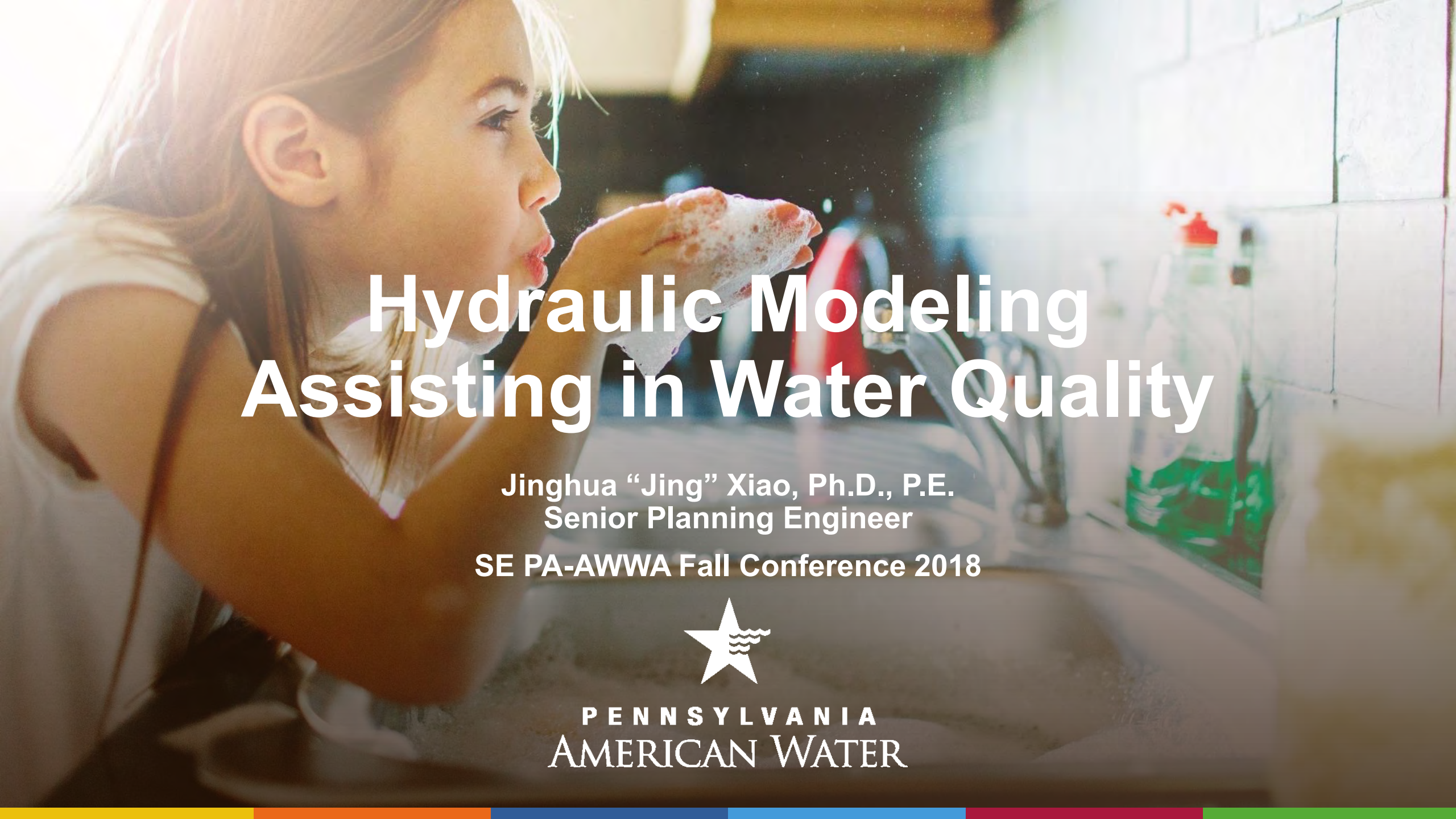

Hydraulic Modeling Assisting in Water Quality

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Senior Planning Engineer

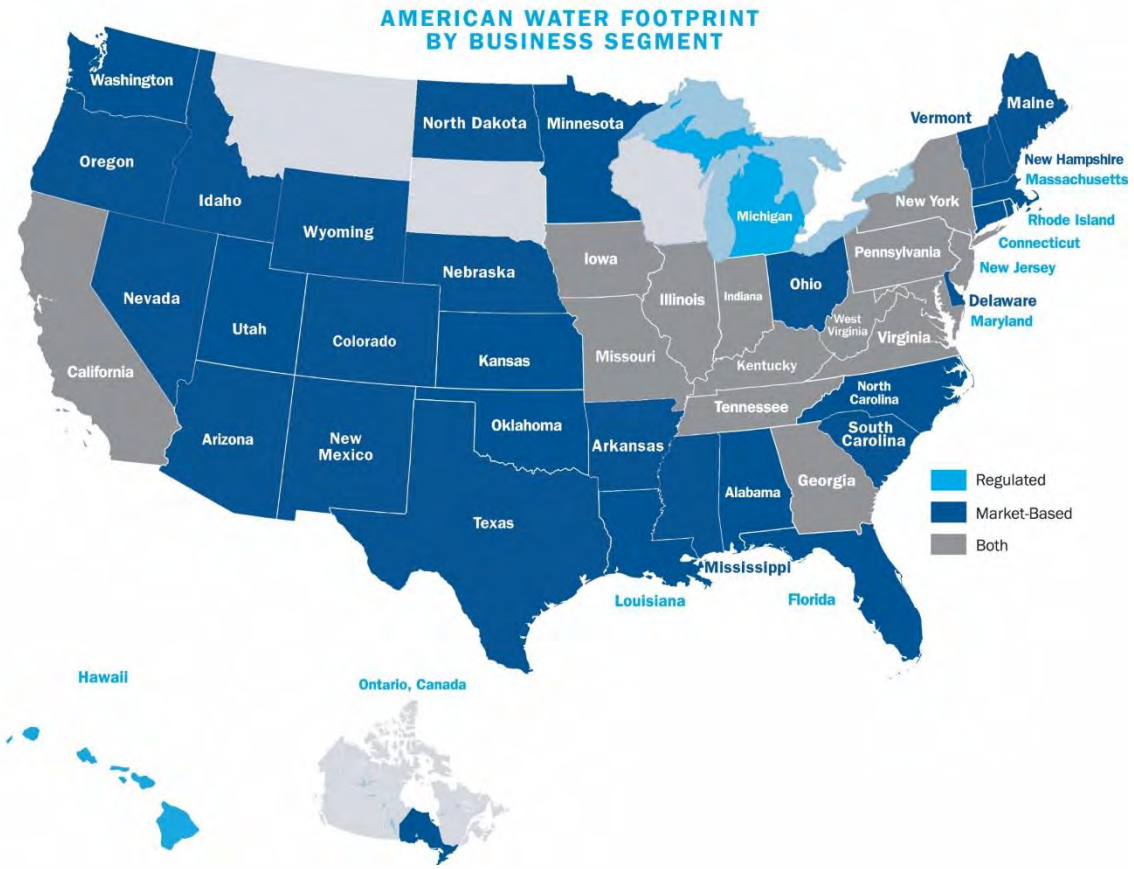
SE PA-AWWA Fall Conference 2018

PENNSYLVANIA
AMERICAN WATER

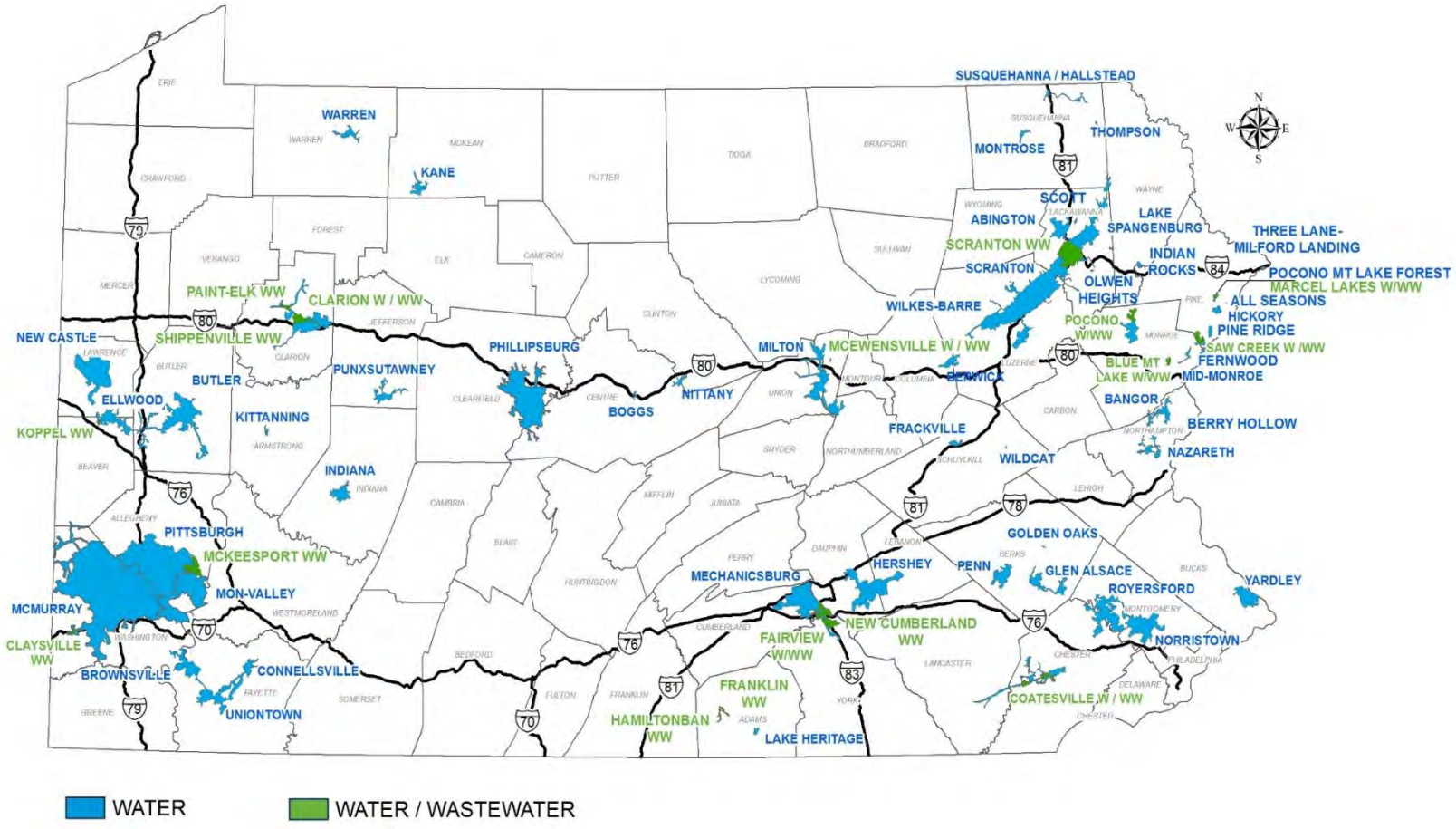
WHO WE ARE

We are the largest and most geographically diverse publicly traded water and wastewater service provider in the Unites States.

- We serve a broad national footprint and a strong local presence.
- We provide services to approximately 15 million people in **46 states** and Ontario, Canada.
- We employ **6,900** dedicated and active employees and support ongoing community support and corporate responsibility.
- We treat and deliver more than **one billion** gallons of water daily.



OUR SERVICE AREA



PENNSYLVANIA AMERICAN WATER

WE SERVE

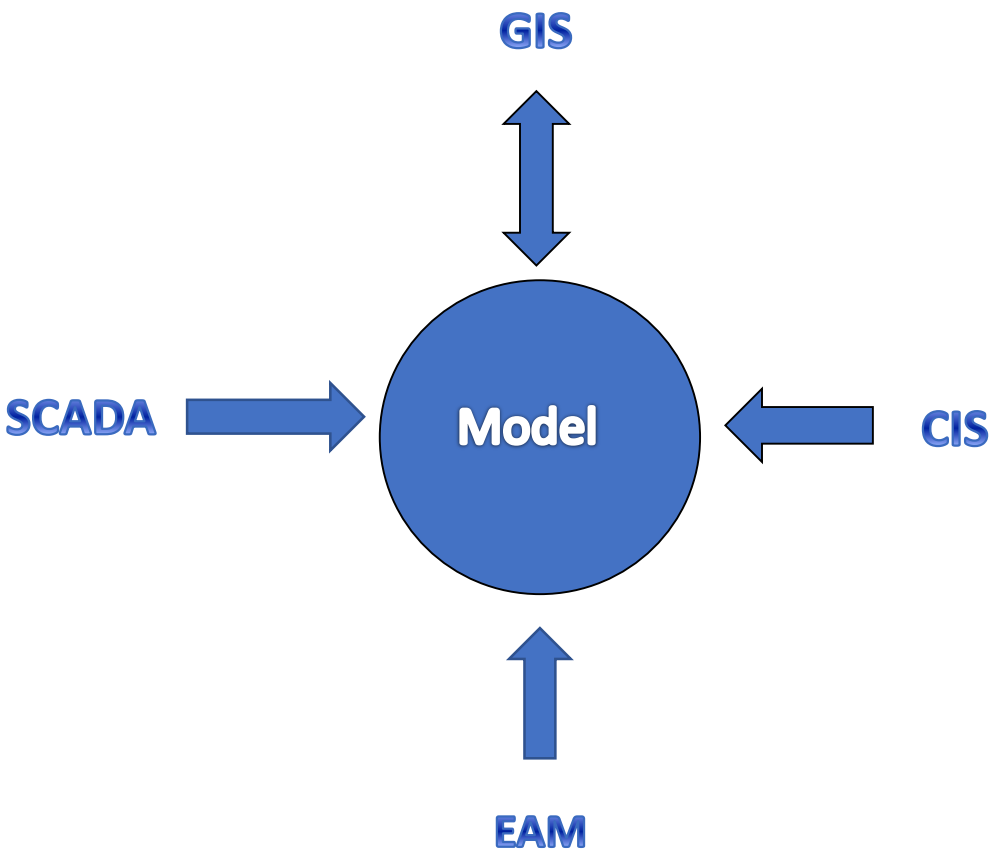
- Approx. **2.4 million people** in 36 counties (19% of the population)
- **658,000 water customers**
- **65,000 wastewater customers**

TRANSMISSION & STORAGE

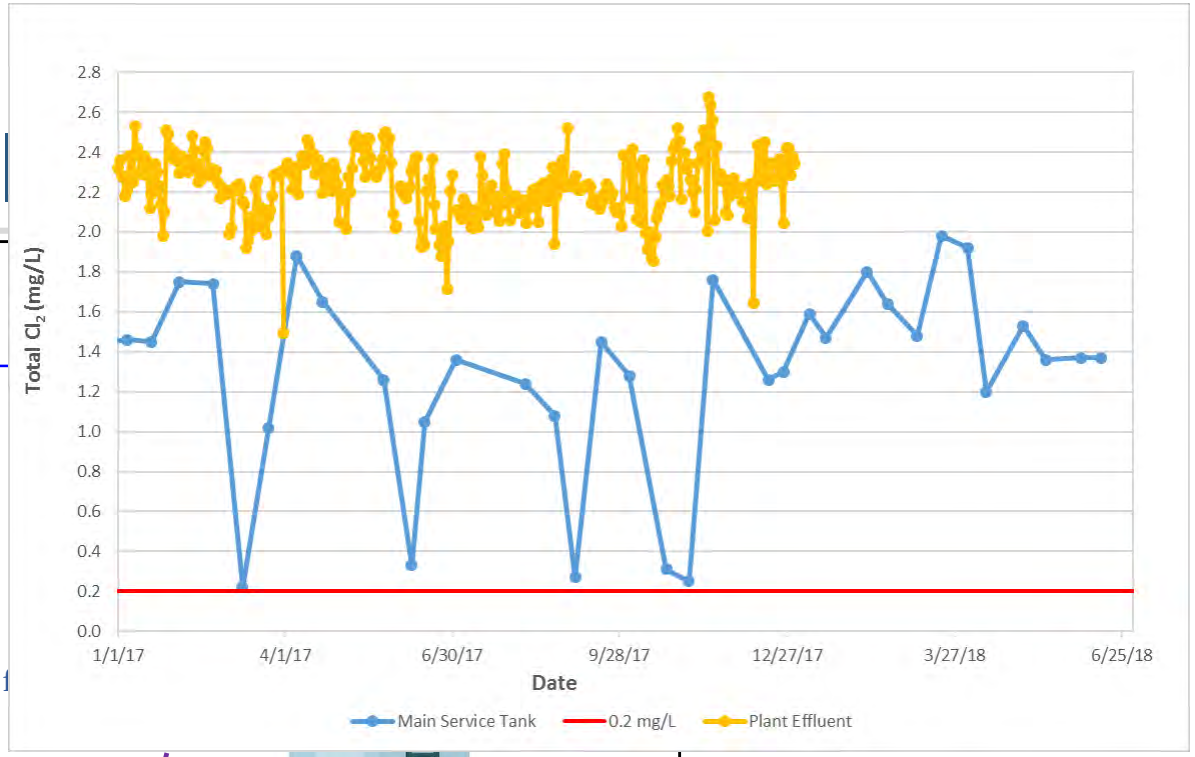
- **11,054 miles of water and sewer pipe**
- **256 water storage facilities**
- **359 water and wastewater pumping stations**

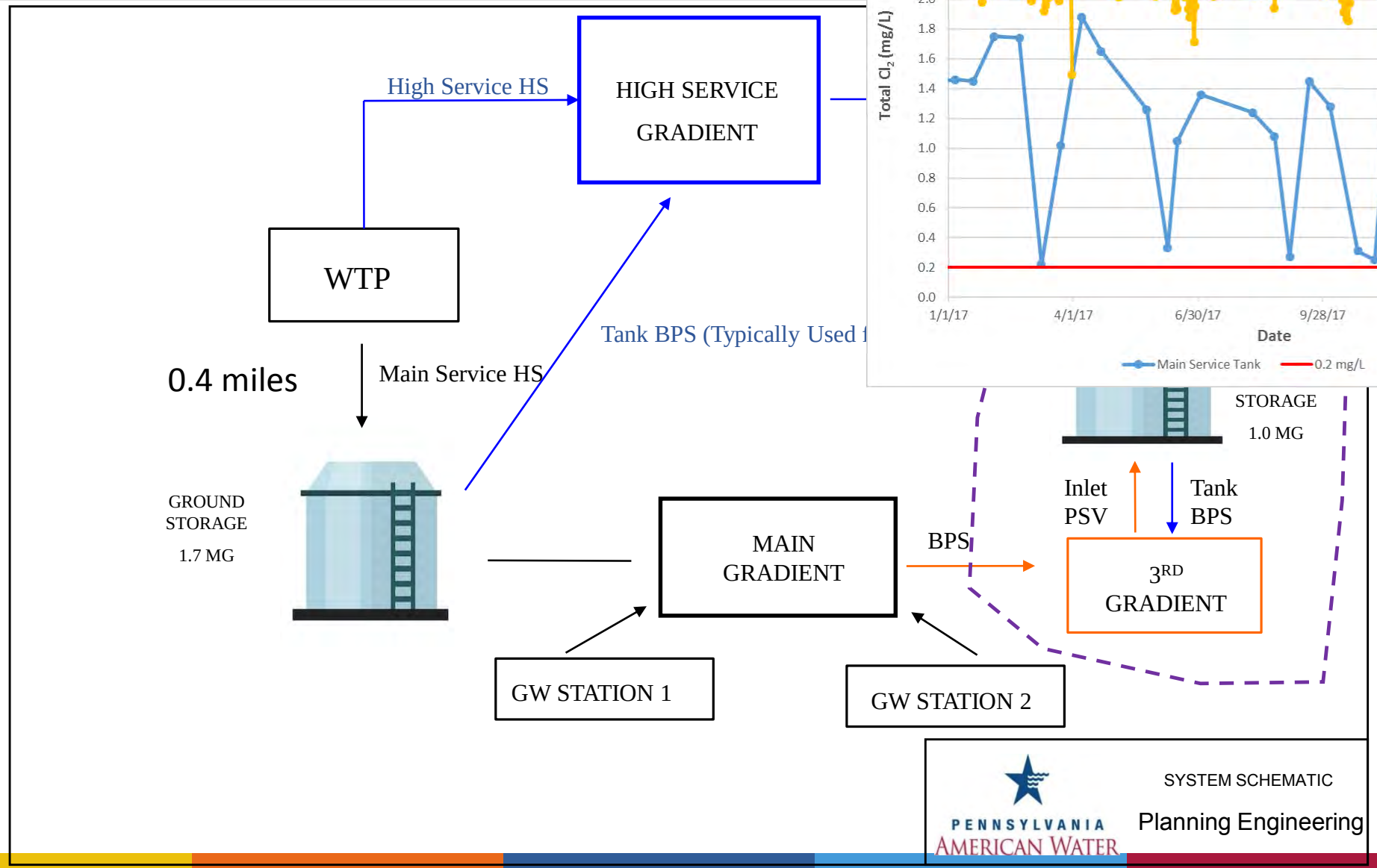
Uses of Hydraulic Modeling

- **Capital Planning**
- **Design**
- **Assist Operation**
- **Assist Water Quality**
  - **Water age**
  - Chlorine residual
  - Disinfection byproduct
  - Flushing (unidirectional flushing plan, flushing location)
  - **Trace study (multiple sources)**



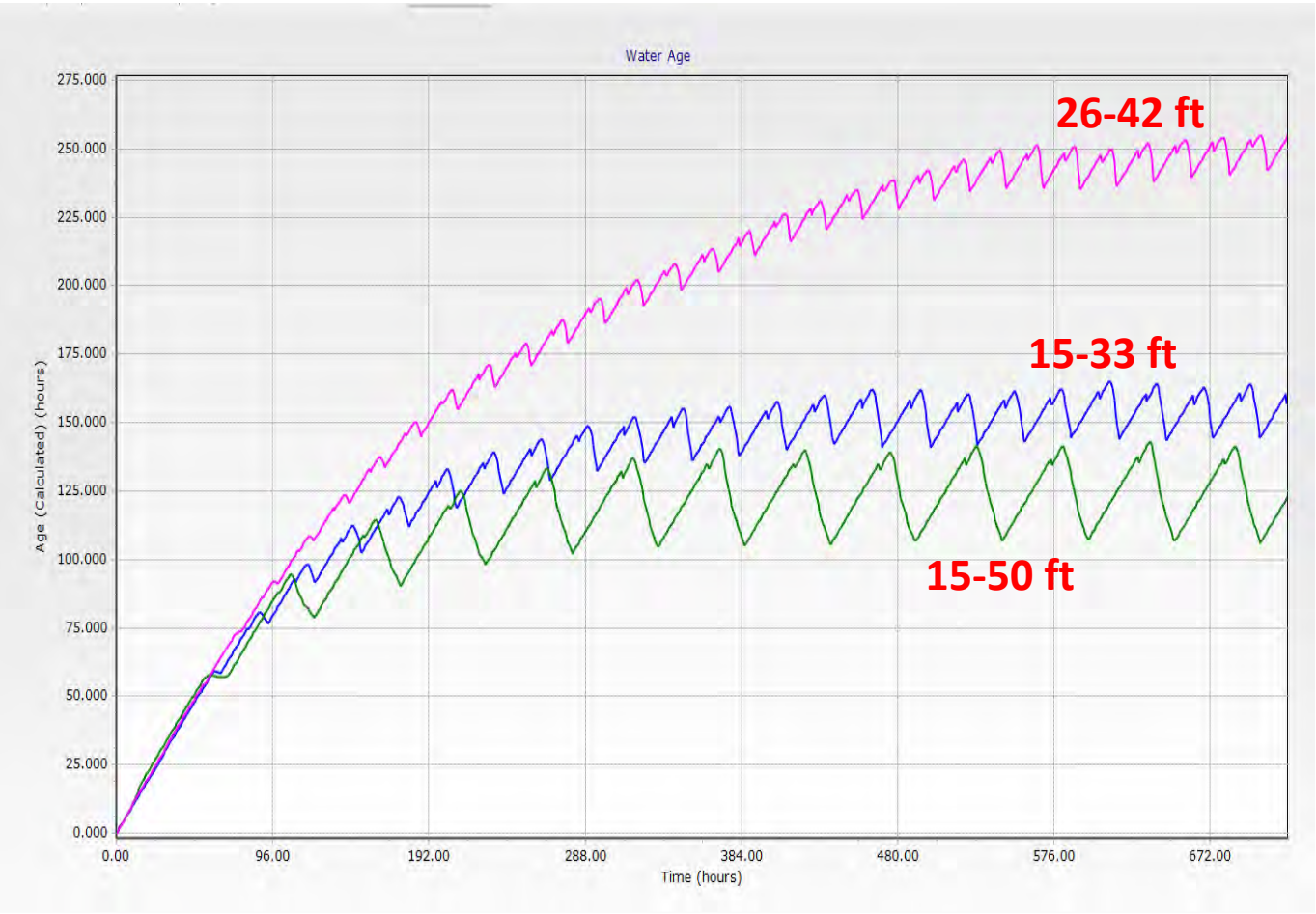
Case 1 – Water Age Simul



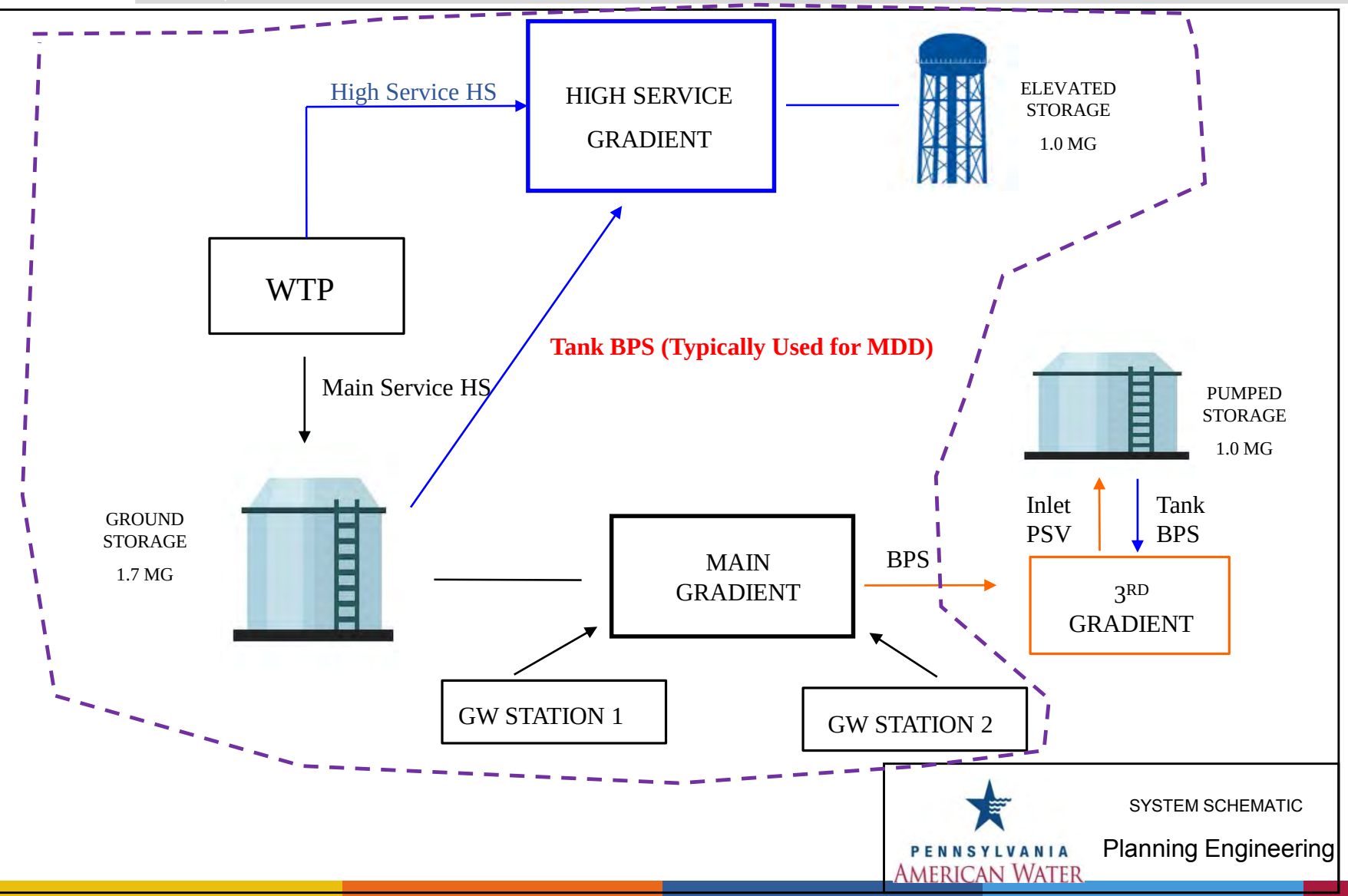


Case 1 – Water Age Reduction

- 3rd Gradient Optimization
  - Change tank operation level (51 feet in height)
  - Mixer



Case 1 – Water Age Simulation

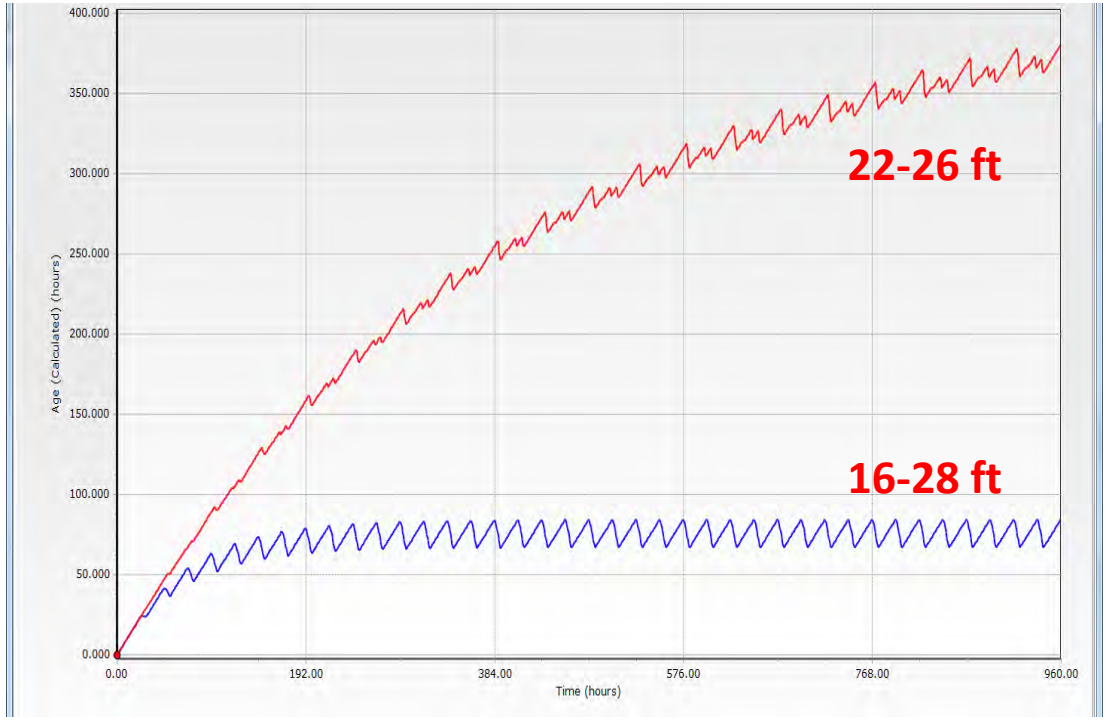


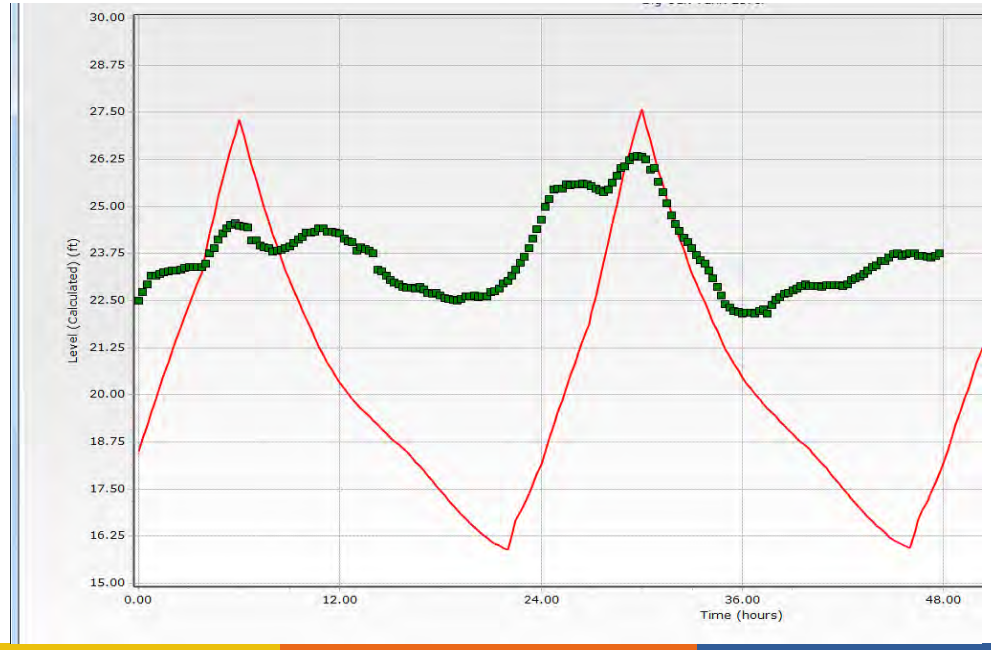
Challenges:

- High demand in HS Gradient
- Plant prefers stable output
- Multiple sources in MS Gradient

Case 1 – Water Age Reduction

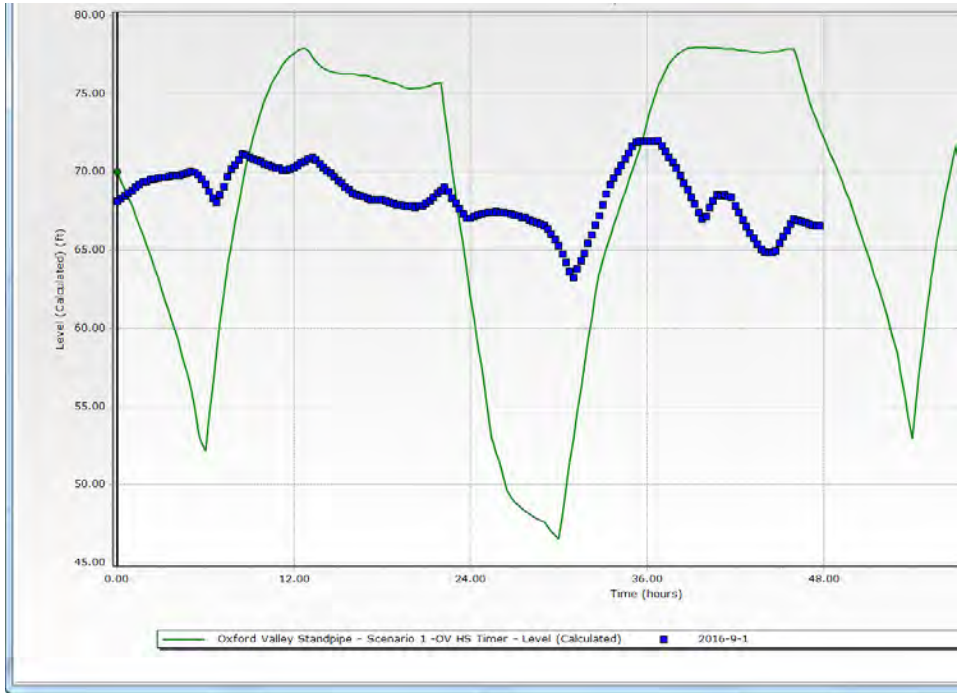
- HS Gradient Optimization
  - HS Elevated Tank operating level (30 feet in height)
  - Fill at night with MAIN TANK BPS

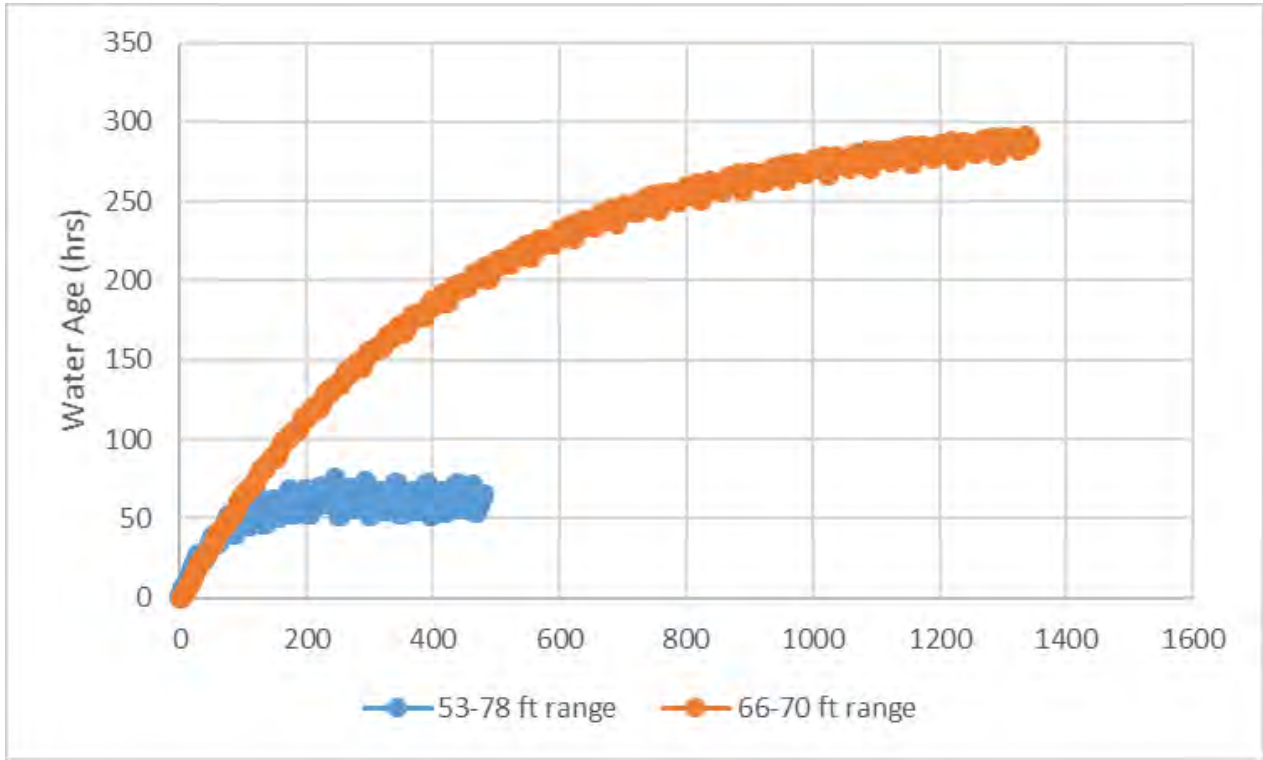




Case 1 – Water Age Reduction

- MS Gradient Optimization
  - MS Ground Tank operating level (80 ft in height)
  - Fill during daytime





Water Age – How Short is Good

Loss of Chlorine = Chlorine Decay Rate * Time (Water Age)

Chlorine decay rate = <u>bulk liquid phase</u> and <u>liquid–pipe wall.</u>

↓ **Bulk Decay** ↓ **Wall Decay**

Many factors that impact chlorine decay rate

- Rate changes constantly due to temperature, pH, constituents in water, mixing sources
- Chloramines vs. Cl_2
- Nitrification?

Water Age – How Short is Good

- Water Age Management Solution Cycle

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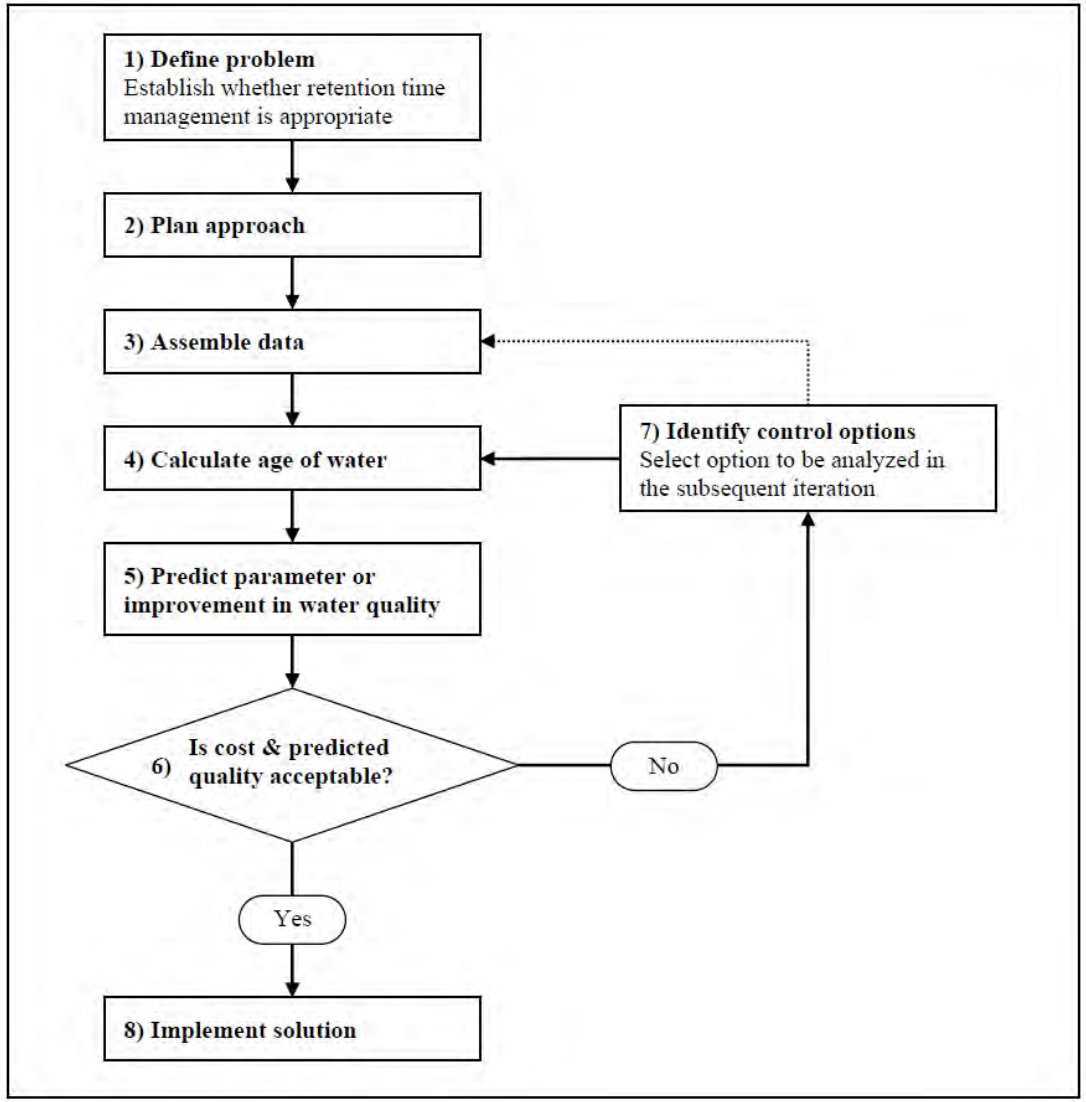


Managing Distribution Retention Time to Improve Water Quality—Phase I

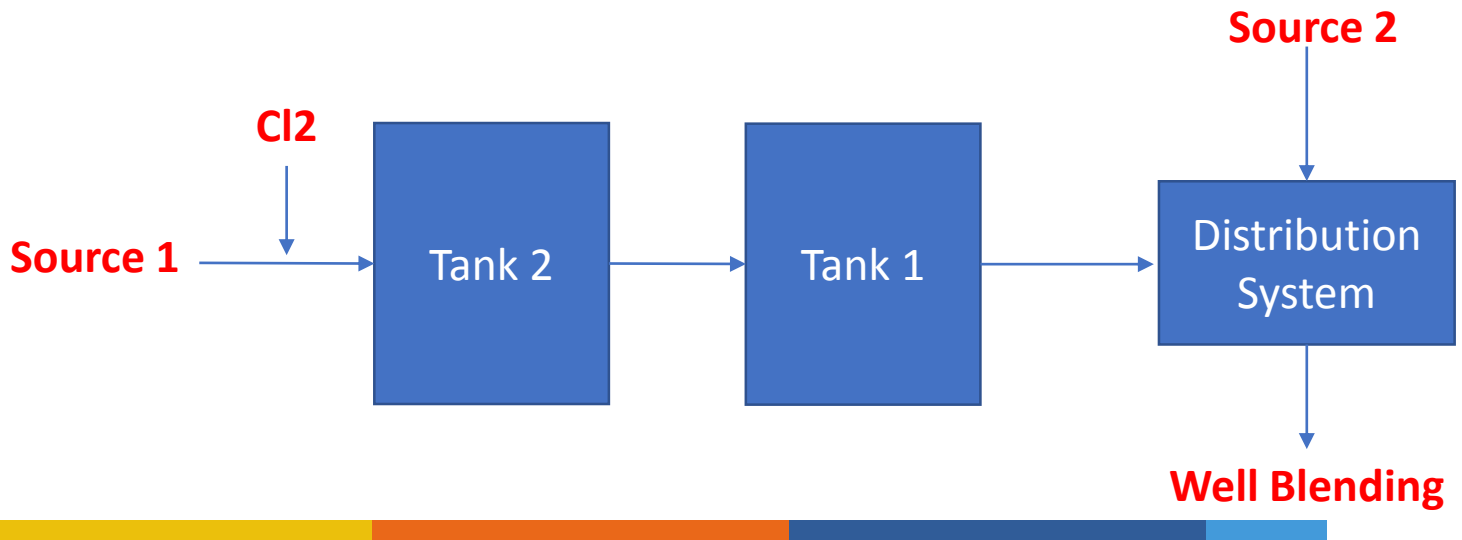
Case 1 Summary

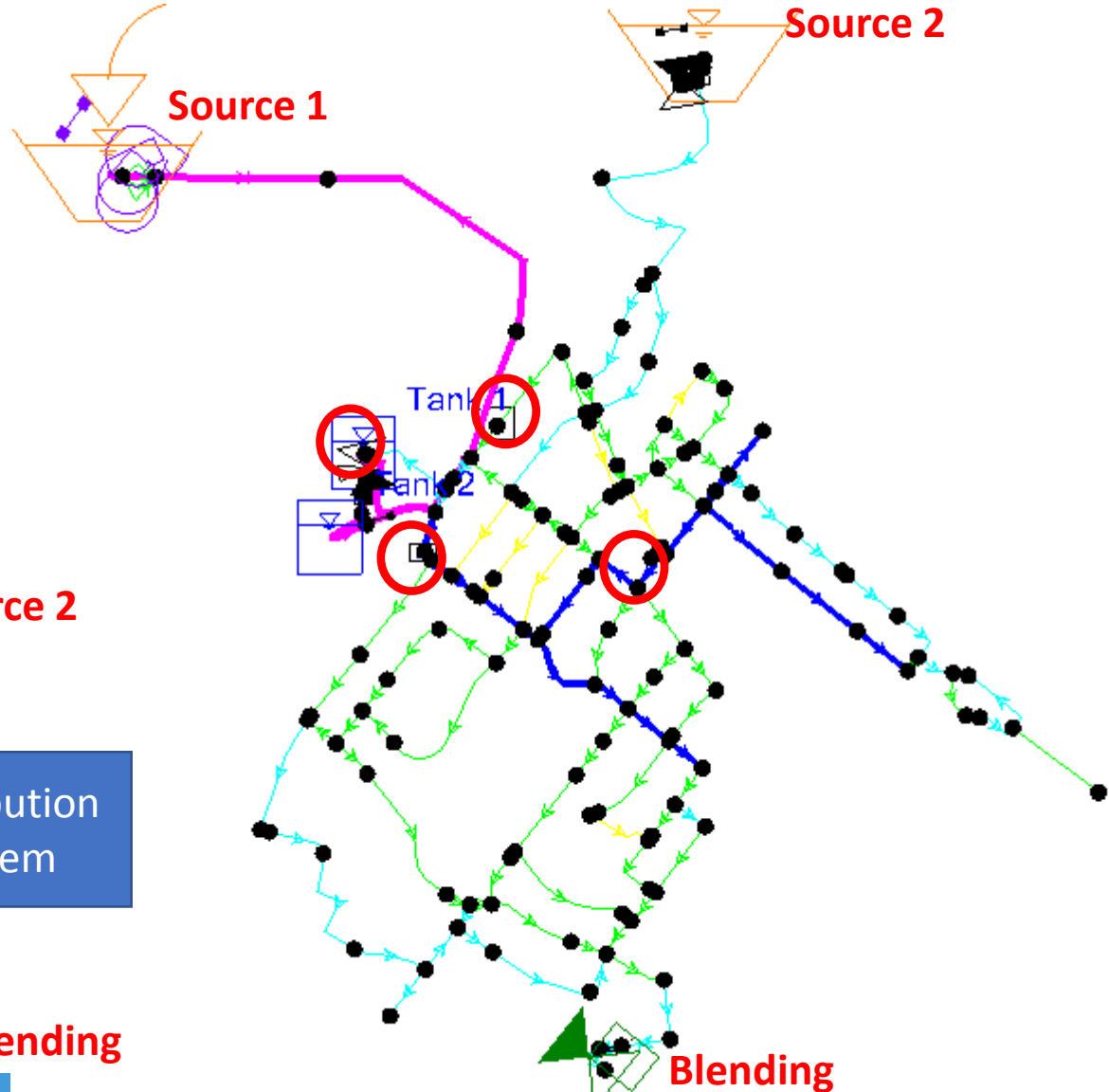
Reduce Water Age

- DO NOT over size
- Operate storage tanks in a good range
- Achieve mixing energy in tanks
- Flush effectively when needed
- Understand your system by monitoring water quality parameters and correlating results with water age

Case 2 – Trace Study and DBP Simulation

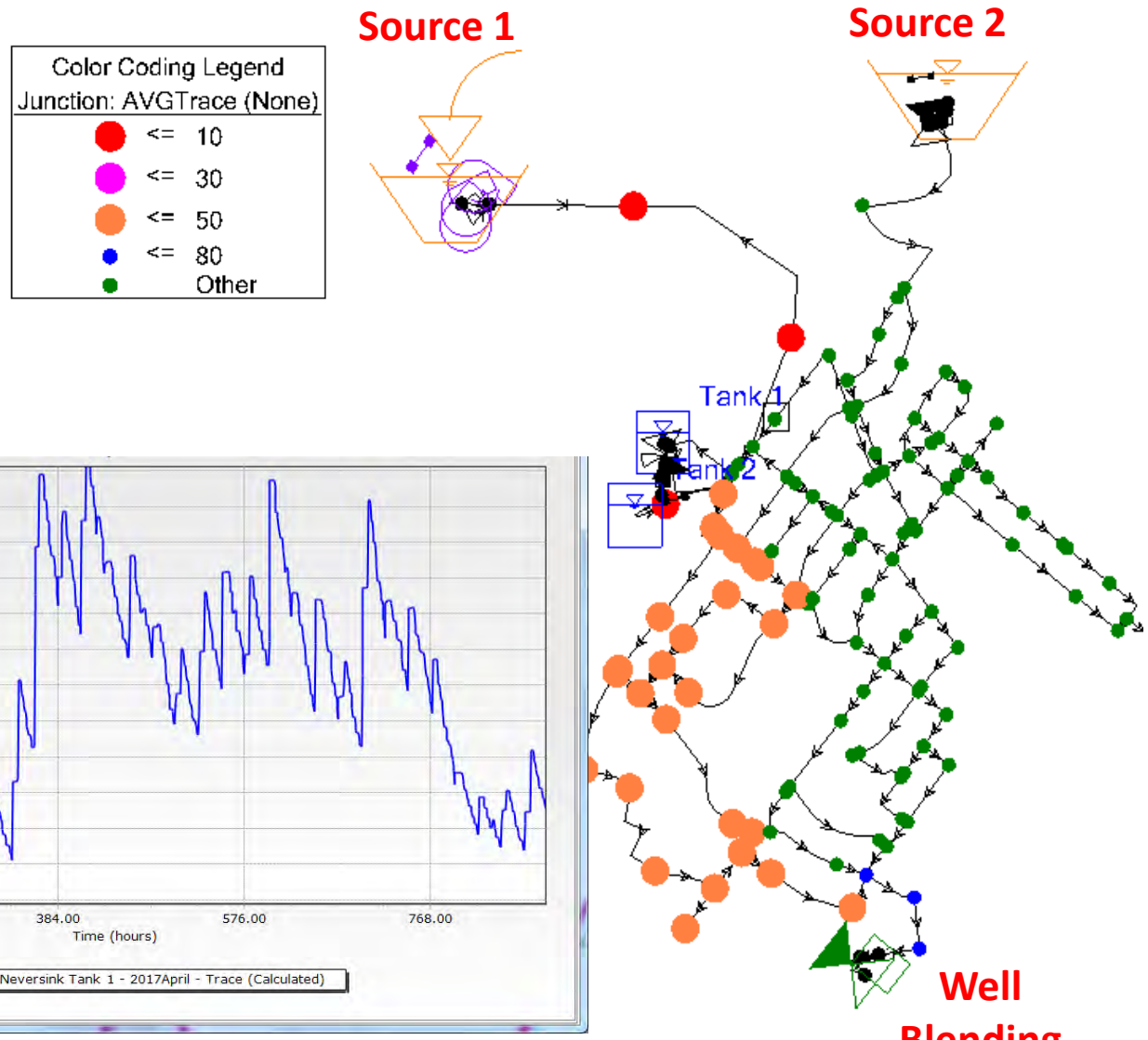
- Two Sources for the study zone
  - Purchase Water 1 – Surface Water with High DBP, minimal purchase, high flow
  - Purchase water 2 – Ground water with low DBP but limited flow of 260 gpm
- May 2017 – HAA OEL > 60 ug/L at Tank 1
- Compliance samples scheduled early July

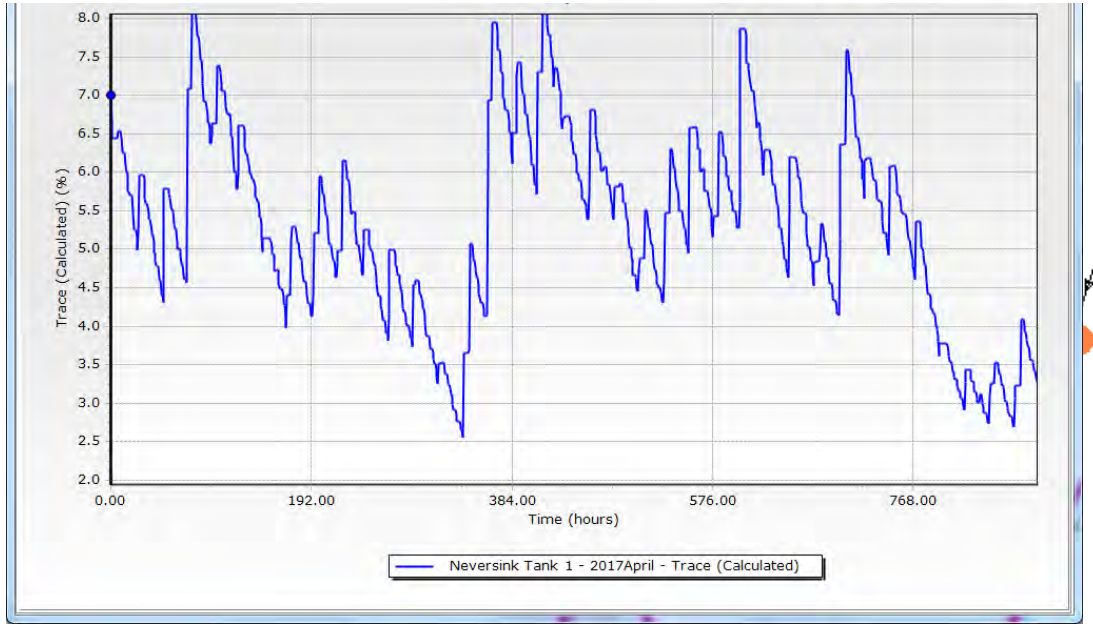




Case 2 – Trace Study and DBP Simulation

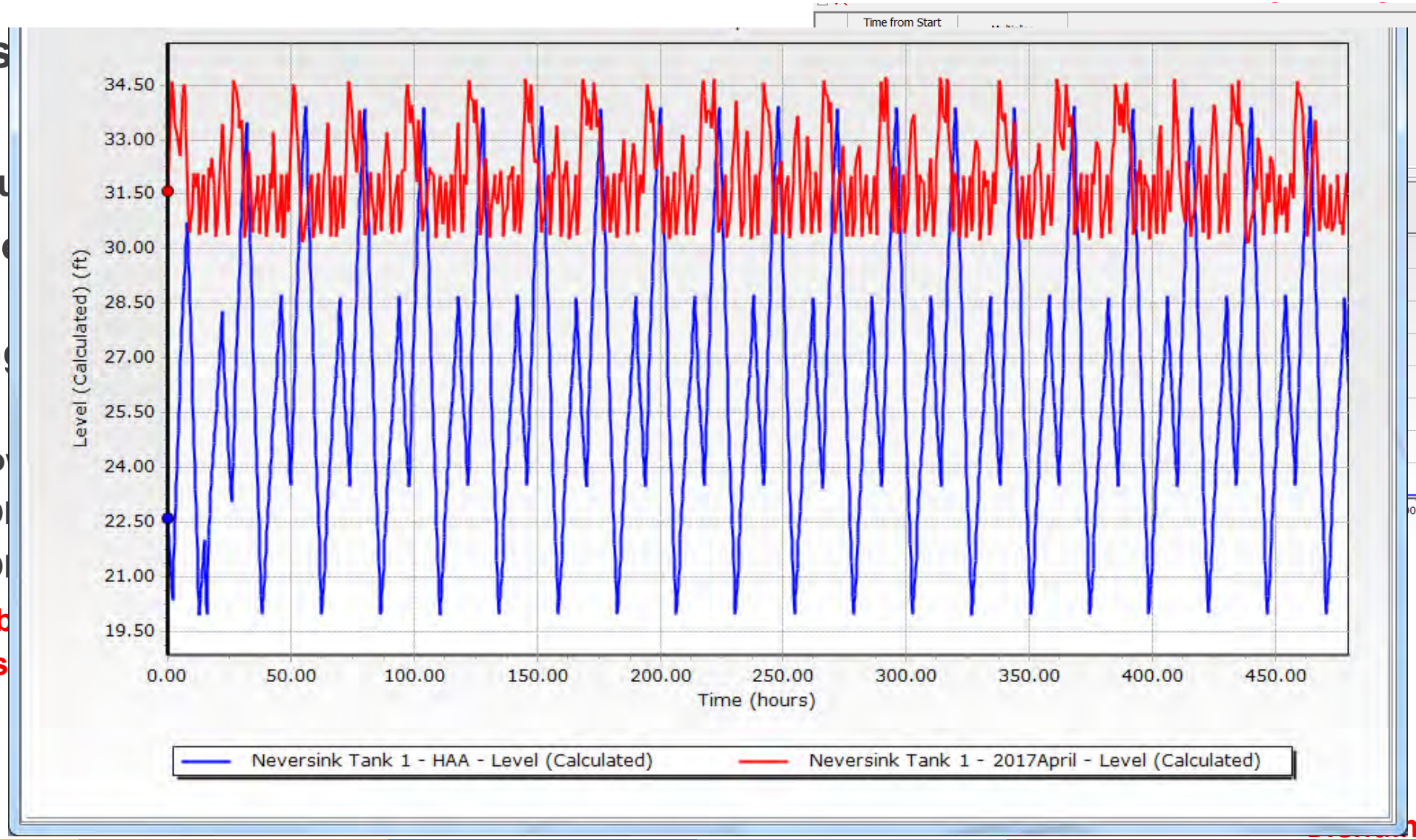
- **April 2017 Control**
  - S1: ON T2 < 10.5 ft OFF T2 >14 ft
  - T2 flow to T1: ON T1 < 30.5 ft OFF T1 > 32 ft
  - S2: ON T1 < 33.5 ft OFF T1 > 34.5 ft
  - Well blending controlled by the tank in another zone
- **April 2017 Demand vs Supply**
  - Customer Demand = 135 gpm
  - Well Blending = 215 gpm
  - S2 = 240 gpm S1= 110 gpm
  - S2/(S1+S2) ~ 70%
- **Trace Study**
  - 2-8% of S2 in Tank 1

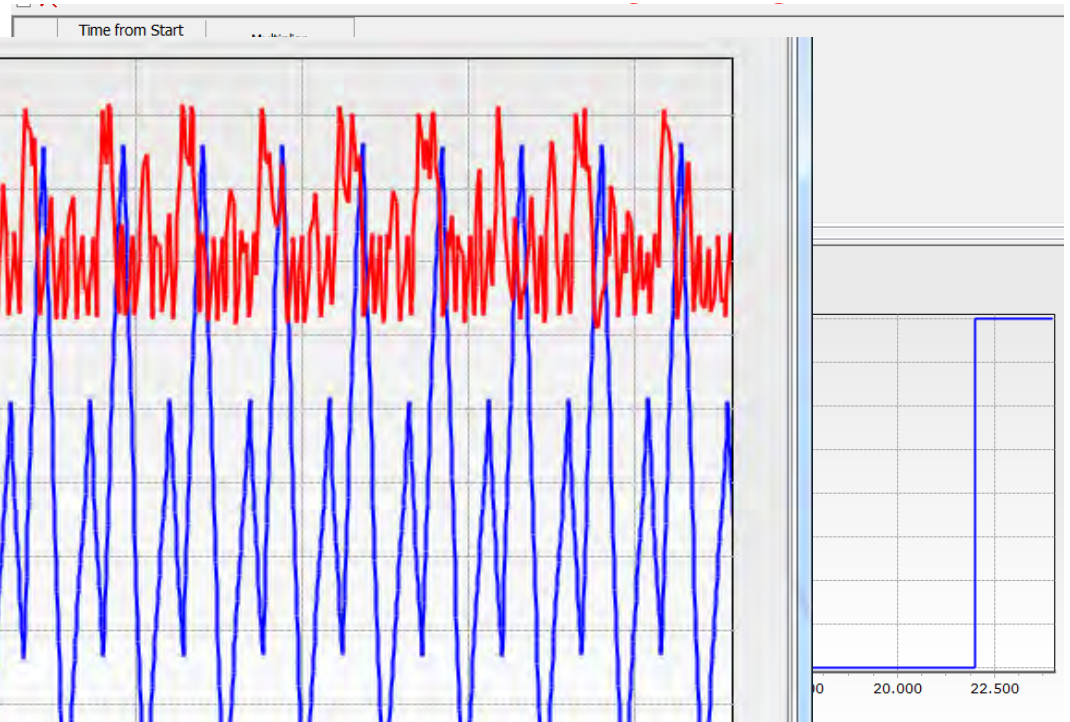




Case 2 – Trace Study and DBP Simulation

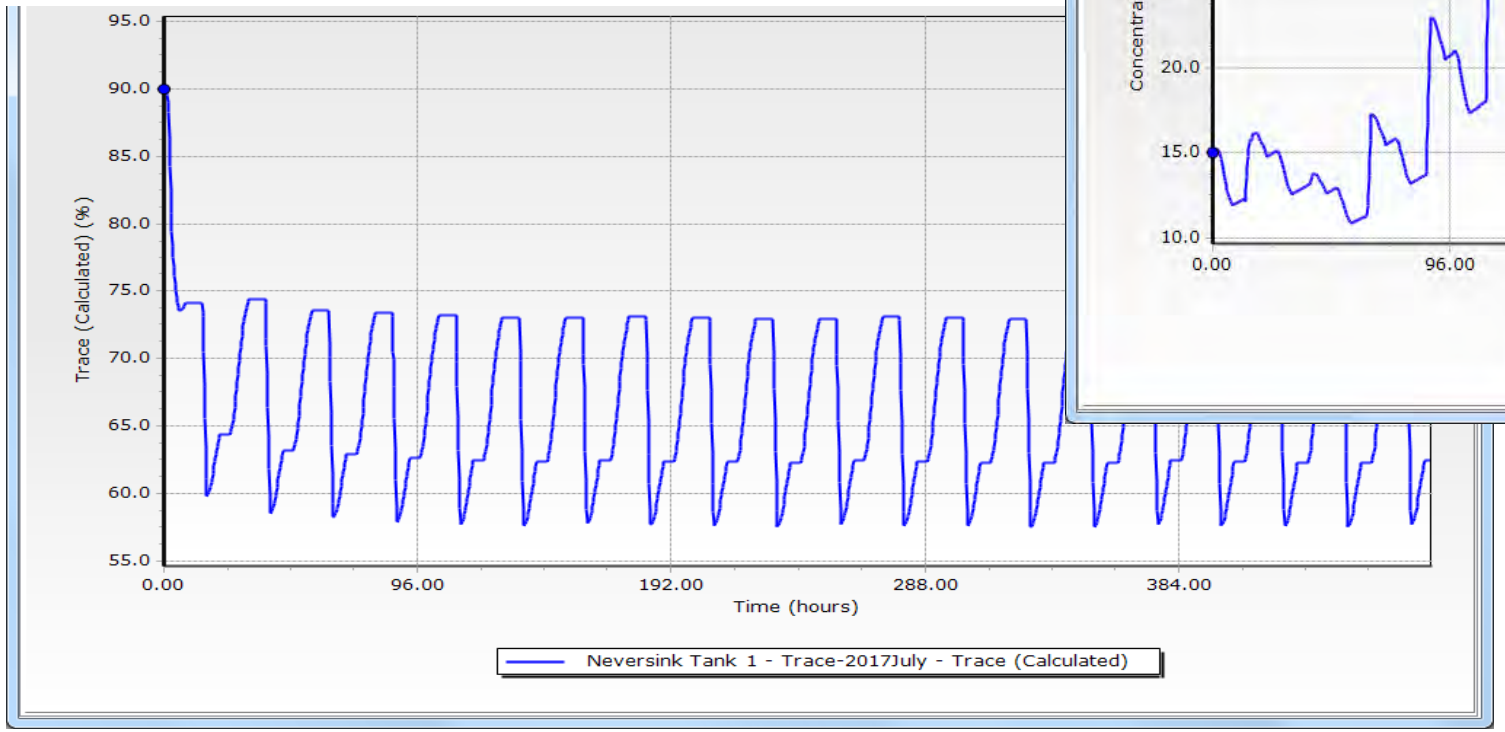
- Propos
  - Max
  - Redu
  - Lowe
  - Max being
  - T2 flo
  - S1: O
  - S2: O
  - Well b hours

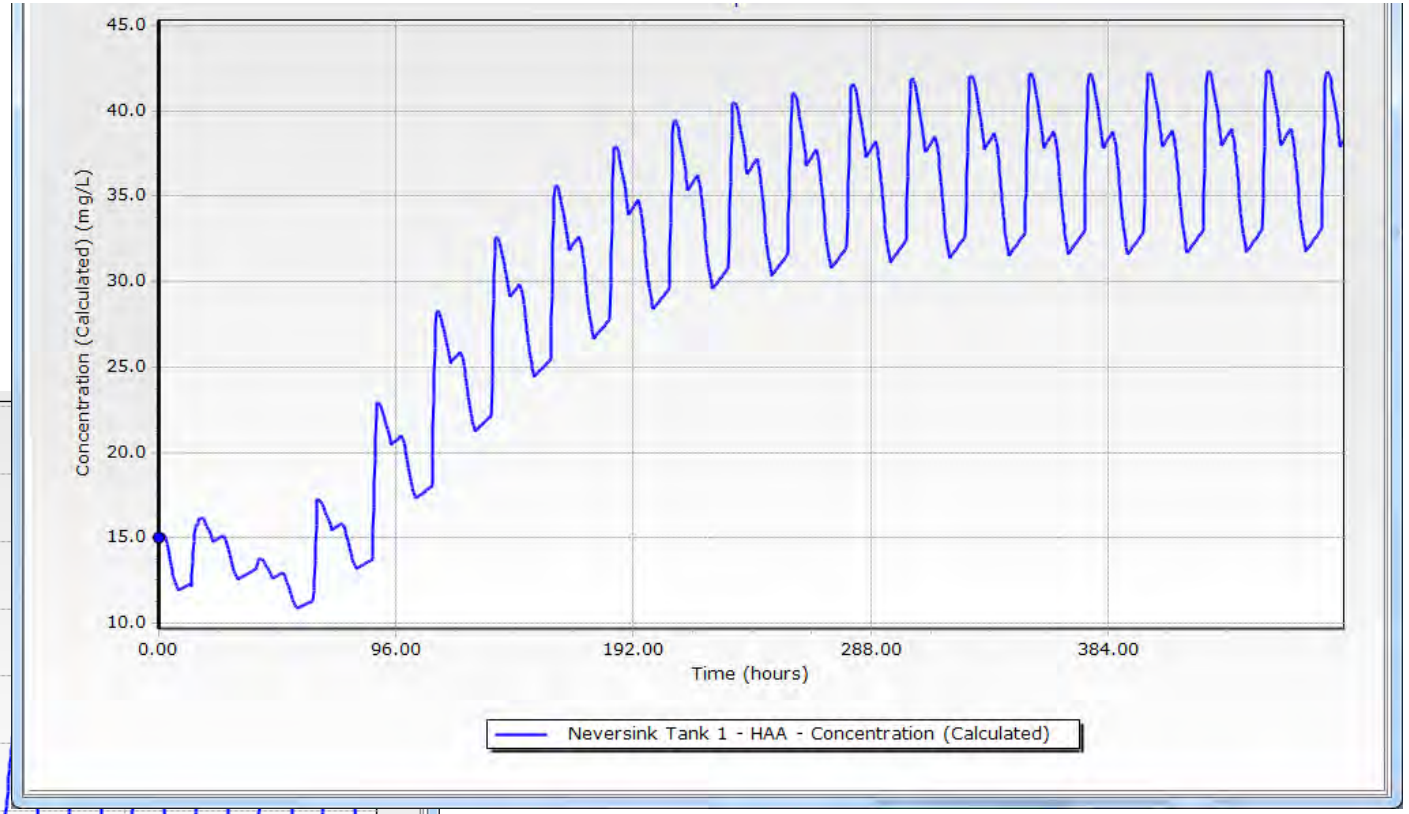




Case 2 – Trace Study and DBP Simulation

- Trace simulation: S2 60-70% in Tank #1
- HAA simulation: <40 ug/L in Tank #1
  - Assumptions: first order bulk reaction
  - Reaction rate estimated from testing results
  - Conservative HAA in S1

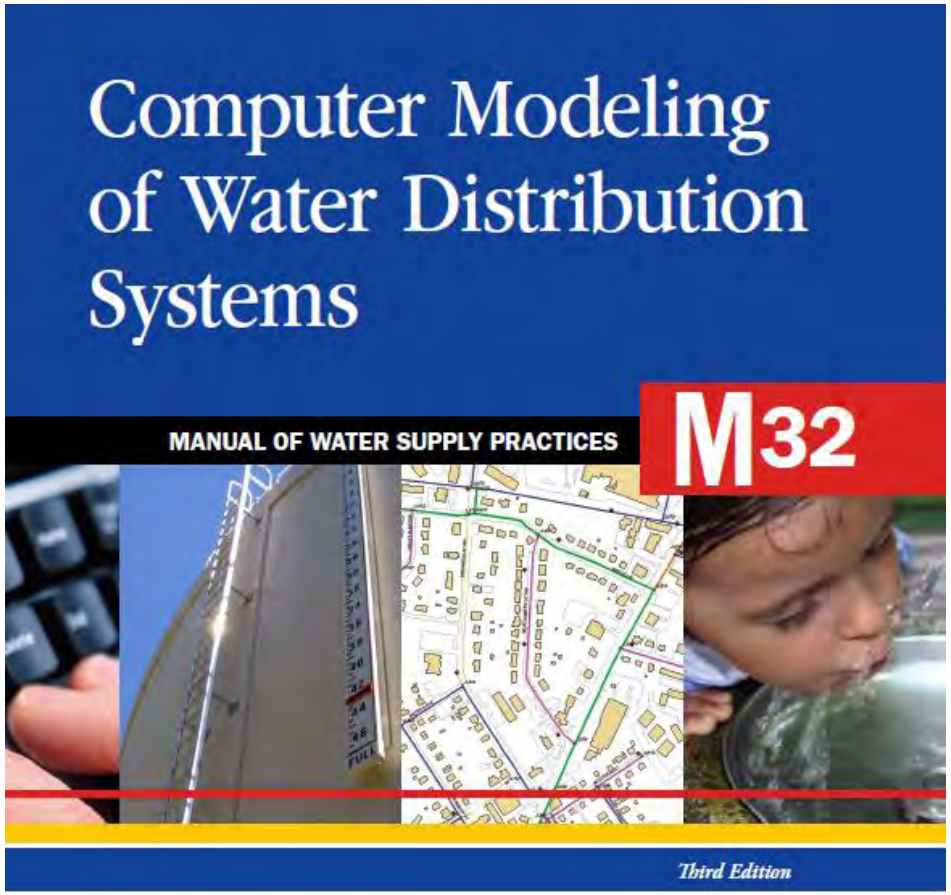




Case 2 Summary

- % of a source withdrawal ≠ % of the source in the tank
- Trace study to optimize operation (variables)
- **Purpose of WQ Modeling is to make better operational decisions, NOT to create a perfect model**

AWWA M32



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QUESTIONS?

PENNSYLVANIA
AMERICAN WATER

THANK YOU