Water Quality: Seriously Consider the System

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1. Confluence Engineering Group
2. Willamette Water Supply Program
3. Tacoma Water
4. City of Longview

American Water Works Association
Pacific Northwest Section

2023 Section Conference May 3-5, 2023
Kennewick, WA

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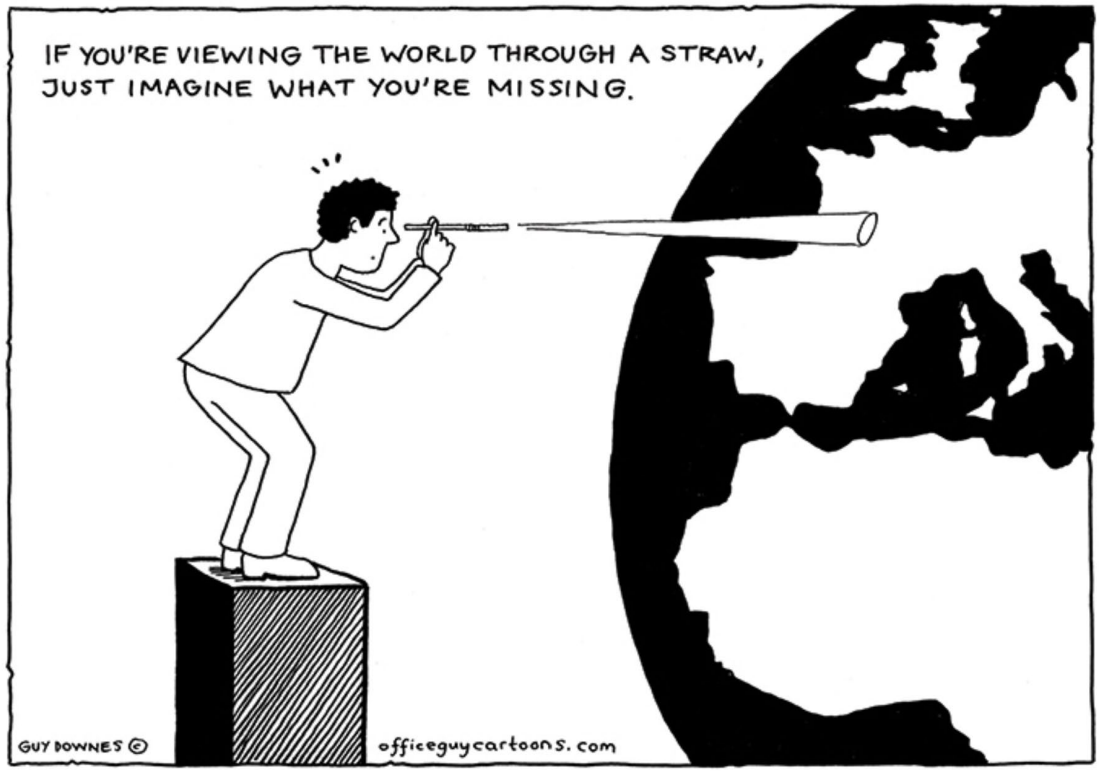
The Project Scope

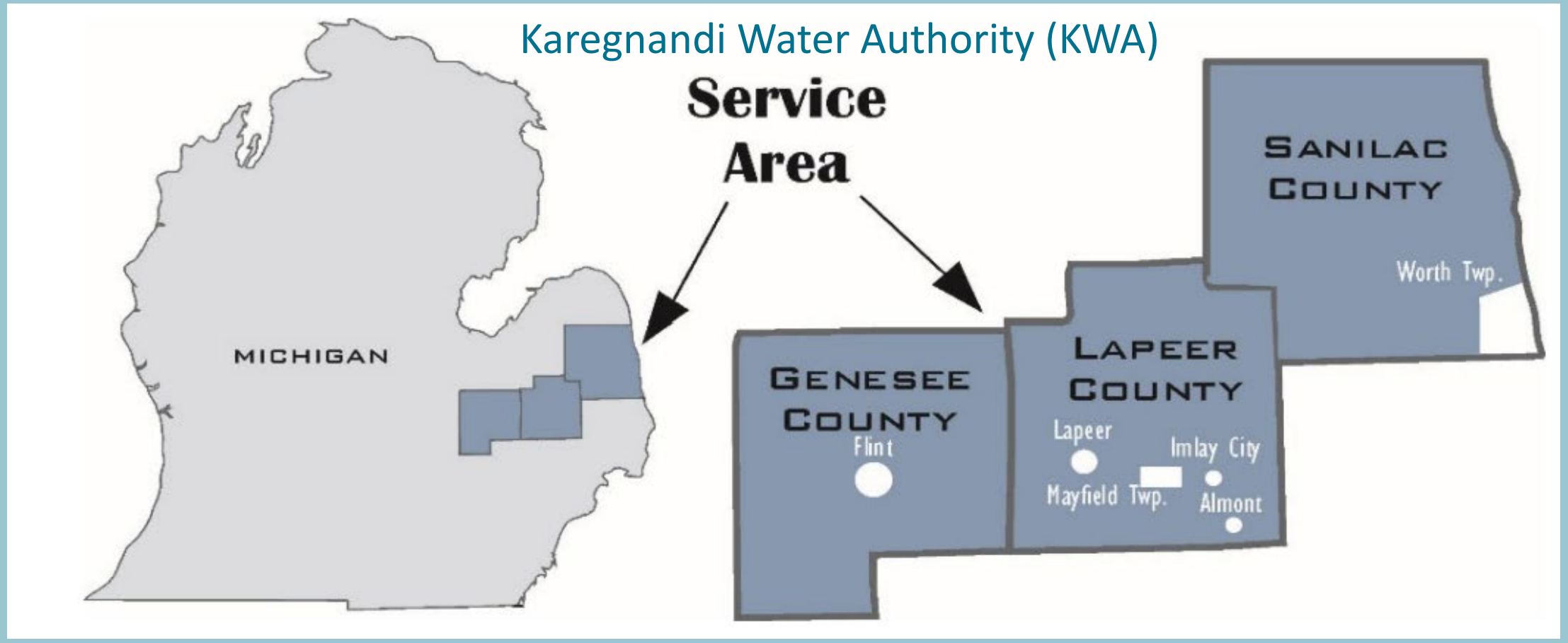
The Whole System

Water Quality



*Source :*Through a Straw - Office Guy Cartoons

1. The Scope the focuses the solution
2. Owners/Utilities manage many things.
3. Contactors (Consultants and Constructors) are expensive and strive to deliver to their Scope (Because it is a *contract*)
4. Complex Systems have "Off site" components (Sometime out of sight)
5. There can be consequences, ranging from inconvenient to disastrous



Flint Case Study

Flint, Michigan

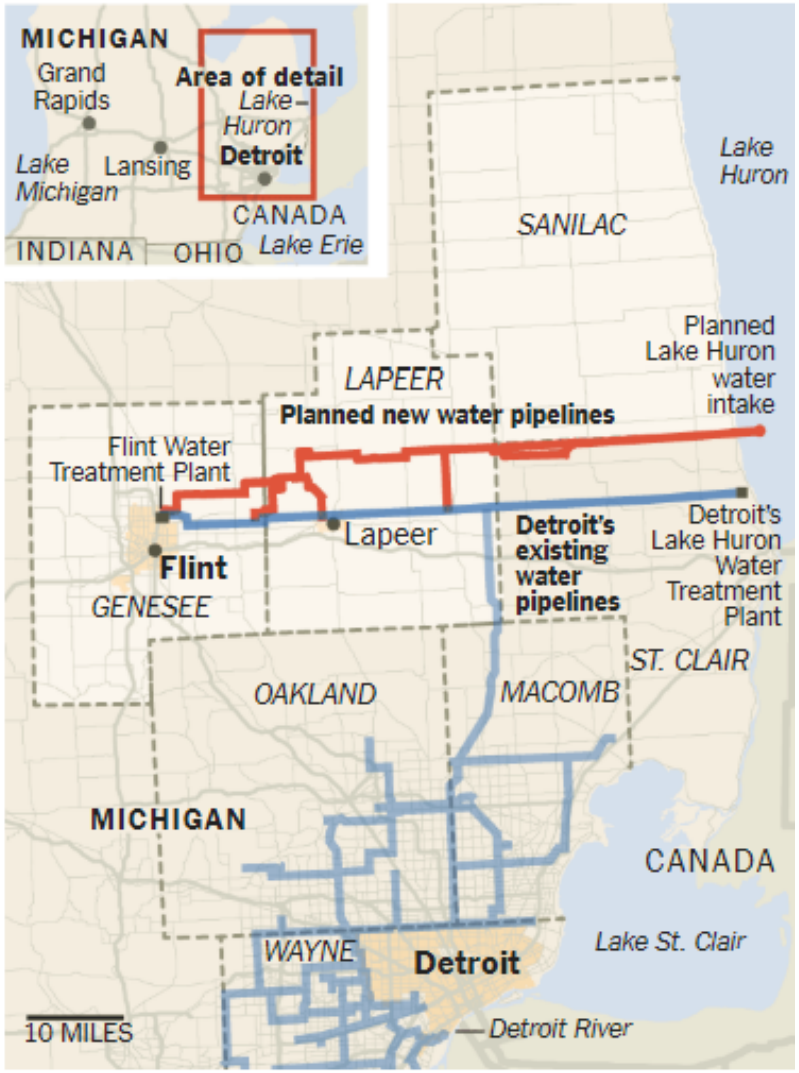
Detroit Plan to Profit on Water Looks Half Empty

Officials in Flint, Mich., raised glasses of treated water to celebrate the city's breakup with Detroit's water system. Samuel Wilson/The Flint Journal, via Associated Press

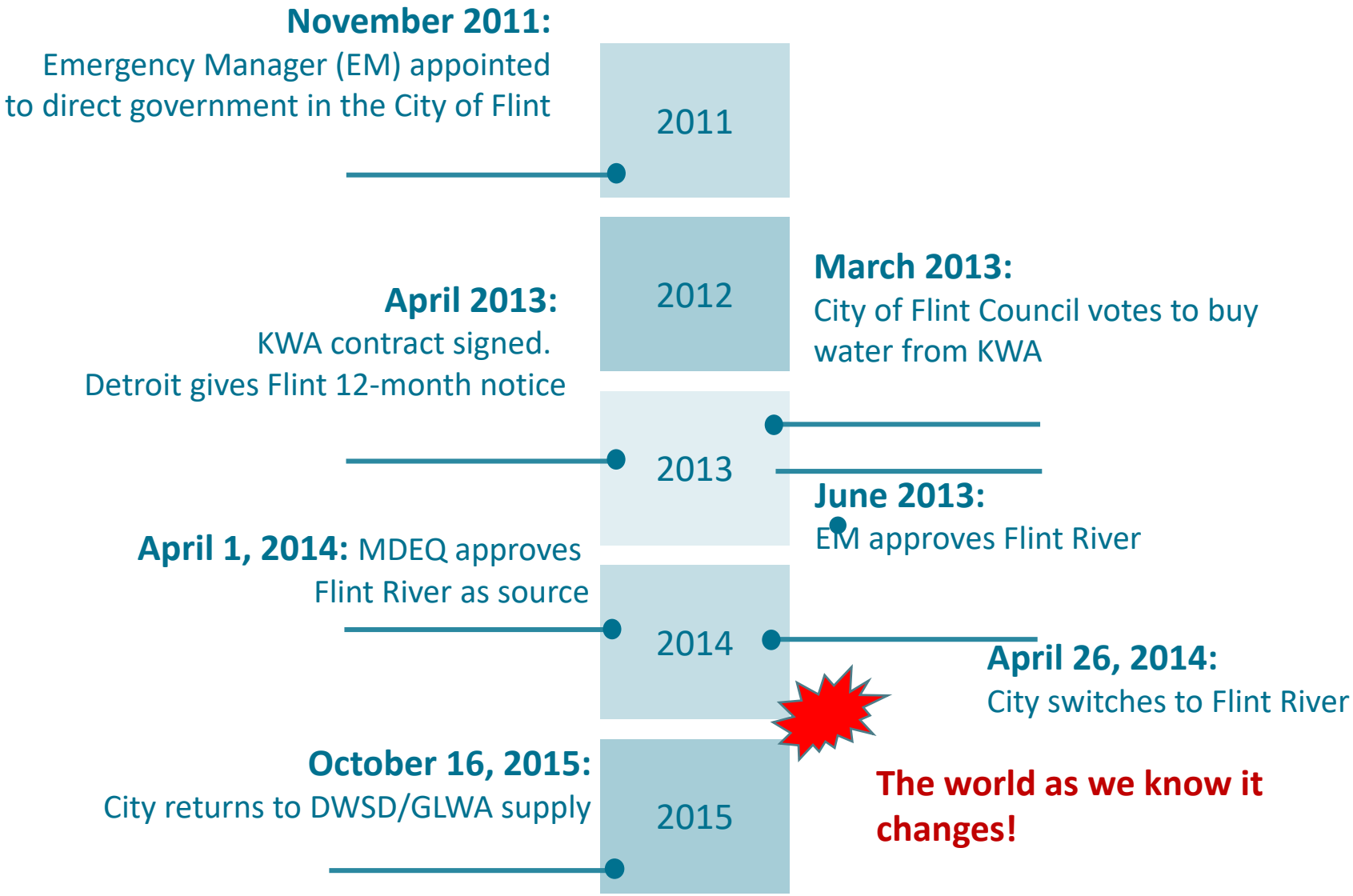
Source: New York Times, Detroit Plan to Profit on Water Looks Half Empty, May 25, 2014

Flint's Plan for a New Water Pipeline

The city of Flint and three counties have proceeded with a plan to build their own water pipeline from Lake Huron. They hope to end their dependency on Detroit's waterworks.



Flint Timeline



Source: Friedman, Melinda, Flint's Path from Crisis to Distribution System Optimization, PNWS-AWWA Annual Conference, 2017

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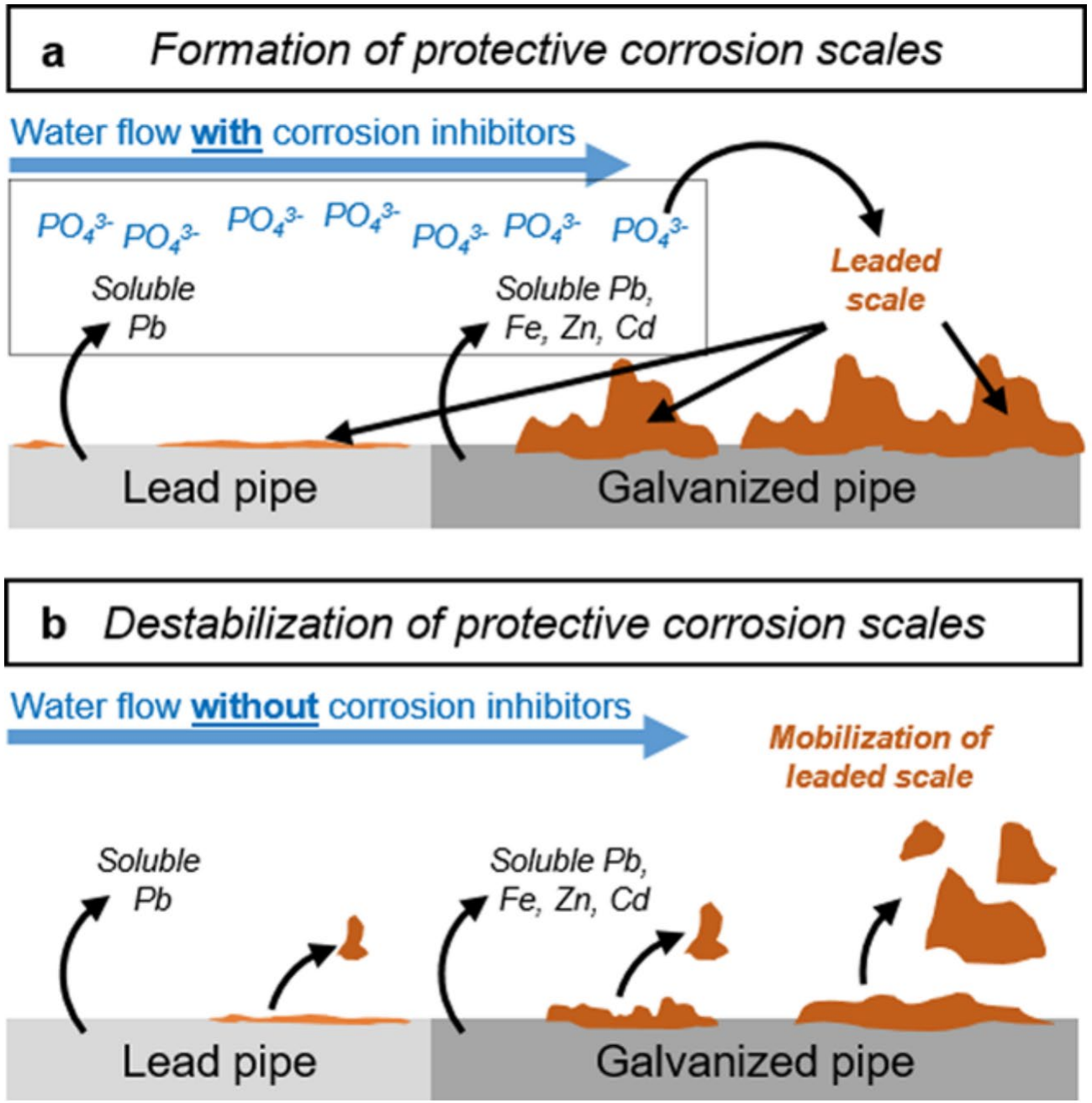


No Orthophosphate Corrosion Inhibitor

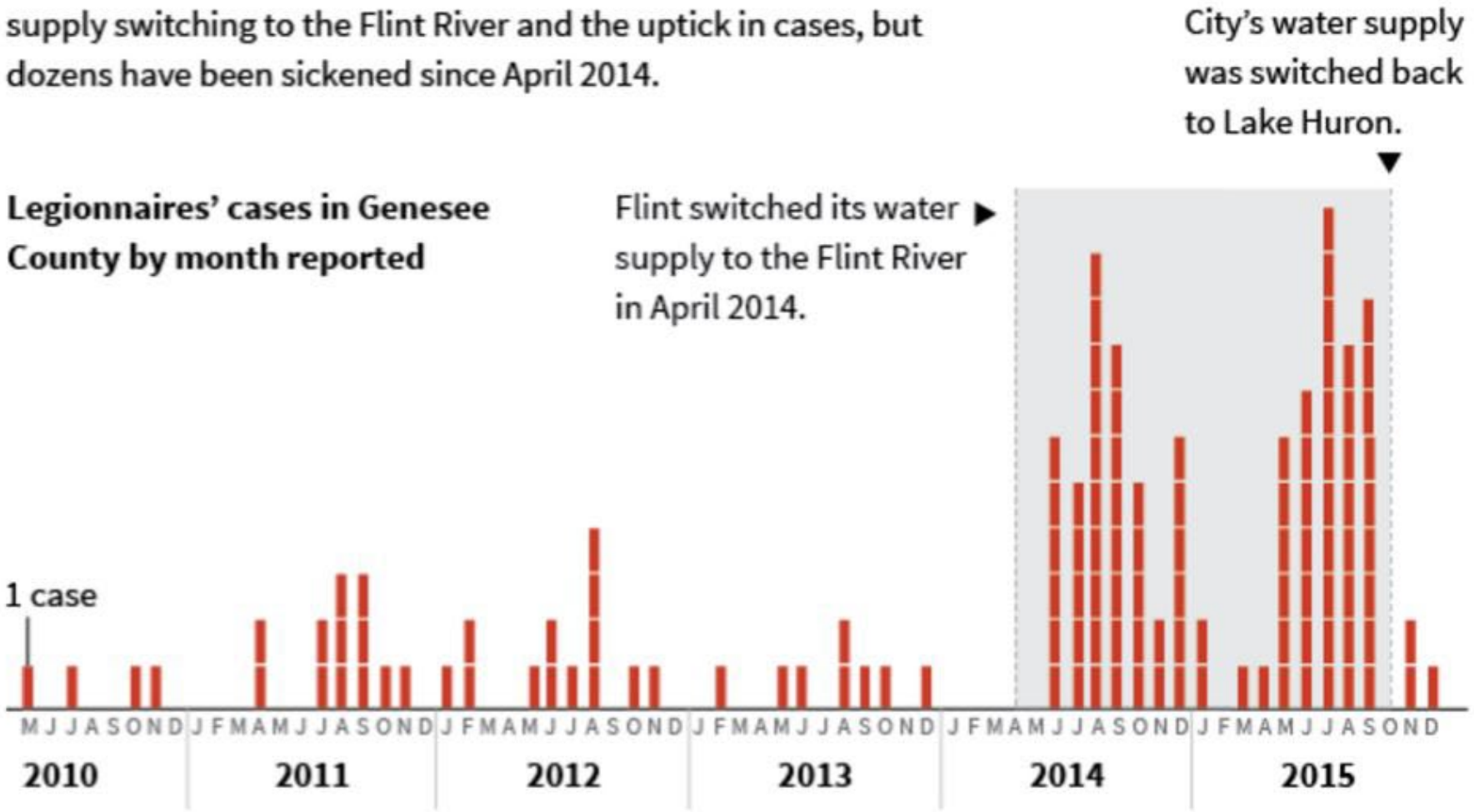
Iron scale release

Along with some other things (i.e. lead, biofilm, etc)

Source: Kelsey J. Pieper, Min Tang, and Marc A. Edwards. (2017) Flint Water Crisis Caused By Interrupted Corrosion Control: Investigating "Ground Zero" Home. Environ. Sci. Technol. 2017, 51, 4, 2007–2014

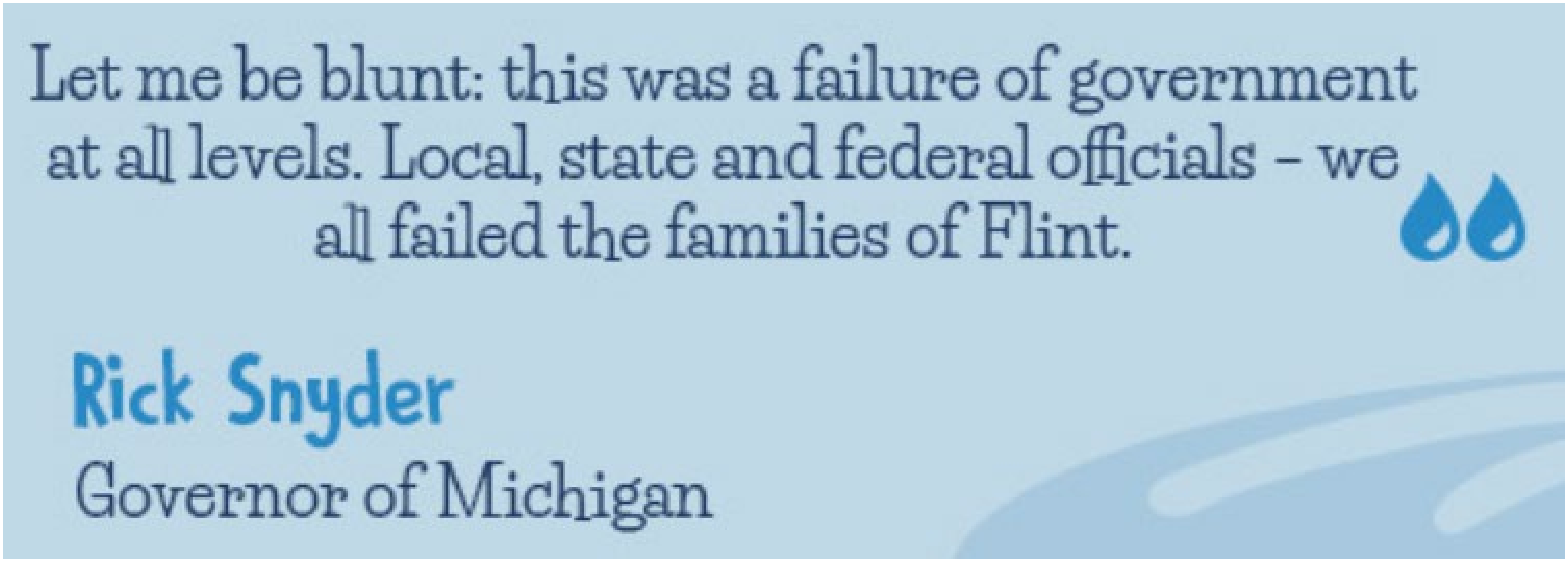
Legionella and *coliform*

No official link has yet been detected between the city's water supply switching to the Flint River and the uptick in cases, but dozens have been sickened since April 2014.



Note: Monthly case values are approximated for May/June 2015 and August/September 2015.

Source: Erin Schumaker, Huffington Post, Flint's Legionnaires' Outbreak May Be Tied To Its Contaminated Water. 1/19/2016



Source: https://infographicjournal.com/wp-content/uploads/2017/03/What-Can-We-Learn-From-The-Flint-Water-Crisis1.jpg

Longview Case Study

City of Longview

City

Downtown Longview

Location of Longview, Washington

Coordinates: 46°08'24"N 122°56'15"W

1. The Focused change
2. The System's reaction
3. The Engaged Response

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The Change


"OLD" SURAFCE WATER PLANT
"NEW" GROUNDWATER PLANT
CONTROLLING SYSTEM STORAGE (11 MG)
ity of Longview Main Reservoirs
Fishers Lane (OLD Surface Water Plant)
Mint Farm WTP
Google Earth

Preparation

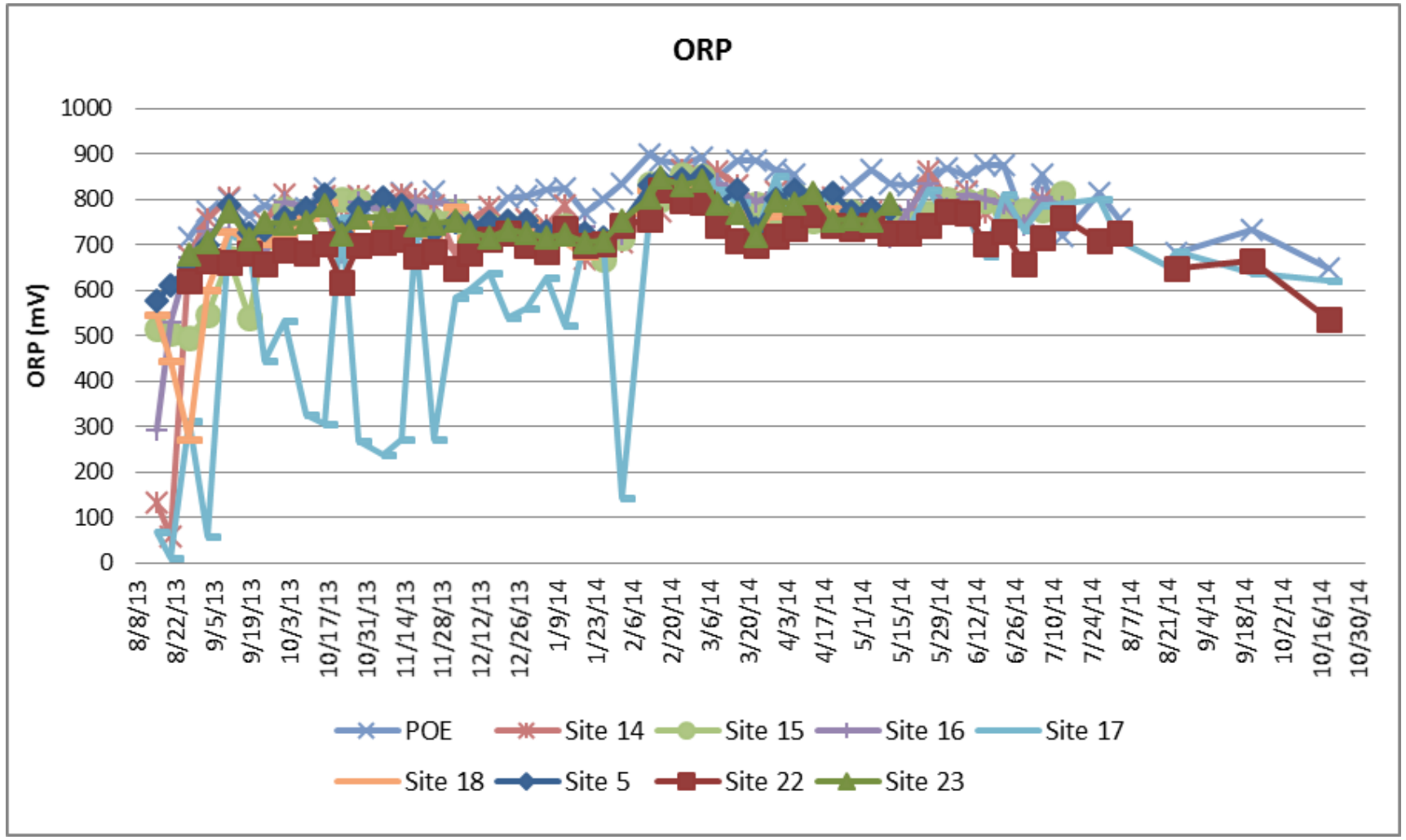
Expected Change	Mitigation
Flow Reversal	Hydraulic water modeling
	Aggressive advance bi-directional flushing
	Simulated flow-reversals
Increased Pressure	Monitored system pressure using data loggers
	Hydraulic water modeling
	Replaced most vulnerable mains
Source Change	Implemented rapid transition to minimize mixing
	pH adjustment to match water chemistry
	Water storage reservoirs cleaned
	Community outreach
	Tracking - Citizen Sentinels recruited

The Source Switch

- Water Quality Complaints began ~3 months after start-up
- Zero chlorine residual in area of town with old CI mains
- City response:
  - Spot flushing
  - No positive coliform tests
  - Only secondary MCL's exceeded
  - Area flushing
  - Ice pigging
- Retained Confluence Engineering

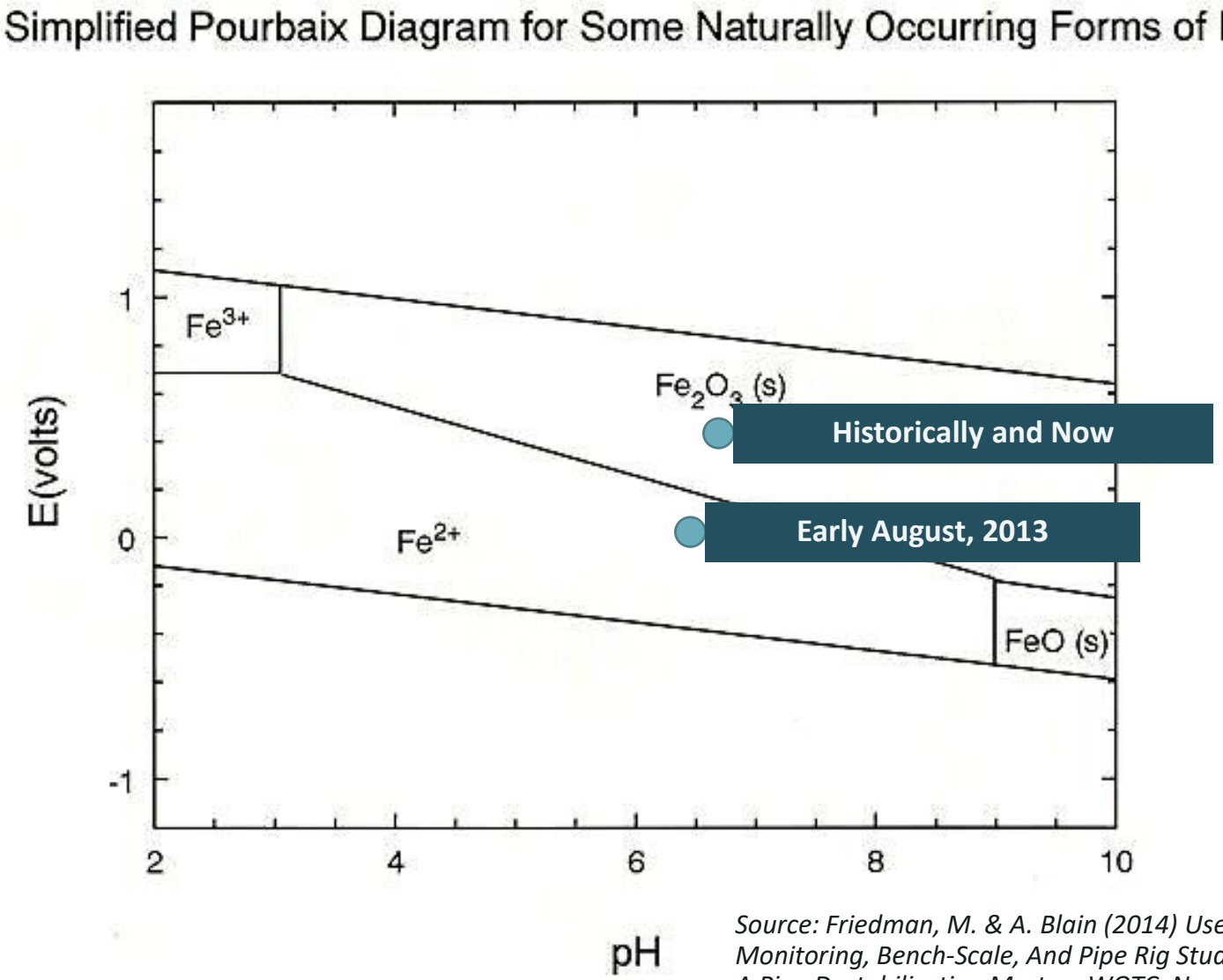
Source: Blain, A. & M. Friedman (2014) Dealing With Major Water Quality Challenges After A Source Changeover. WQTC, New Orleans, LA

An Engaged Response
Major Monitoring Effort: Change in Oxidation-Reduction Potential in the system



Source: Friedman, M. & A. Blain (2014) Use of Monitoring, Bench-Scale, And Pipe Rig Studies To Solve A Pipe Destabilization Mystery WQTC, New Orleans, LA

Chemical Destabilization

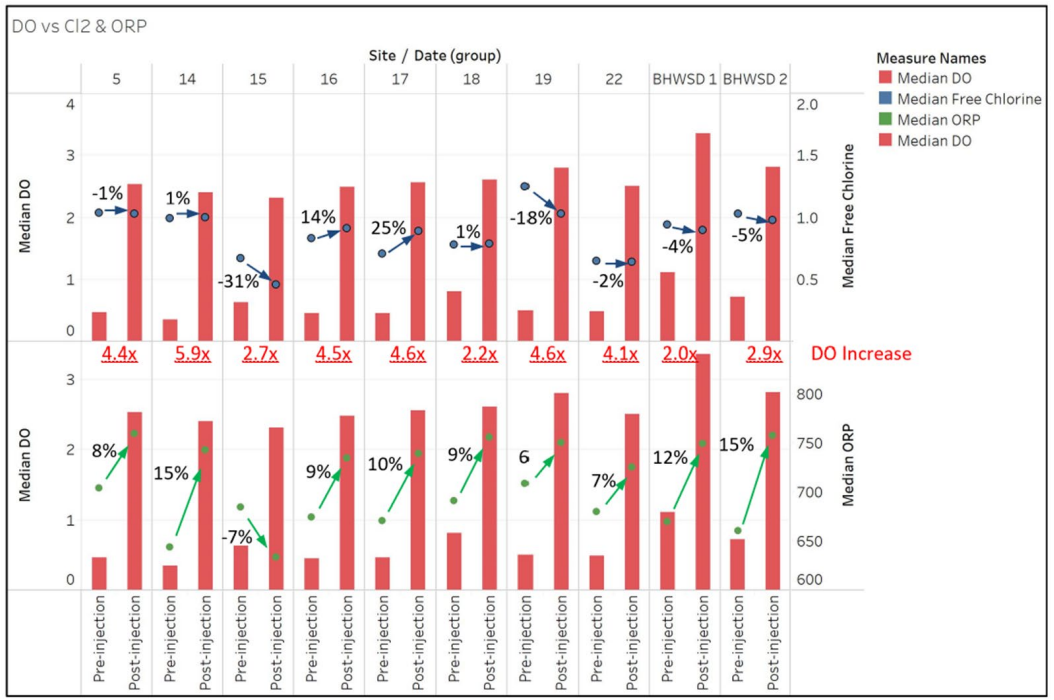


- Challenges at start-up with establishing a consistent chlorine residual
- Groundwater – No Dissolved Oxygen – negative ORP
- Water age issues – loss of chlorine residual
- Reducing Conditions
- Destabilization of iron scales

Source: Friedman, M. & A. Blain (2014) Use Of Monitoring, Bench-Scale, And Pipe Rig Studies To Solve A Pipe Destabilization Mystery WQTC, New Orleans, LA

An Engaged Response

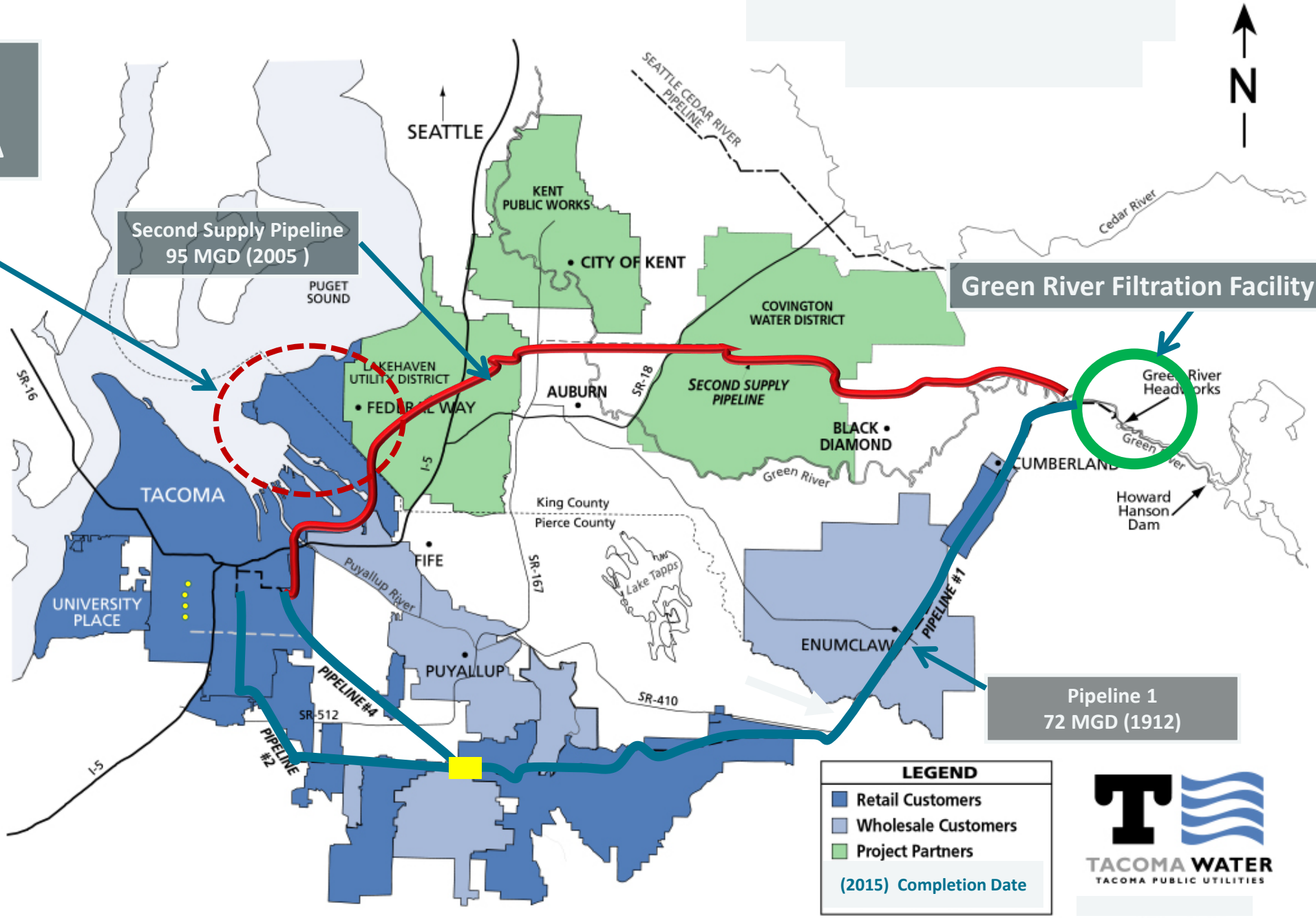
- Added an air injection system to augment ORP
- Complete an analysis of reservoir mixing & chlorine management in the primary reservoirs
- Investing in the first phase of mixing improvements
- Continued long-term monitoring
- Designing long-term transmission system improvements
- The system has been stable!



Median DO, Chlorine, and ORP in Distribution System Samples (1/2017 – 11/2020)

Tacoma Case Study

NE TACOMA SERVICE AREA

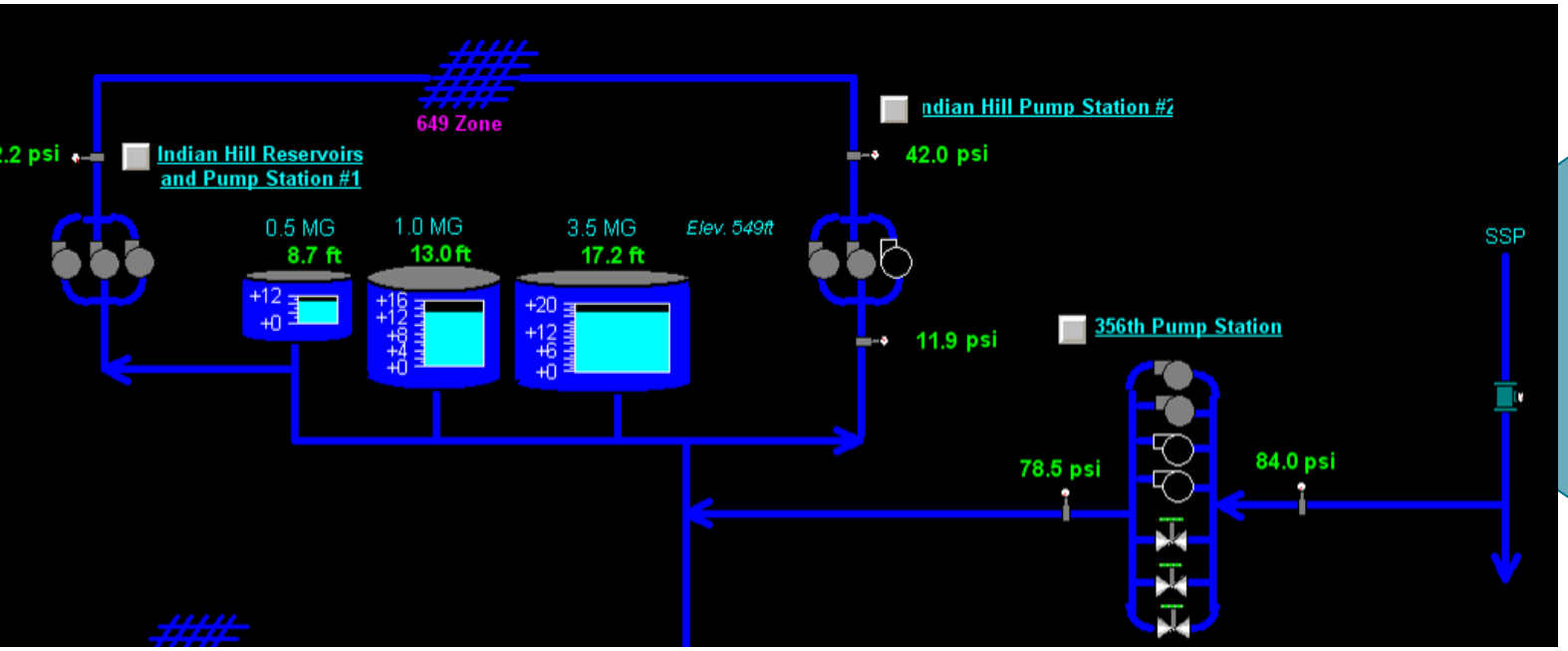


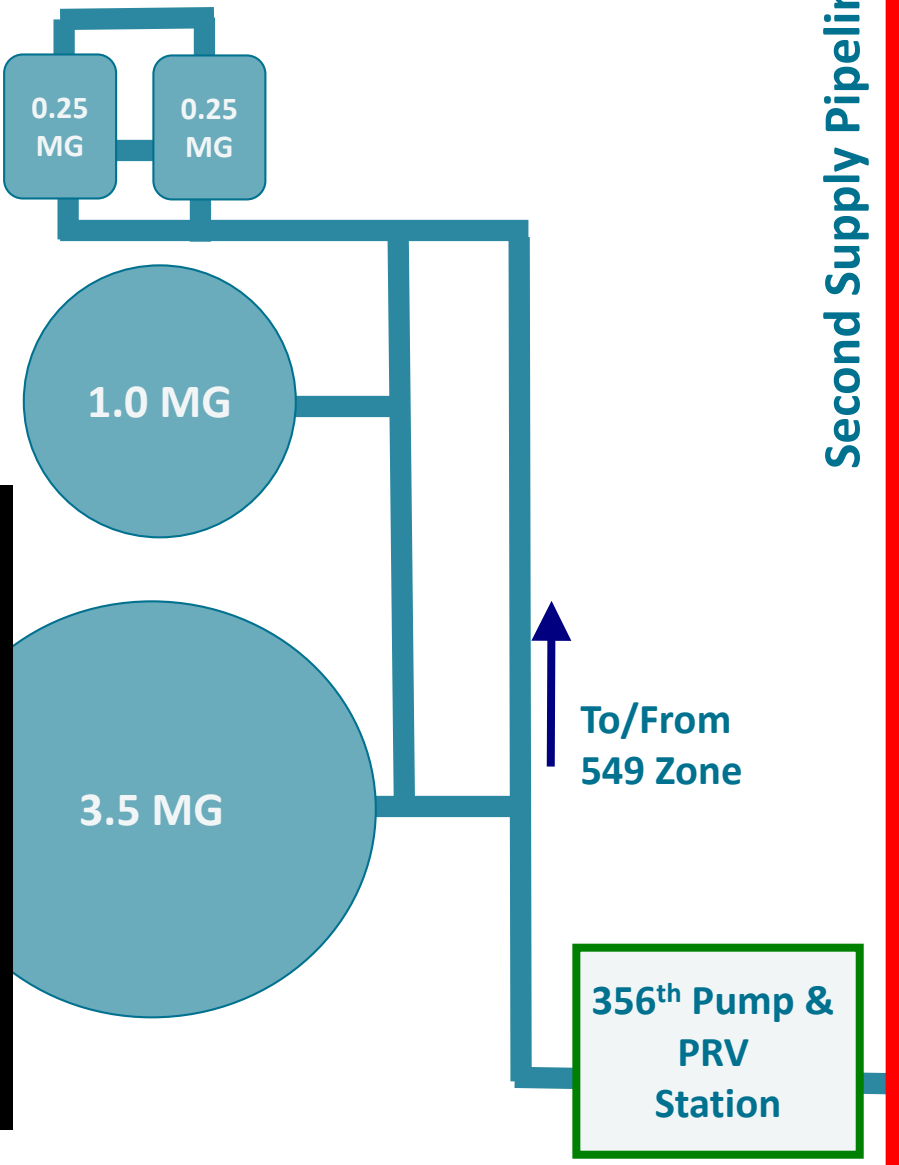

Indian Hills Reservoirs
Indian Hills Reservoirs
Second Supply Pipeline
95 MGD (2005)
356th Pump Station
Image Landsat / Copernicus
Google

Indian Hills Reservoirs & 356Th Pump Station

Indian Hills Reservoirs

- Located in NE Tacoma
- Controlling Reservoirs for 356th Pump Station (supplied by Second Supply Pipeline)
- These tanks "float" on the 549 zone





Indian Hills Reservoirs
Fall 2007

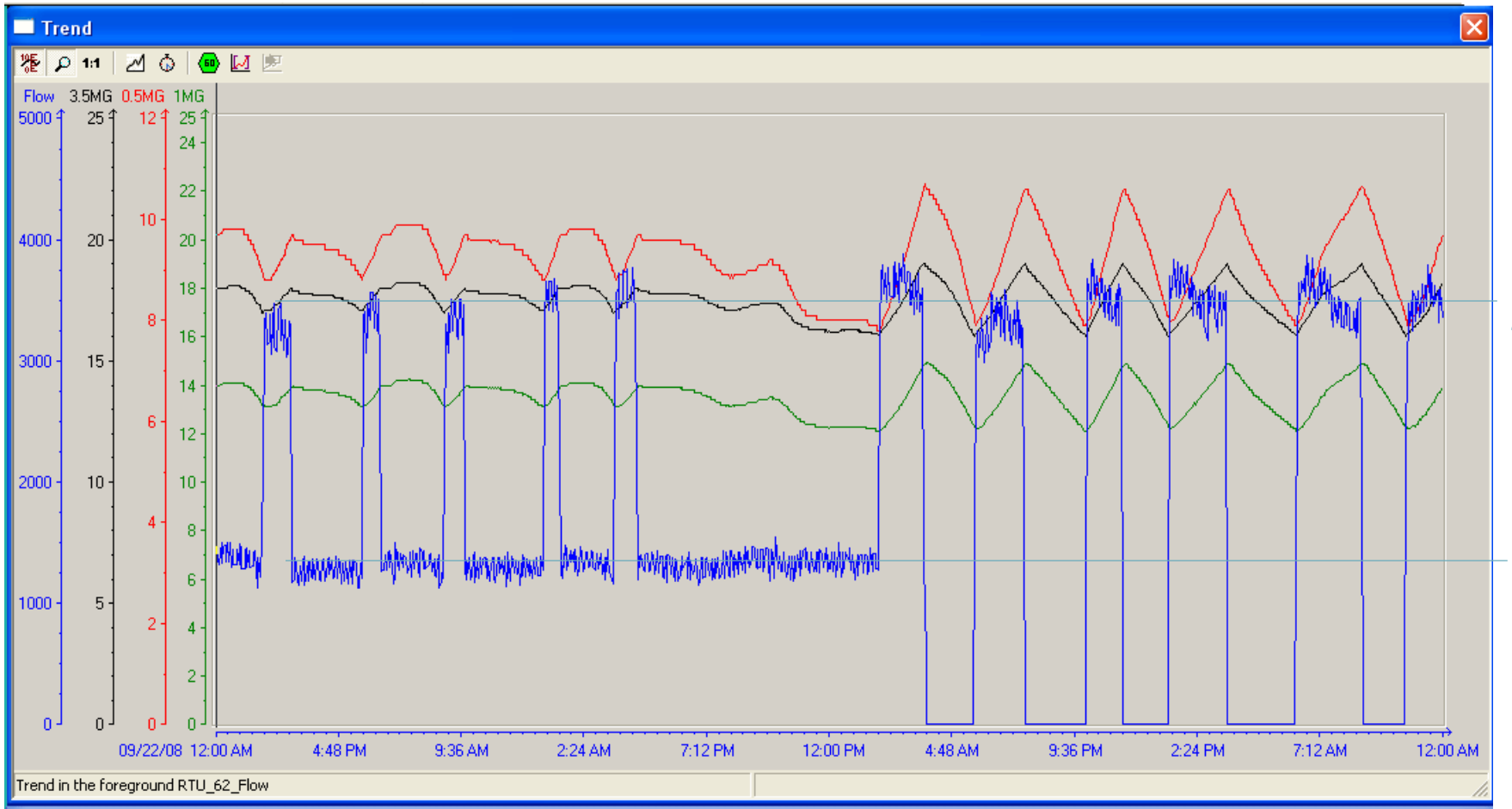
Low Chlorine Residuals were noted in portions of NE Tacoma in October 2007.

Chlorine residuals were taken at various depths in each of the reservoirs:

- 3.5 MG Reservoir ranged from **0.04 mg/l** at top to **0.16 mg/l** at bottom
- 1.0 MG Reservoir ranged from **0.01 mg/l** at top to **0.03 mg/l** at bottom
- 0.25 MG Reservoirs ranged from **0.02 mg/l** at top to **0.23 mg/l** at bottom.

What is happening in the Zone?

356th Pump Station Flow and Reservoir Levels Week of September 22, 2008



Trend

Trend	Tag Connection	Value	Date/Time
Flow	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_62_Flow	1467	09/21/08 11:59:37.125 PM
3.5MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_35MG	18.00	09/21/08 11:59:37.125 PM
0.5MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_05MG	9.70	09/21/08 11:59:37.125 PM
1MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_10MG	14.00	09/21/08 11:59:37.125 PM

HIGHER FLOW FILL RATE
~ 3,500 GPM

LOWER FLOW FILL RATE
~ 1,400 GPM

Indian Hills Trending Analysis
Chlorine - Week of September 22

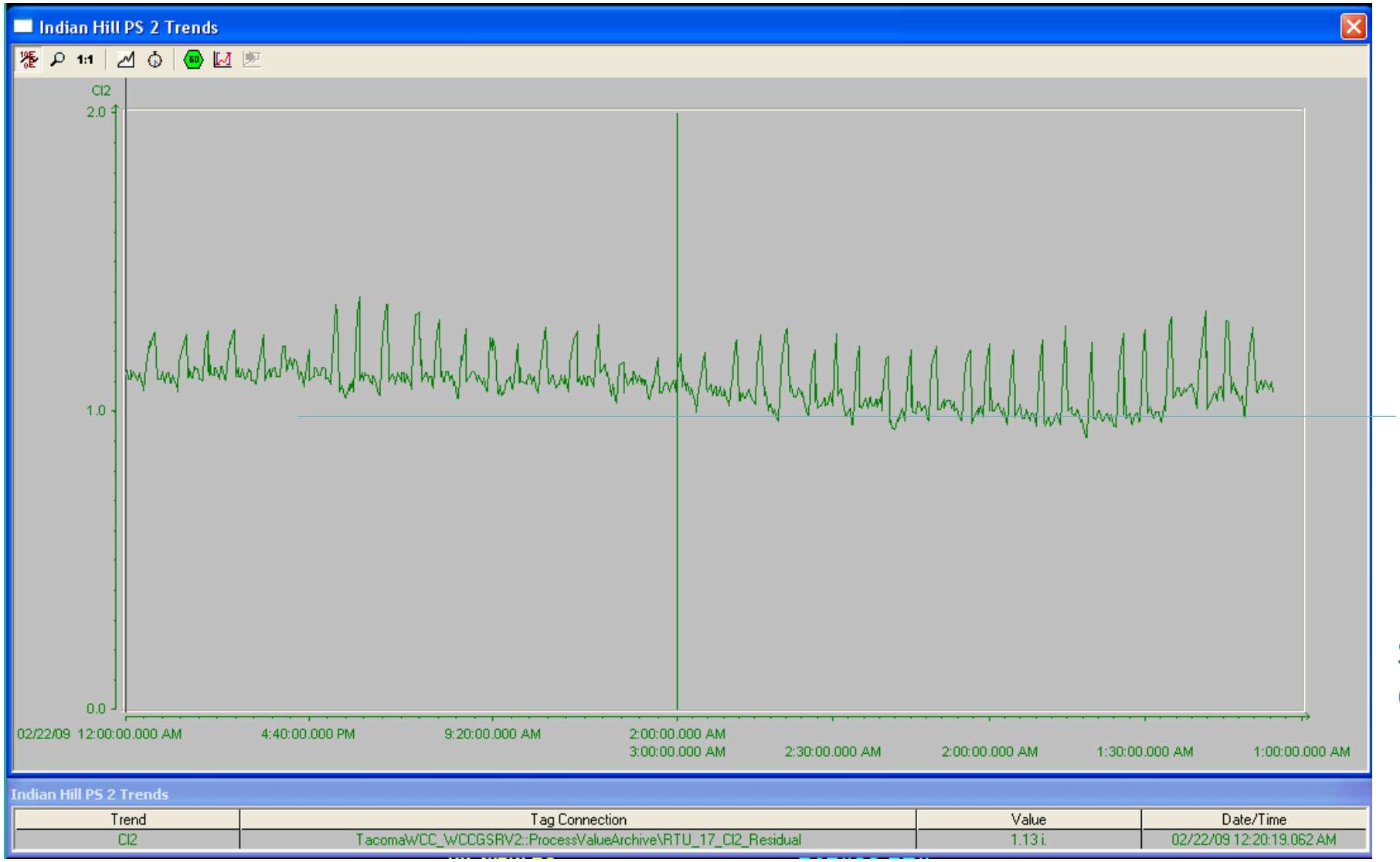
356th Pump Station Flow and Reservoir Levels (Post-Change)

Trend

Trend	Tag Connection	Value	Date/Time
Flow	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_62_Flow	0	03/14/09 11:59:44.343 PM
3.5MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_35MG	17.10	03/14/09 11:59:44.343 PM
0.5MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_05MG	8.90	03/14/09 11:59:44.343 PM
1MG Res	TacomaWCC_WCCGSRV2::ProcessValueArchive\RTU_17_Level_10MG	13.15	03/14/09 11:59:44.343 PM

CONSISTENT AND SUSTAINED HIGHER FLOW FILL RATE
~ 3,500 GPM

Indian Hills Reservoirs Chlorine (Post-Change)



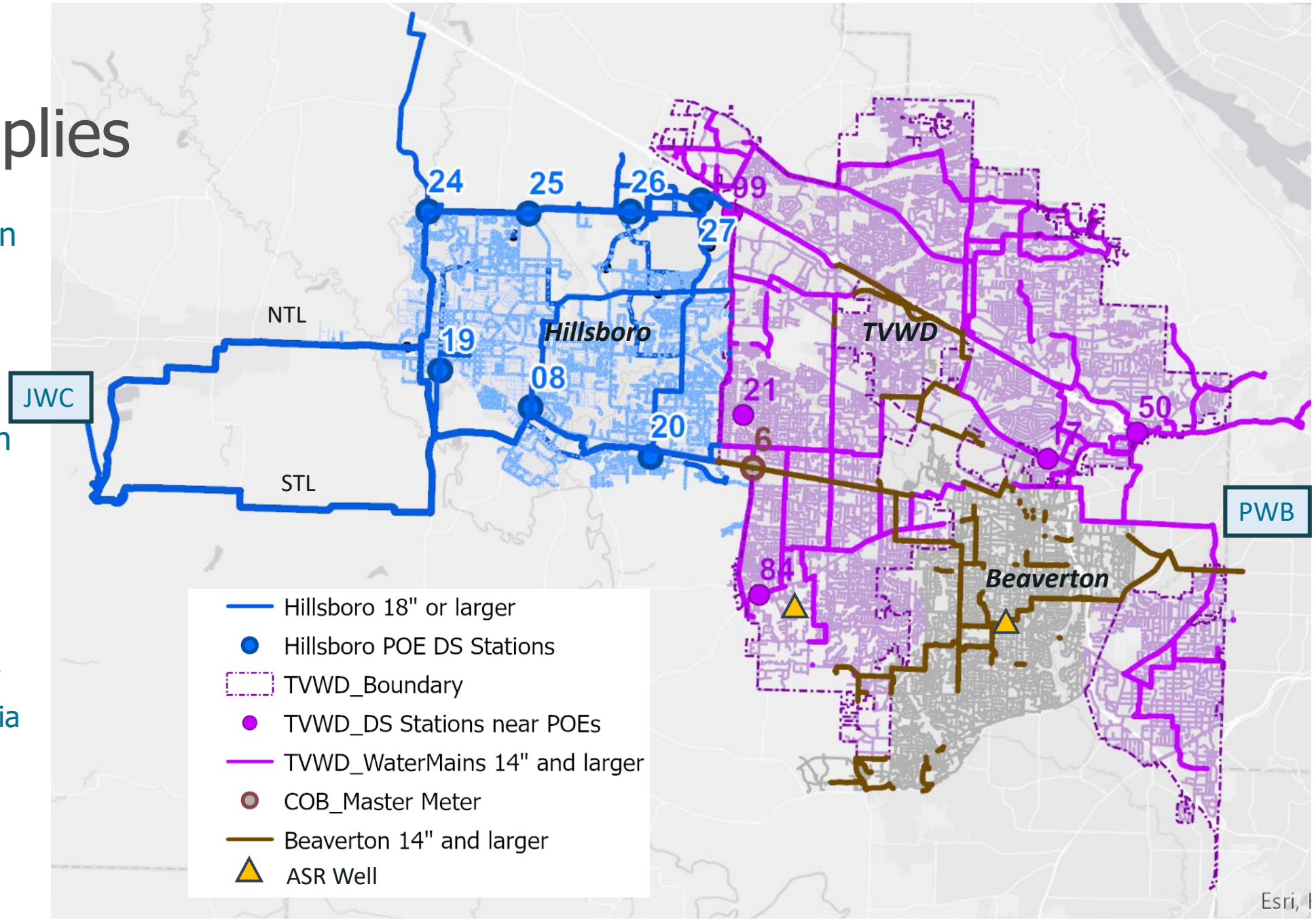
MORE CONSISTENT AND HIGHER CHLORINE RESIDUAL ~ 1 MG/L

MODIFYING OPERATIONAL SETPOINTS IMPROVED WATER QUALITY

Willamette Water Supply System

Partners & Existing Supplies

- Joint Water Commission WTP (JWC WTP)
  - Conventional WTP
  - Free chlorine
- Aquifer Storage & Recovery (ASR) wells in Beaverton and TVWD
  - Free chlorine
- Portland Water Bureau (PWB) supplies TVWD
  - Bull Run unfiltered surface water supply
  - South Shore Columbia Well Field
  - Chloramines



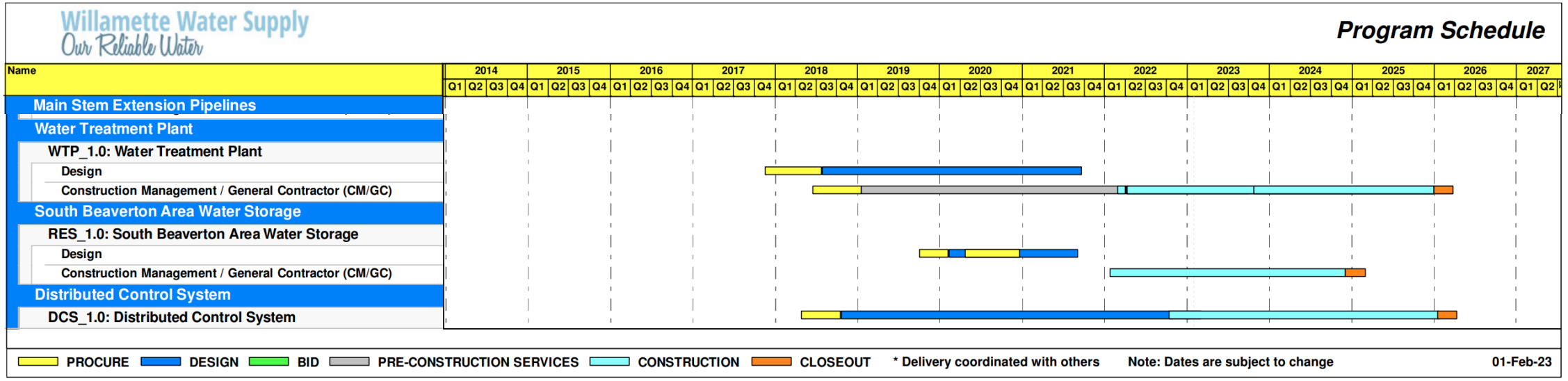
Willamette Water Supply System (WWSS) Overview

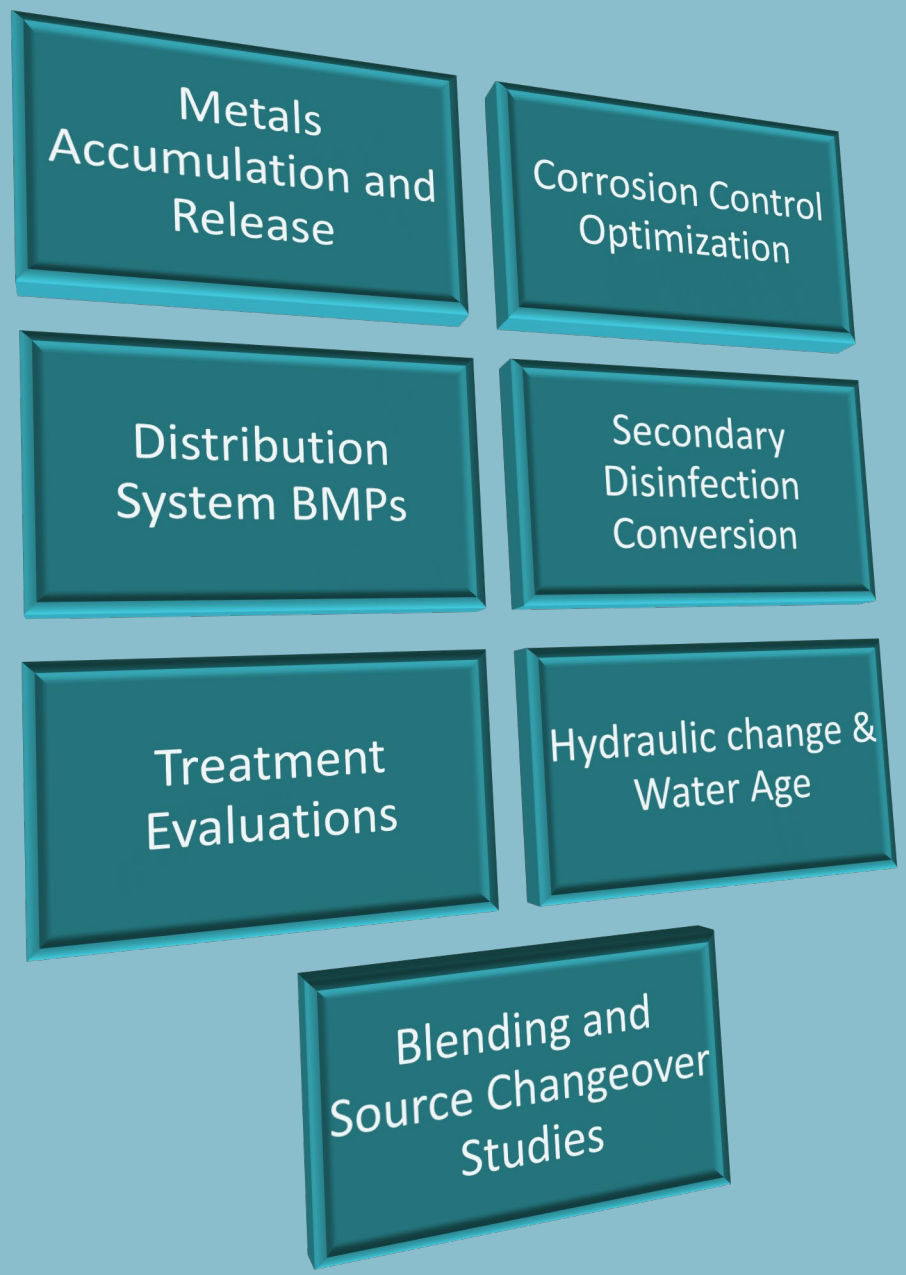
1. Willamette River intake, located in Wilsonville
2. New state-of-the-art water treatment plant
3. 30+ miles of large diameter transmission pipeline
4. Water storage tanks

Willamette River flows north from Eugene to the Columbia River.

What is the Water Supply Integration Project?

- Analysis, Planning & Preparation for integration of the WWSS
  - Prepare existing systems to receive water from the WWSS
  - Integrated with the new Water Treatment Plant design project
  - Identify potential need for distribution system modifications/operations
  - Support for development of effective customer communications
  - Protect public health through and after transition to new supply





….No Stone Unturned…

- Chemistry
  - pH, alkalinity and corrosion control
  - Microbiological management
  - Chlorine chemistry, and conversion from chloramines
- Hydraulics (In collaboration with Partners' Modelers)
  - Mixing
  - Water Age
  - Flow direction and velocities
- Communication
  - Blue Ribbon Panel
  - Technical and Community-Focused Planning

Water Supply Integration Project Goals

- Establish finished water quality
- Assess compatibility and blending
- Define system preparation needs
- Develop the integration schedule

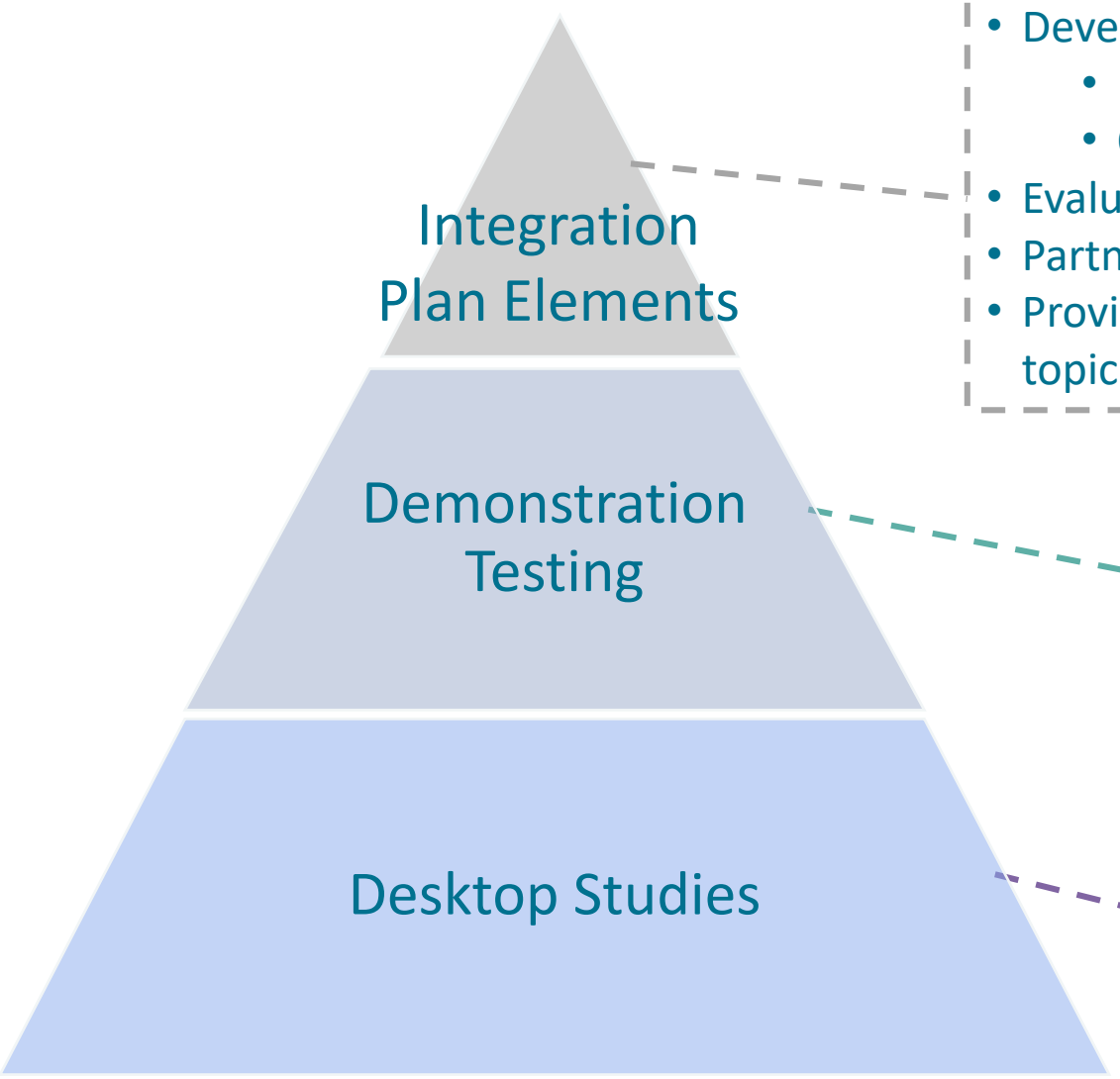
Incorporate
the new water supply
seamlessly and safely

- Uneventful integration is key to overall WWSS success

Internal & Outside Experts Inform Integration Plan

- WWSP's Subject Matter Experts
- Confluence Engineering Group
- Blue Ribbon Panels

Water Supply Integration Process



- Develop Program and Partner-specific:
  - Integration Risk descriptions
  - Operations & Maintenance Roadmaps
- Evaluate specific changes, like chloramine to chlorine conversion
- Partners developing and implementing system preparation activities
- Provide Technical Communications information for use in developing topic or area-specific customer outreach

- Combination of bench-scale tests and field trials
- Chlorine demand/decay and DBP testing
- Flushing trials or other main cleaning tests

- Understand the existing systems and supplies
- Perform blending analyses
- Perform chemical equilibria modeling
- Review main cleaning practices
- Evaluate future system hydraulics and anticipated changes

Consider the System

- Engage all the right people
- Analyze system-wide, thoroughly and follow-through
- Complex decisions require tradeoffs – just be fully informed
- Avoid the inconvenience, or….crisis

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Consider the System

Change:	Existing Source - New Treatment
Consider:	Source Water Chemistry: Compatibility, variability, blending & transition process. Impacts to established, stable chemistry and biofilms
	Process treatment chemistry (both "involved" parameters and seemingly uninvolved; e.g. Chloride or sulfate removal)
	Treatment Process Alternatives: Consider more than "in plant" impacts only
	Inorganic contaminant removal and behavior (iron, manganese and aluminum)
	Distribution system preparation (UDF, Swabbing, hydraulics, renewal)
Change:	**New Source Introduction**
Consider:	Likely with Treatment - so All of the Above
	New points of introduction to transmission / distribution
	Impacts to storage dynamics (mixing, water age)
	Impacts to transmission / distribution dynamics (flow patterns, stagnation zones)
	Prepare the distribution system (UDF, Swabbing, hydraulics, renewal)

Consider the System, *continued*

Change:	New / Reconstructed Storage
Consider:	Sizing with water quality in mind
	Water Turnover
	Internal Mixing, determine if augmented mixing needed
	Assess need for, and/or impacts from rechlorination (DBPs)
	Transmission / Distribution network
	System redundancy factors
	Reexamine pump sequence/operations
	Analyze current operational monitoring (augment, automate, status quo)
Change:	**New/Reconstructed Pump Station**
Consider:	Economic operating efficiency
	Impacts to Storage Fill/Draw
	Changed flow patterns & velocities (both high and low)
	Pressure transients
	Distribution system preparation (UDF, Swabbing, hydraulics, renewal)

Acknowledgments:

Coauthors

Operators Everywhere who live the pain of our errors

Consider the System

Chris McMeen, PE, WDM4,WTPO4

Chris@confuence-engineering.com

Thank You!

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