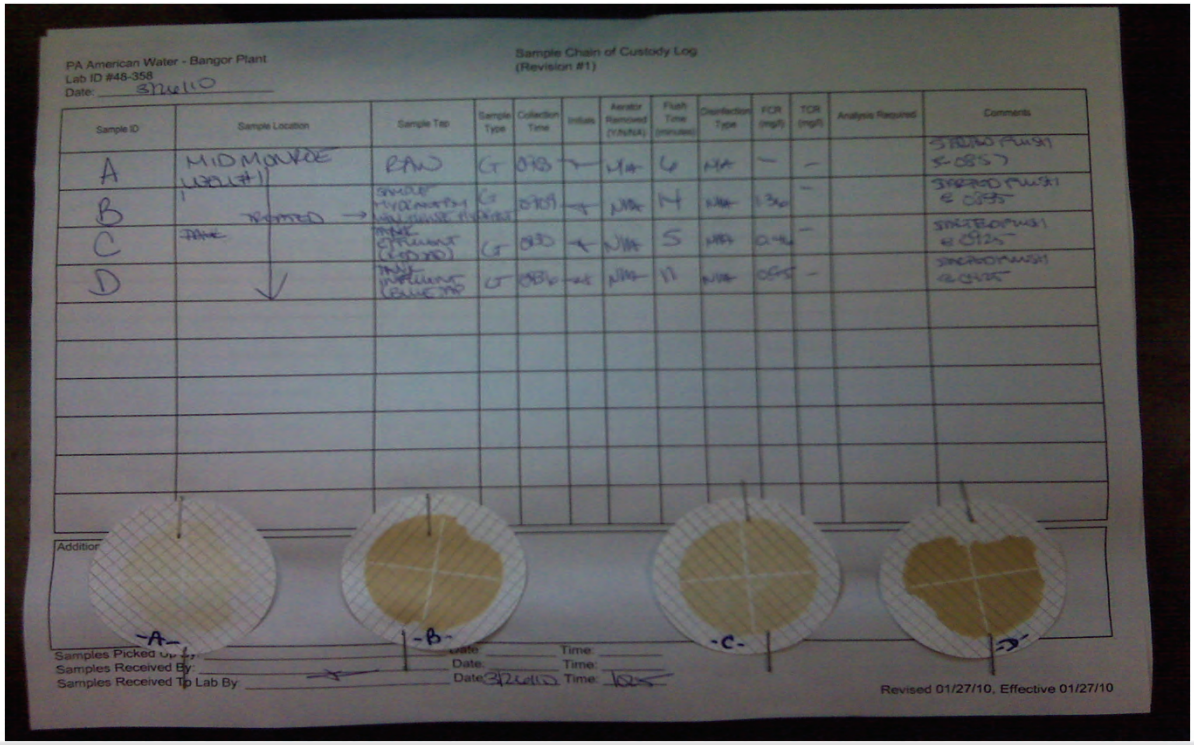
# Mid-Monroe Water System – Raw Water Quality

| Wells | Iron (mg/l) (SMCL = 0.3 mg/l) | Manganese (mg/l) (SMCL = 0.05 mg/l) | Sulfide | pH |
|---|---|---|---|---|
| 1&2 | 0.18 | 0.54 | ND | 7.9 |
| 3&5 | 0.10 | 0.076 | ND | 7.3 |

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

    $H_2S$ - up to 3 ppm

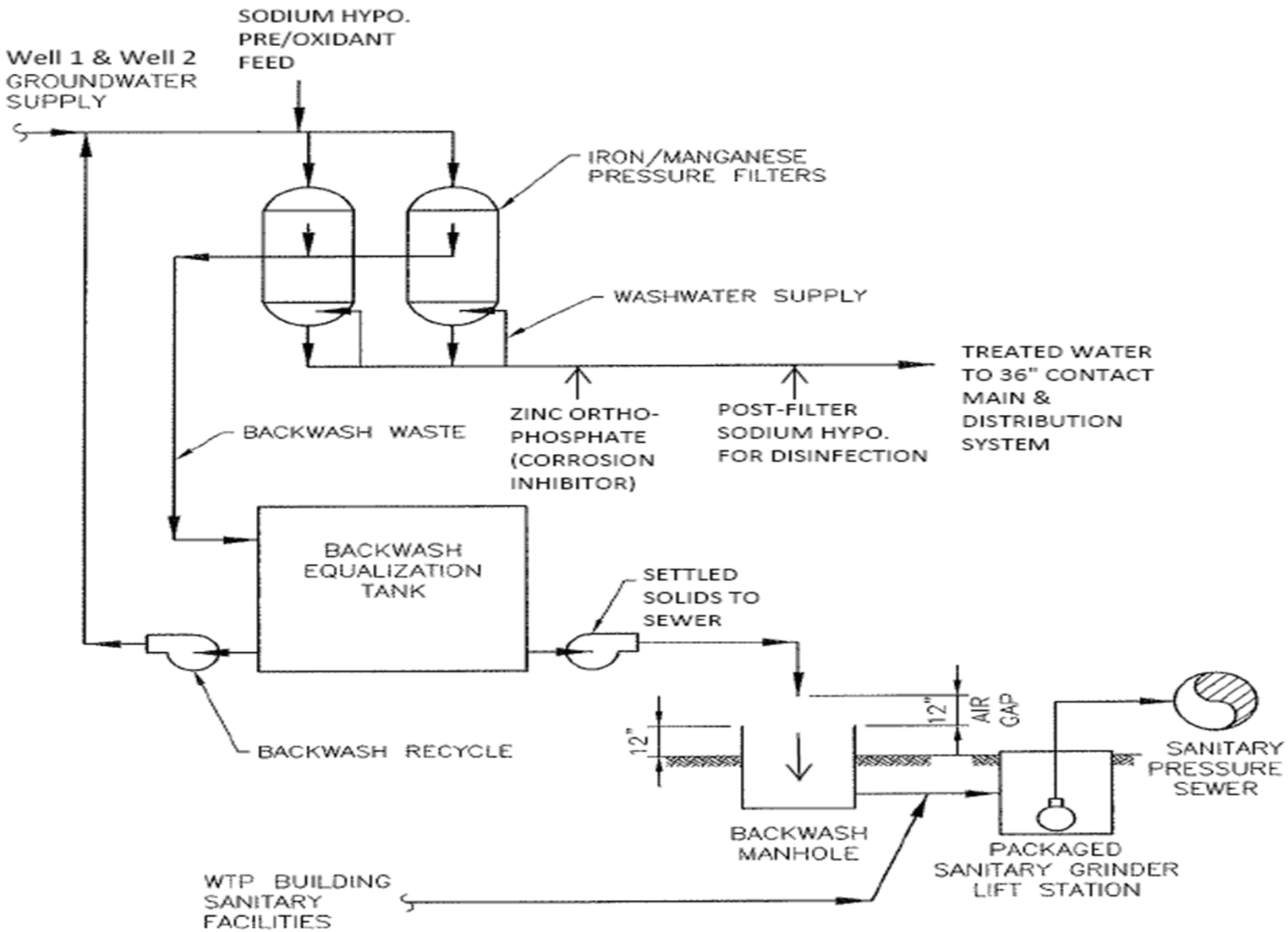
    pH - 6.2 to 8.5
  - Can withstand high differential pressures (+/- 20 psi)
  - Low operating costs

    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.


SODIUM HYPO. PRE/OXIDANT FEED
Well 1 & Well 2 GROUNDWATER SUPPLY
IRON/MANGANESE PRESSURE FILTERS
WASHWATER SUPPLY
TREATED WATER TO 36" CONTACT MAIN & DISTRIBUTION SYSTEM
ZINC ORTHO-PHOSPHATE (CORROSION INHIBITOR)
POST-FILTER SODIUM HYPO. FOR DISINFECTION
BACKWASH WASTE
BACKWASH EQUALIZATION TANK
SETTLED SOLIDS TO SEWER
BACKWASH RECYCLE
12"
12"
AIR GAP
SANITARY PRESSURE SEWER
BACKWASH MANHOLE
PACKAGED SANITARY GRINDER LIFT STATION
WTP BUILDING SANITARY FACILITIES

# 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 $ft^2$ 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 $Cl_2$ residual through filters**
  - ~2.0 ppm pre-feed ⟶ ~1.5 ppm post filter

- **Typical:**

| Mn (mg/l) (SMCL = 0.05) | | | Fe (mg/l) (SMCL = 0.3) | | | Color (Pt/Co) | | |
|---|---|---|---|---|---|---|---|---|
| In | Out | Δ | In | Out | Δ | In | Out | Δ |
| 0.54 | <0.01 | (0.53)<br>98%<br>1.13 lbs/d | 0.18 | <0.01 | (0.17)<br>94%<br>0.36 lbs/d | 5 | 0 | (5) |

# 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

| Item | Cost |
|---|---|
| Pressure Filter System Procurement, Install, etc. | $235,000 |
| Site Work/Yard Piping/Security Fence | $128,000 |
| Structural | $370,000 |
| Electrical/HVAC/Plumbing | $310,000 |
| Pumps/Controls/Instrumentation[1] | $120,000 |
| Well Improvements (two wells) | $70,000 |
| Start-Up/Testing/Misc. Soft Costs | $17,000 |
| Total | $1,250,000 |

[1]Excluding filter system instrumentation

# Lessons Learned

- **Loading of media into 10' high filters options**
  - Bucket Brigade/Scaffolding
  - Escalator/Skylights
- **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