Mining your water quality data can be golden

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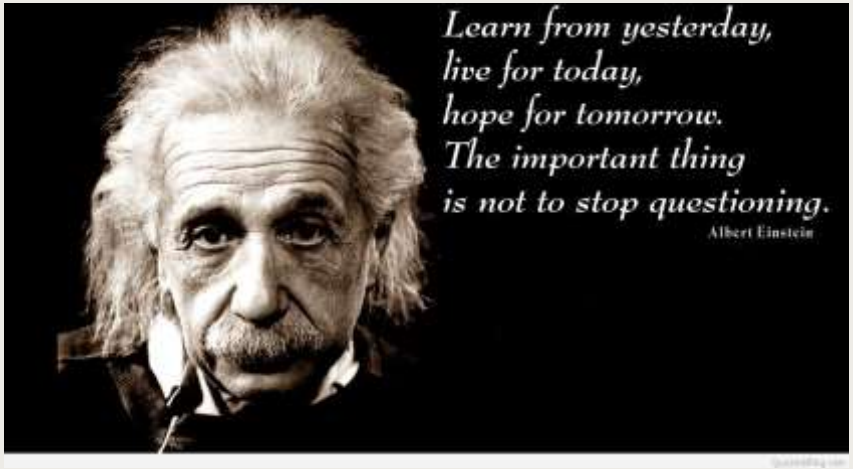
To Much and Too Little Data

Not everything that can be counted counts, and not everything that counts can be counted.

- ← Corollary for environmental monitoring →
- Not everything that can be measured is worth measuring, and not everything worth measuring is measurable.



Data Analysis

Truth Statement: When you change the way you look at things the things you look at change…

- ← Corollary for water systems →
- As we gather and analyze our plant and distribution system water quality data system operations may improve.
  - Water storage tanks – sanitary survey
  - Service line profiles for lead

Presentation Outline

- Benefits of an Enhanced Distribution System Water Quality Monitoring Program
- Partnership for Safe Water
- Relationship to the earlier presentation on smart infrastructure
- Relationship to distribution system corrosion
- Relationship of lead and copper
- Aqua PA case study

Benefits of an Enhanced Distribution System Water Quality Monitoring Program

A Monitoring Program may address:

- Internal corrosion of water mains that could impact main breaks
- Maintaining an adequate chlorine residual in all parts of the distribution system
- Discolored water
- Disinfection by-products
- Lead and copper

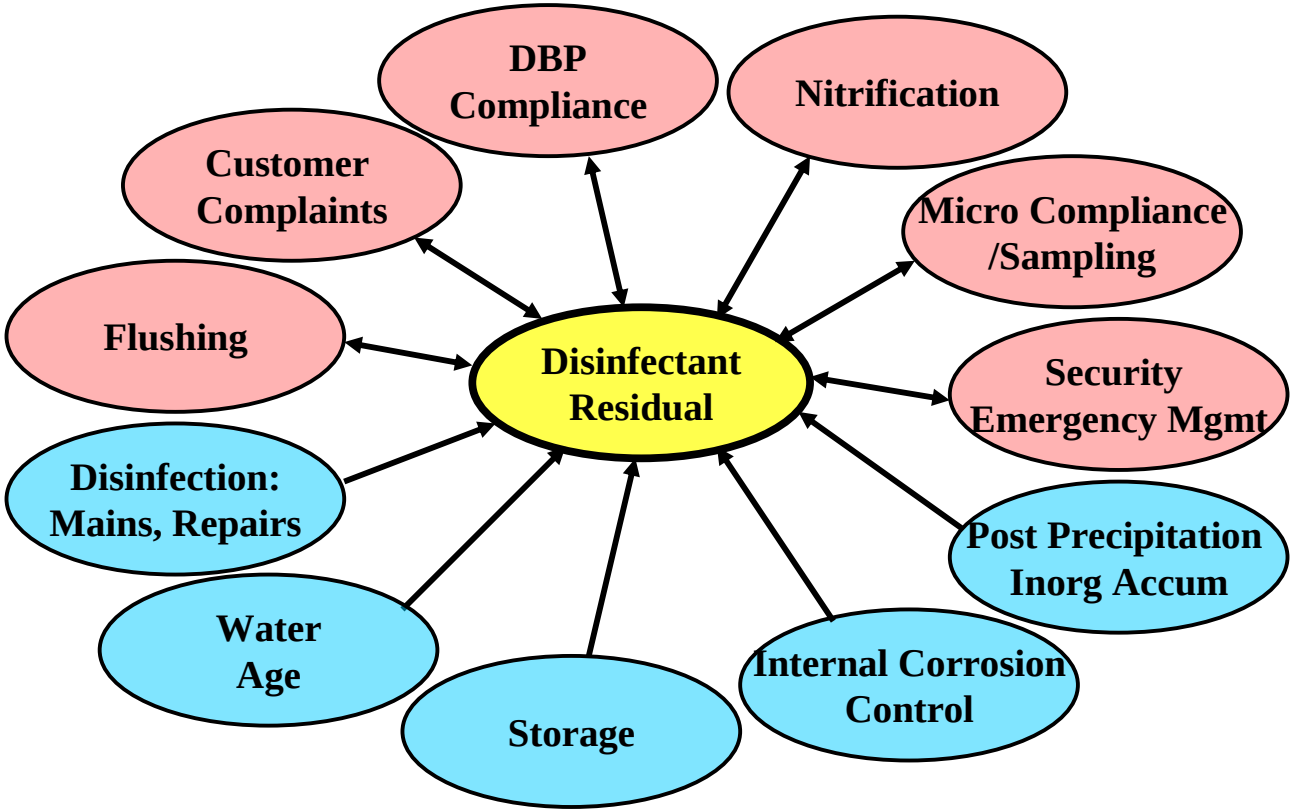
Partnership for Safe Water (PSW)

- Partnership for Safe Water mission:
  - To improve the quality of drinking water delivered to customers of community water systems by optimizing operations.

Partnership for Safe Water (PSW)

- Disinfectant Residual (>95% of meas.)
  - Free Chlorine: ≥ 0.20 and ≤ 4.0 mg/L
  - Total Chlorine: ≥ 0.50 and ≤ 4.0 mg/L
  - Chlorine Dioxide: ≥ 0.20 and ≤ 0.80 mg/L
- No consecutive residual measurements outside target concentrations at optimized routine sample locations
- Disinfection by-products within regulatory requirements

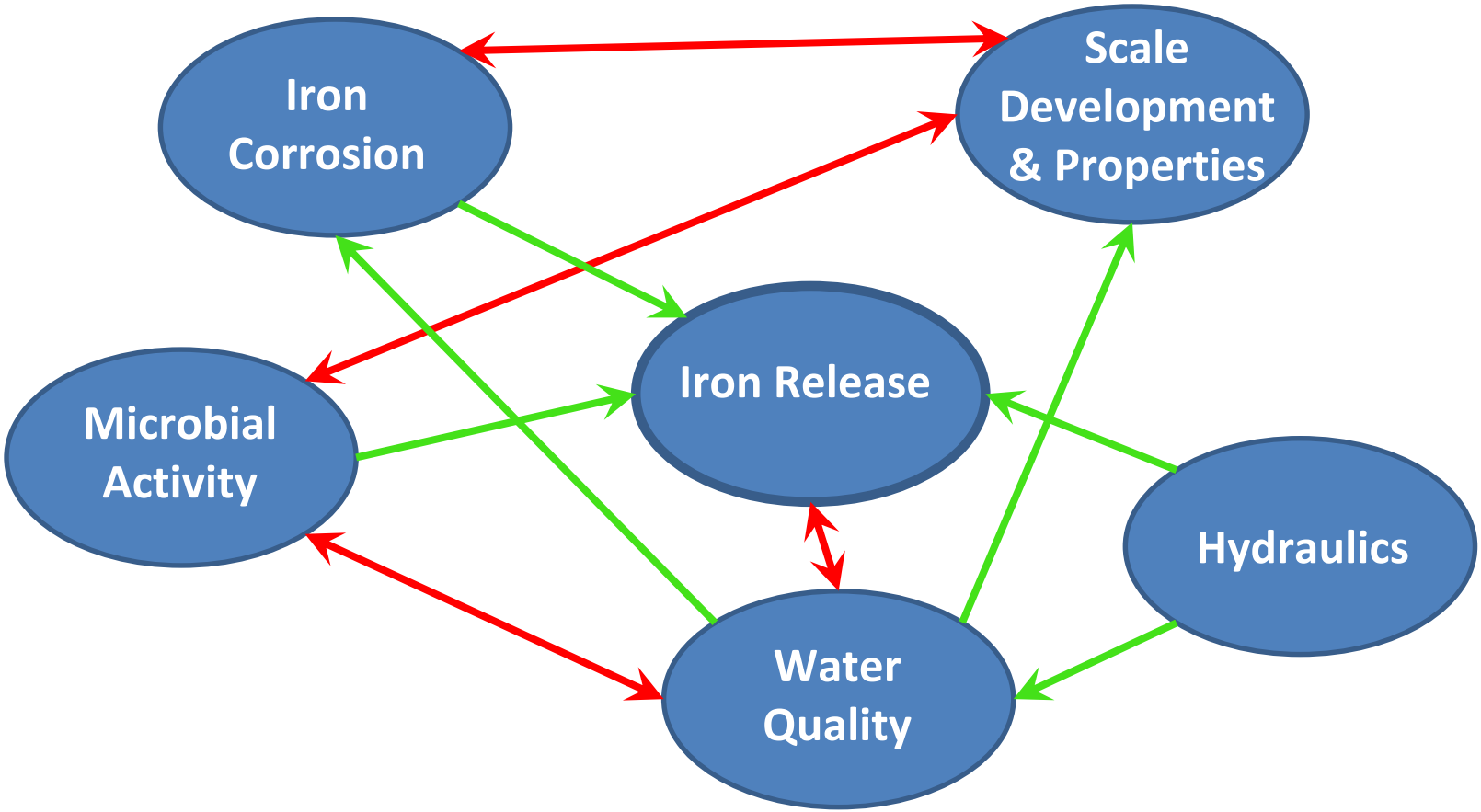
PSW Relationships



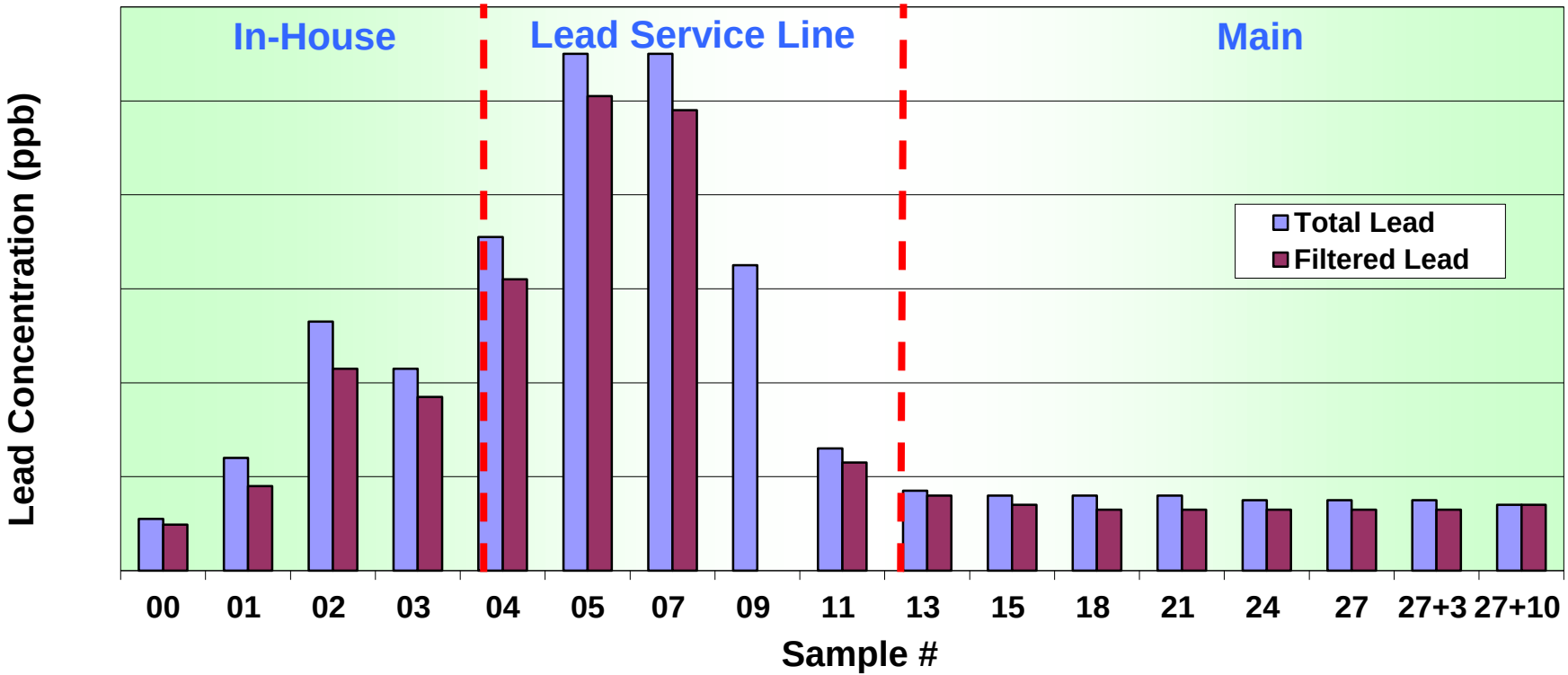
Smart Infrastructure

- Statistical analysis
  - Shewart control charting
- Source water monitoring
- Leveraging SCADA to provide intelligence

Distribution System Corrosion



Lead and Copper



Lead and Copper (continued)

- Distribution system data
- Lead and copper rule sampling does not tell entire story

Optimization Statement

Understanding distribution system data

- Large system & wealth of distribution system data – valuable information may be unutilized
- Data review practices tend to be fragmented among programs and management areas
- Comprehensive review by utility staff is difficult
- New state regulations expected to redefine disinfectant residual requirements

Case Study


1.
Problem statement / objective
2.
System overview – Aqua PA's Main Division dist. system
3.
Data mining – Information collected
4.
Observations and possible explanations for disinfection residual loss
5.
Data gaps, preliminary recommendations and initiatives
6.
Develop data visualization tools / establish review processes
7.
Findings and system improvements made to date

Main System Case Study

Matthew Miller

System overview

Large distribution network of Aqua PA's Main Division:

System overview

Large distribution network of Aqua PA's Main Division:

Serving approximately 300,000 connections

6

Surface water treatment plants

27

Active Wells

3400

Miles of pipes

48

Water storage tanks

74

Pressure zones

Objective:

Data management approach

- Synthesize available data
- Develop easily accessible and comprehensible information tools
- Generally improve distribution system understanding
- Facilitate best practices for chloramine residual maintenance

Data mining

Information collected:

Historical Water quality data

Plant laboratory data

Sampling results from regional surveys

Chloramine stability study results

SCADA data for storage tanks and wells:

- Tank levels
- Well flows
- Online Cl_2

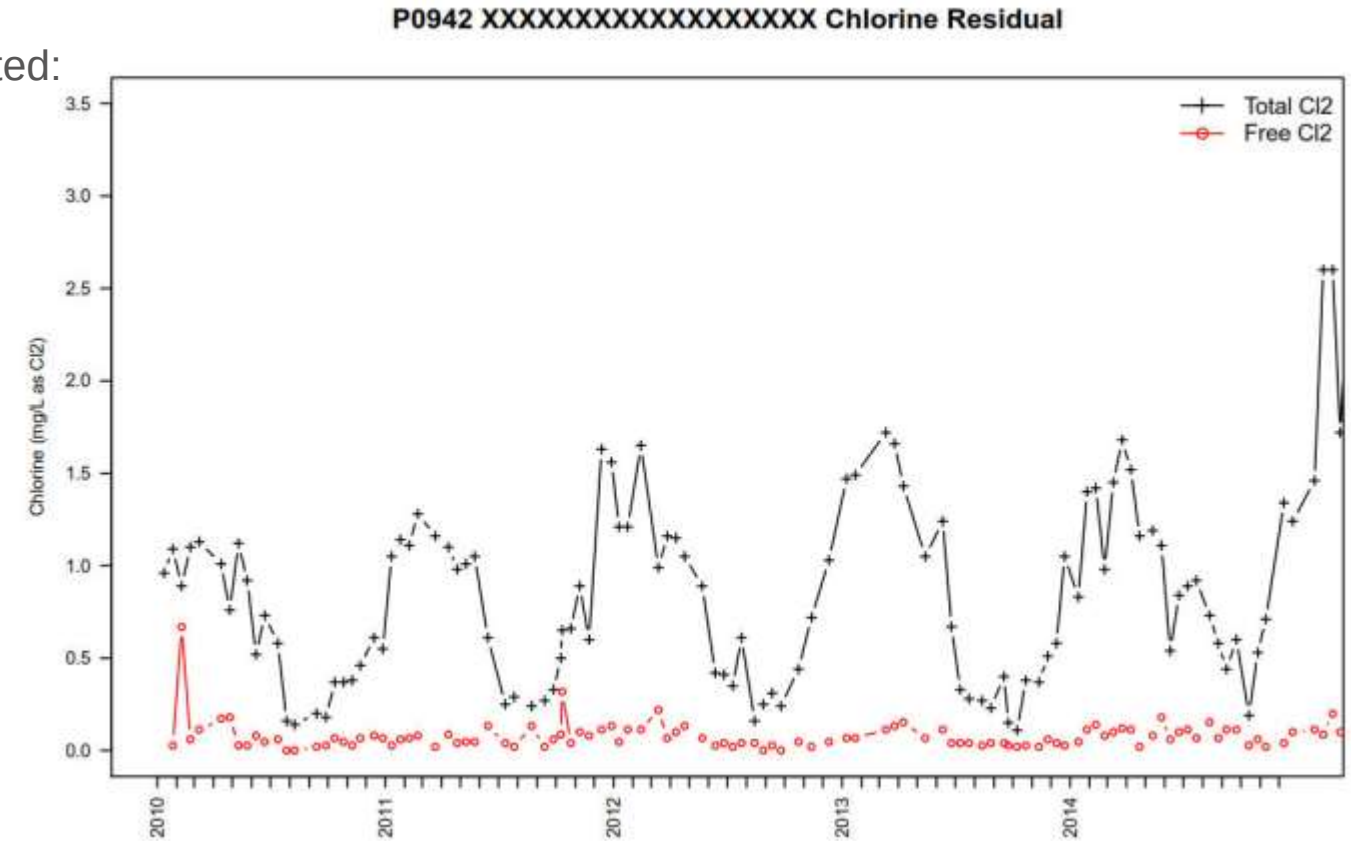
GIS tools and data

Facilities, production, and distribution system hydraulic modeling information

Data mining

Information collected:

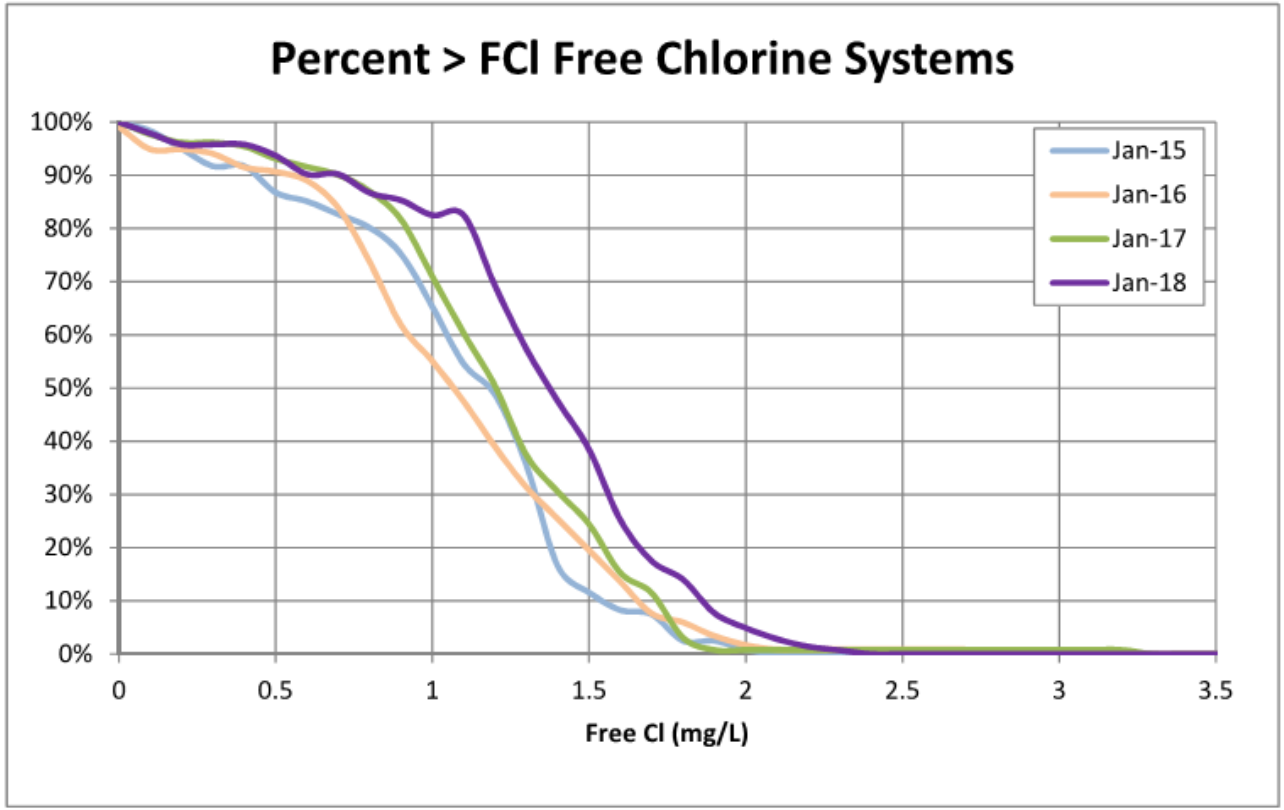
Distribution system monitoring site shows a seasonal pattern of chlorine residual loss



Data mining

Information collected:

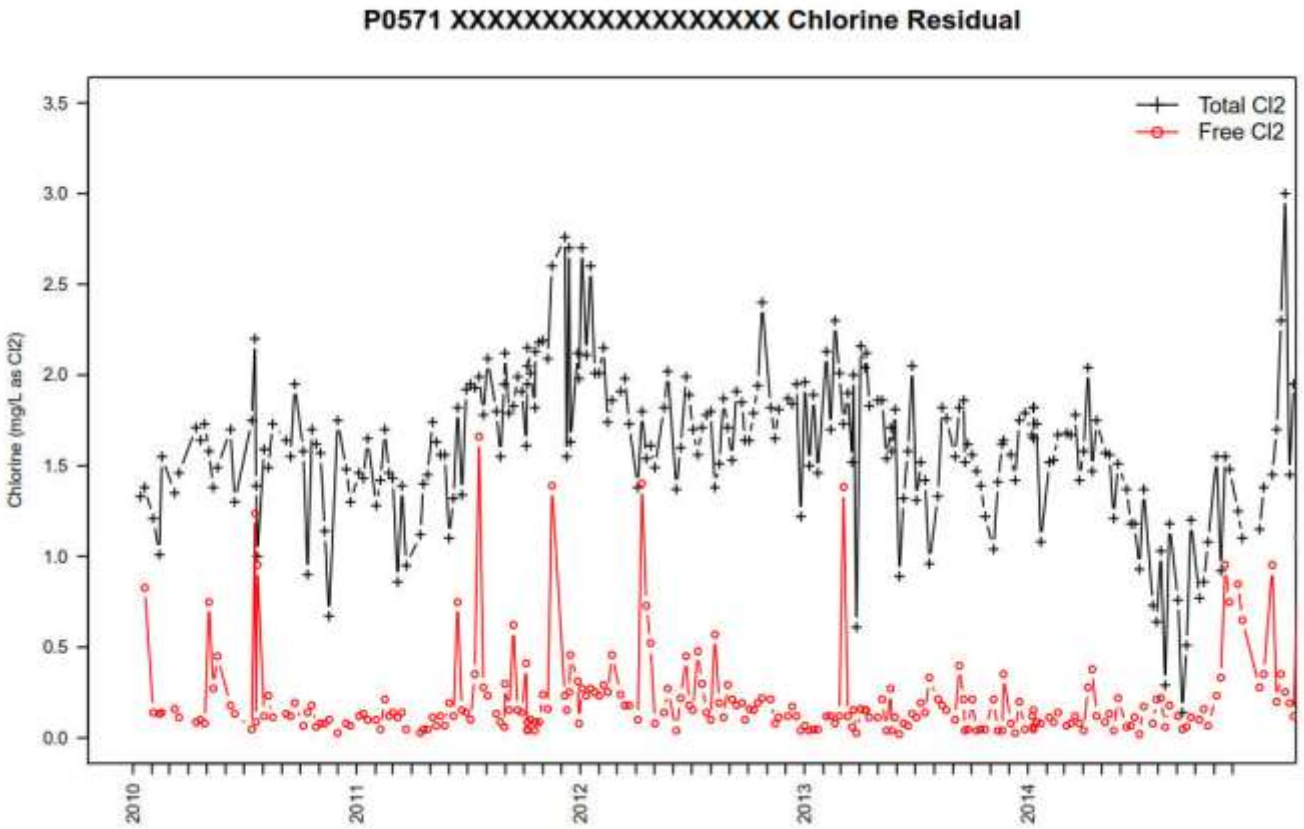
Percent of samples with free chlorine levels greater than a given value



Data mining

Information collected:

Simultaneous existence of free and combined chlorine at a sampling site may indicate blending and/or chloramine decomposition reactions in progress



Data mining

Information collected:

Report Card – water quality data

- # samples with total chlorine less than 0.2 mg/L
- # samples with free chlorine less than 0.2 mg/L
- # samples with nitrite detected (>0.05 mg/l)

SEPA WQ Report Card			January-18
RTCR WQ Data			Comments
Avg. Dist. Temp (C)			
Total Coliform Positive			
Chloramine Systems			
# TCl samples ≤0.2mg/L			
# Nitrite samples ≥0.05mg/L			
Free Chlorine Systems			
# FCl samples ≤0.2mg/L			
TOC Ratio at WTPs			
Lowest results for this month			

Data mining

Information collected:

Report Card (multiple locations):

- # of locations with low chlorine (entire year)
- DBP Data - # of samples over limit

DBP Data

1Q Schedule

Jan Quarterly Sampling:
Feb Quarterly Sampling:
Mar Quarterly Sampling:

Nov-17	TTHM	HAA	
No results over limit			
Jan-18	TTHM	HAA	
No results over limit			

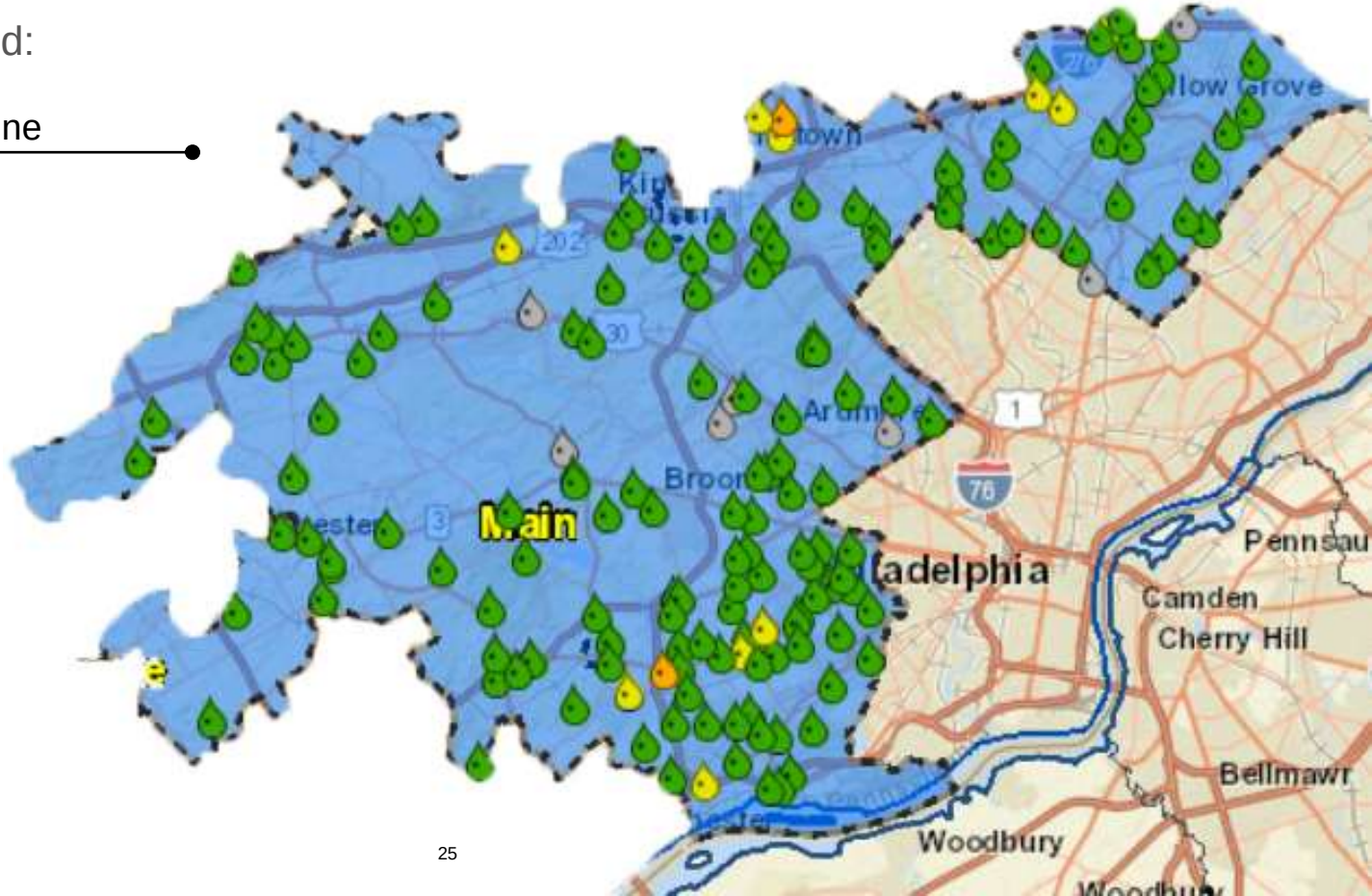
Data mining

Types of data collected:

GIS Map – Total Chlorine

Sample value range indicated by color

- TCL - No data
- TCL - < 0.15
- TCL - 0.15 ≤ x < 0.5
- TCL - 0.5 ≤ x < 1.0
- TCL - 1.0 ≤ x < 1.5
- TCL - ≥1.5
- Repeat Low TCL



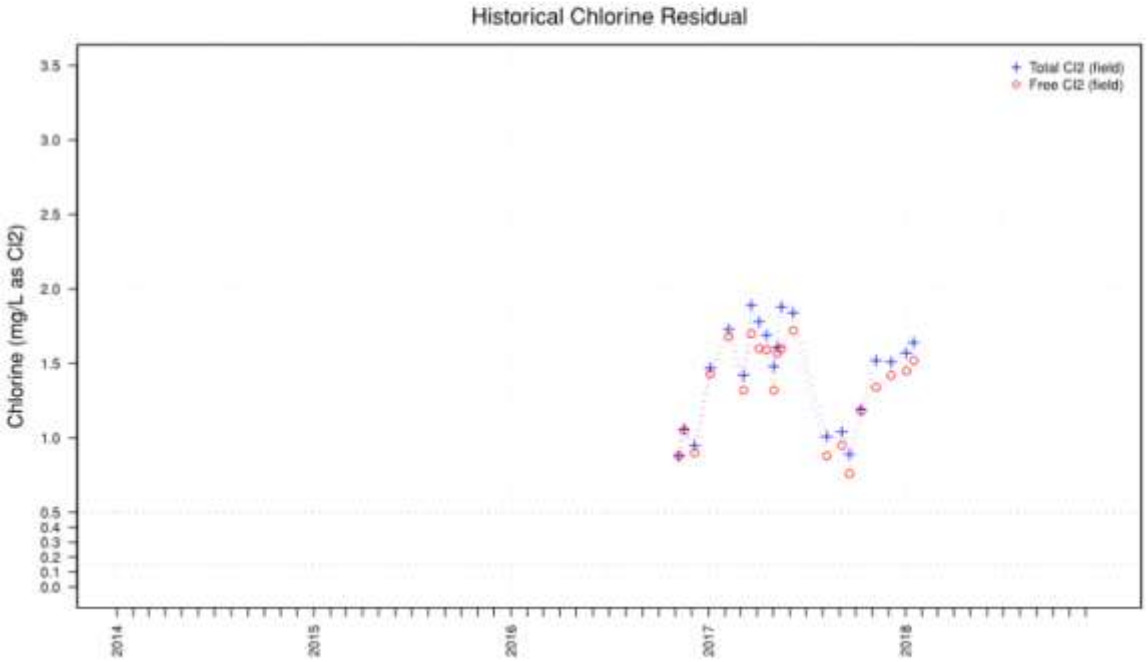
Data mining

Information collected:

GIS Data – by location

- Historic chlorine residual

PWS		Pipe Comments	
WQ Region			
Pressure Zone			
NP Code	Distribution_FCI	Premise #	
Typical Supply		Tap Serial #	
DEP Loc Type (ID#)			
Modeled Water Age	High (6–10 days)		
Pipe Material	DI		
Pipe Diameter (in)	12		
Pipe Install Date	2001		

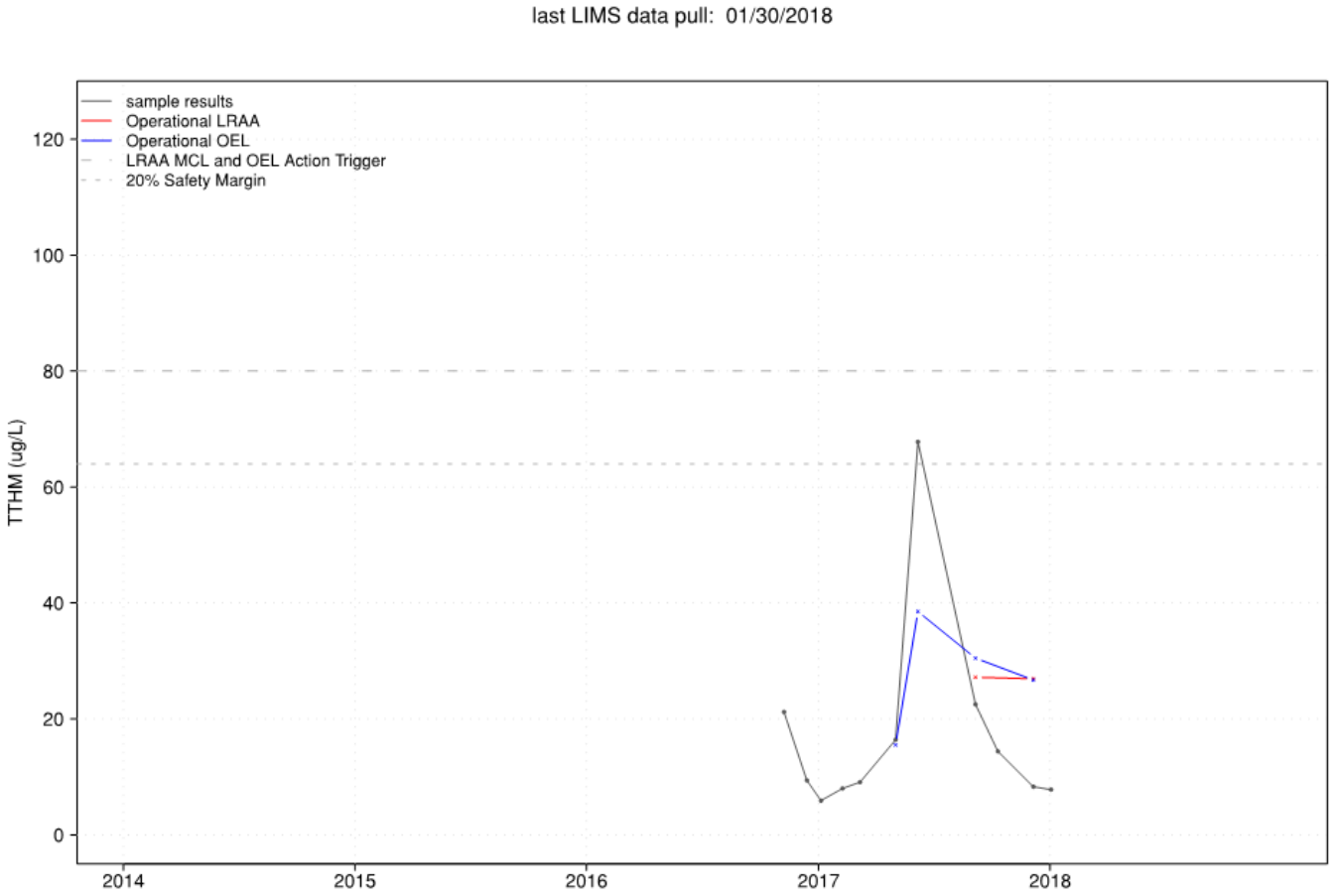


Data mining

Information collected:

GIS Data – by location

- TTHM results

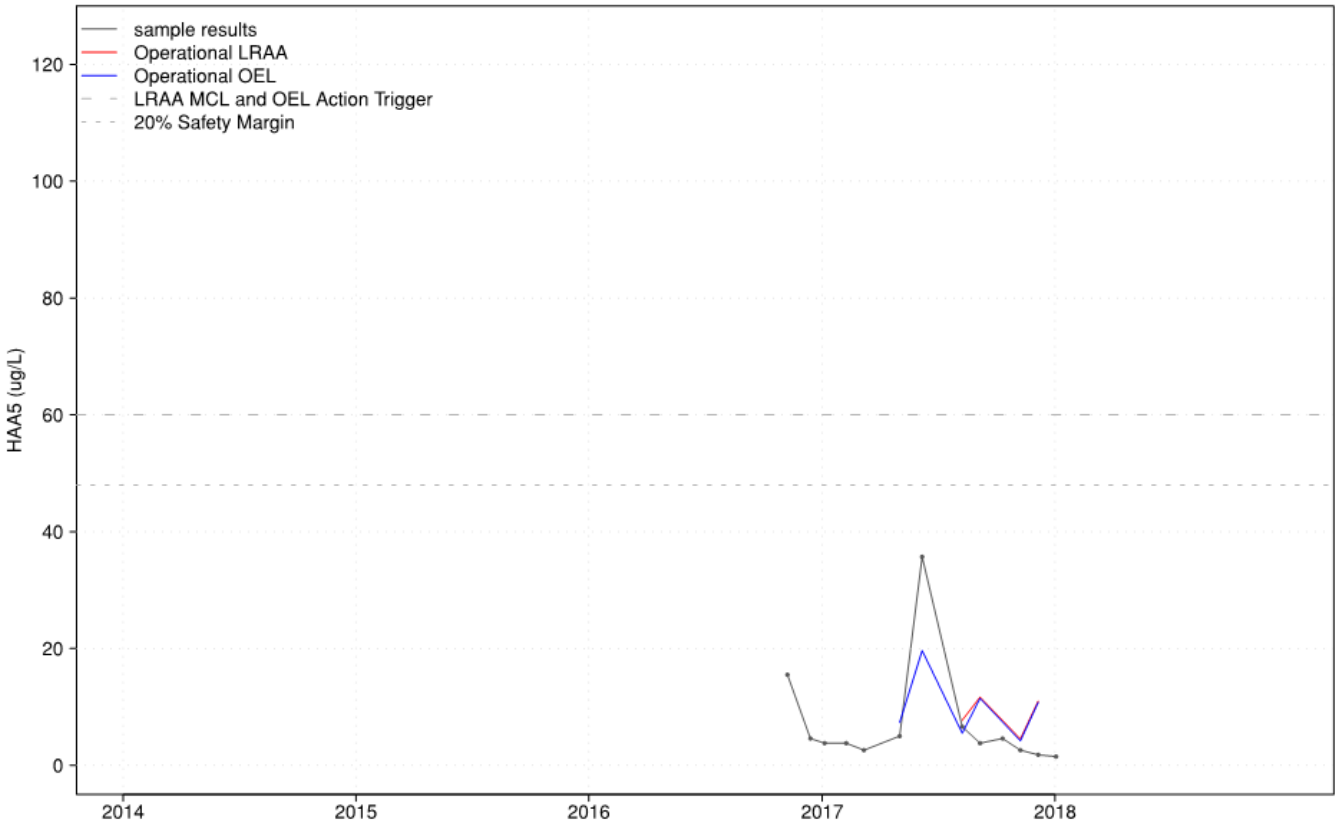


Data mining

Information collected:

GIS Data – by location

- HAA5 results



Data gaps, preliminary recommendations, and initiatives

- Better understand source paths and possible blending zones in the DS.
- Resolve tank sampling challenges and identify upstream/downstream control sites.
- Identify and prioritize problem areas for further analysis and/or operations.

Data gaps, preliminary recommendations, and initiatives

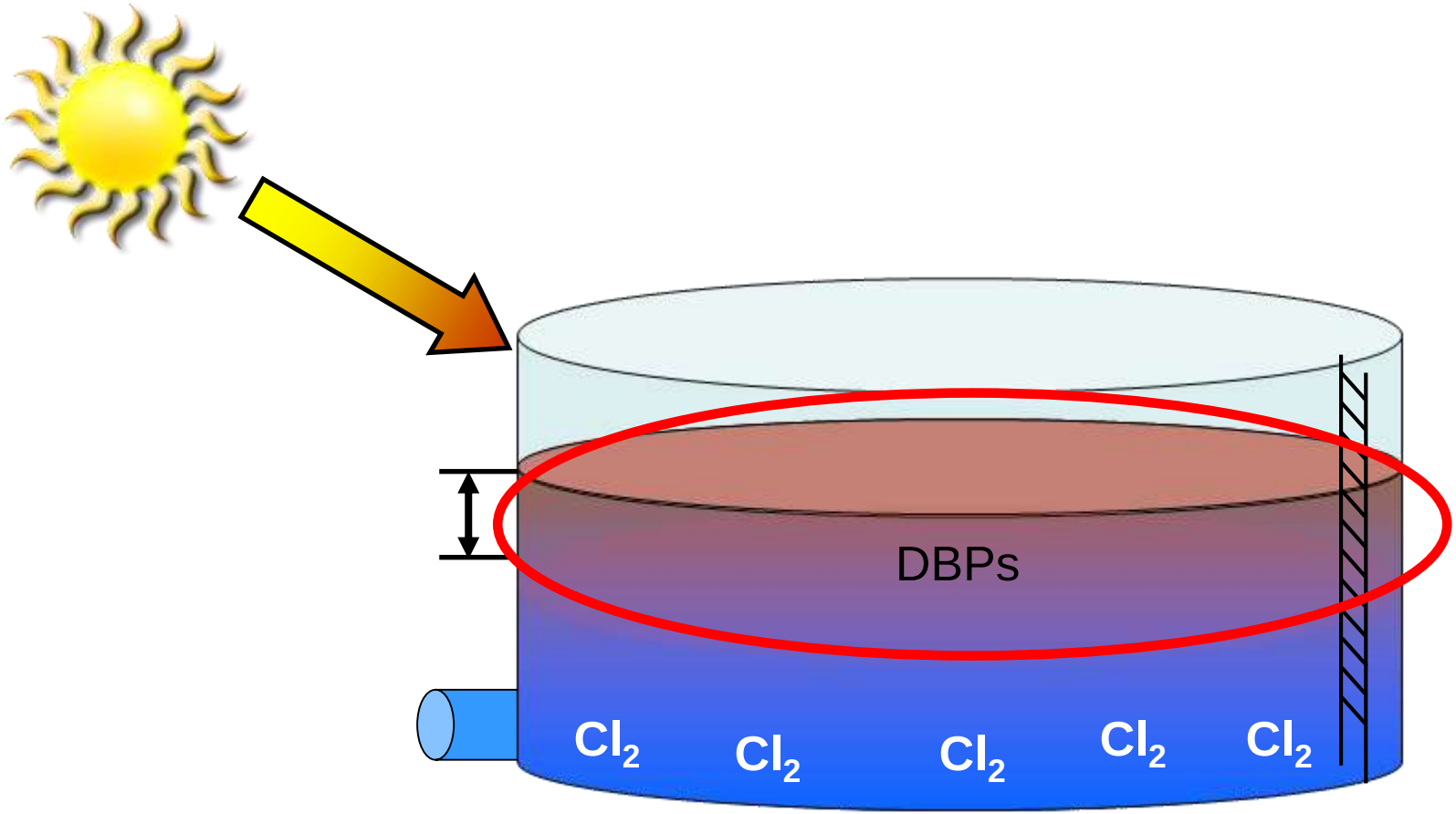
- Perform more systematic nitrite sampling. The reporting limit for nitrification monitoring data should be 10x lower than for nitrite/nitrate compliance.
- Operate with finished water pH 7.5 or higher for chloramine stability.

Data gaps, preliminary recommendations, and initiatives

- Ensure good mixing for monochloramine formation.
- Limit finished water free ammonia to 0.1 mg/L N (Cl2:N ratio 4.5-5).
- Caution: Do NOT raise finished water total chlorine targets in an effort to combat nitrification problems until AFTER nitrification is controlled.

Data gaps, preliminary recommendations, and initiatives

- Convert wells to combined chlorine and better isolate free chlorine zones.
- Boosting with free chlorine to tie up free ammonia at tank influents may be a useful tool for tank management.


DBPs
Cl_2
Cl_2
Cl_2
Cl_2
Cl_2

Develop data visualization tools

and establish review process routines

Box and whisker plots

describe whole data distributions to facilitate comparing their features between locations or time periods for a single parameter

Heat map plots

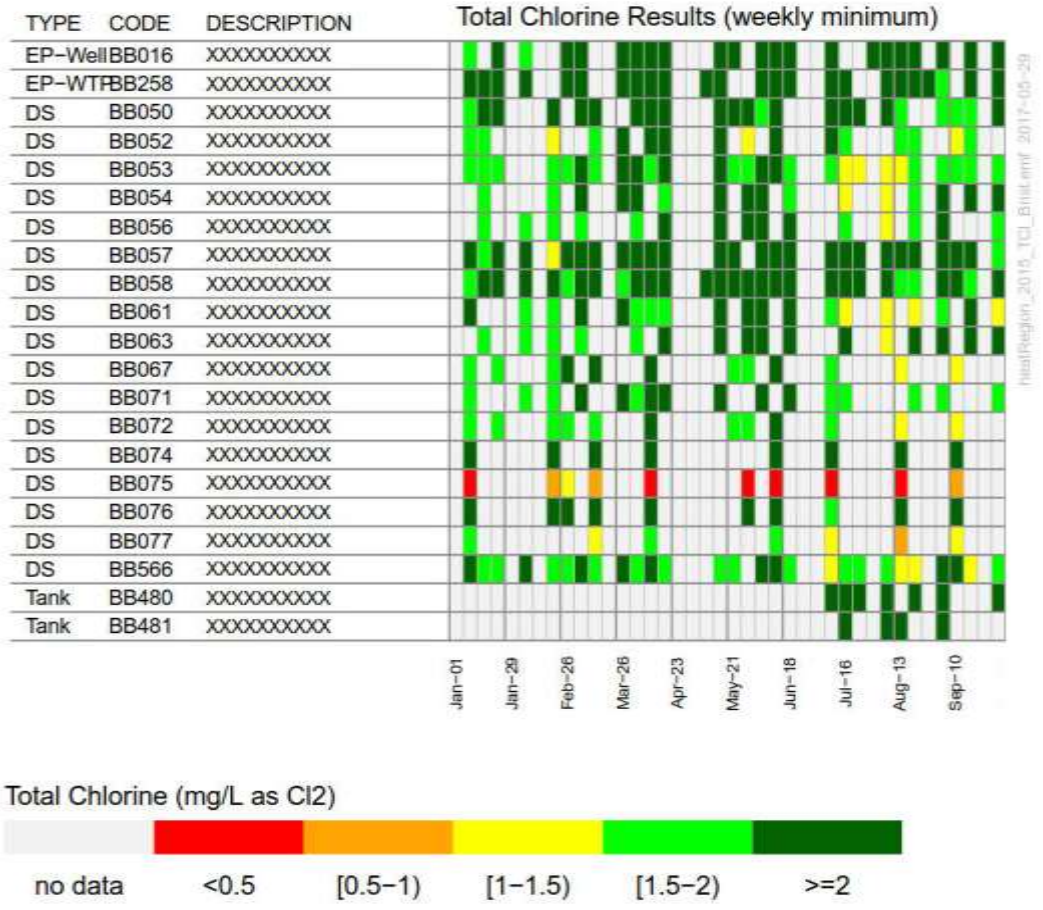
reduce water quality data for each location within a chosen time period into a color-coded tile, providing an overall schematic map of system conditions over space and time that shows progressions, “hot spots,” and data gaps

Automated tank sampling data interpretation

used for tanks with common inlet/outlet. Analysis of tank elevation records and sample collection times was automated to assign a “Tank” (tank in drain mode) or “Distribution” (tank in fill mode) tag to each sample to improve the data value.

Develop visualization tools

Annual heat map plots for 2015 and 2016 show weekly total chlorine results in one region before and after chlorine dioxide addition at the treatment plant was implemented.



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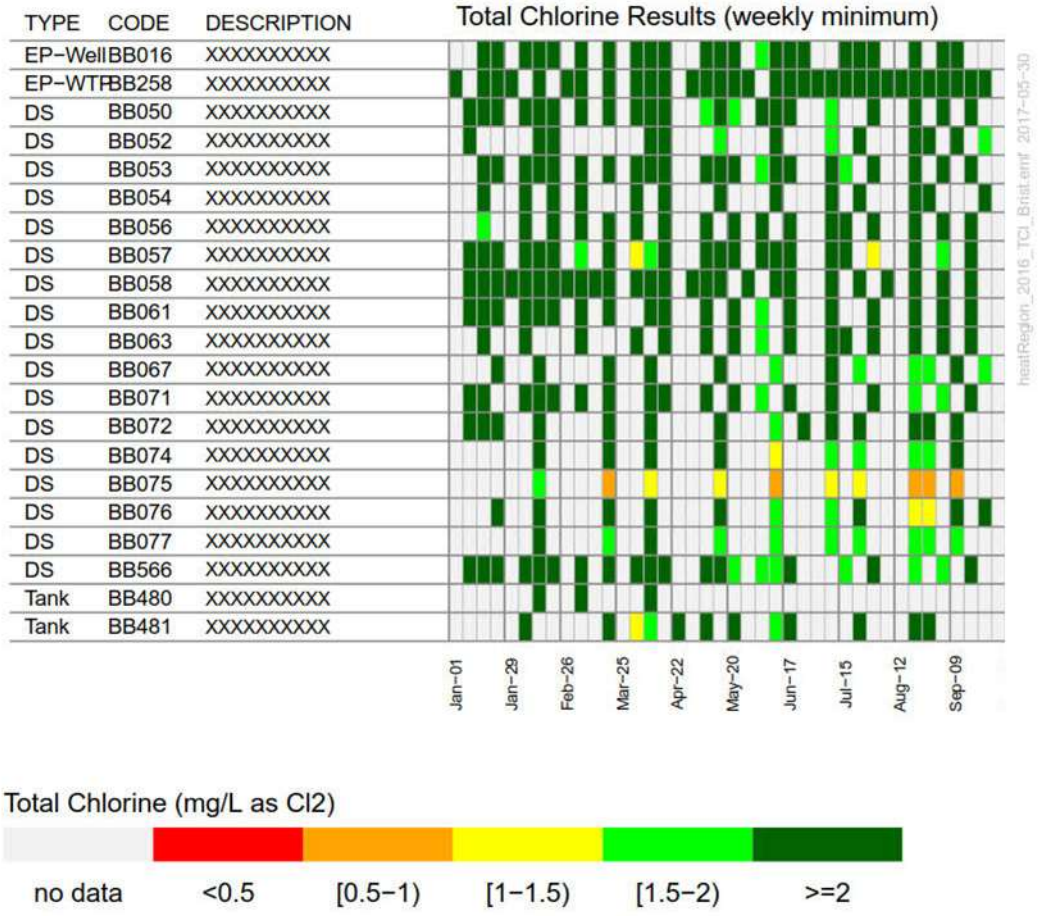


Develop data visualization tools

and establish review process routines

Historic time series Cl_2 residual trend plots

synthesize and update historic data trends and are annotated with critical location attributes for rapid information retrieval. The files are linked to site points in the GIS.

Historic time series multi-parameter trend plots

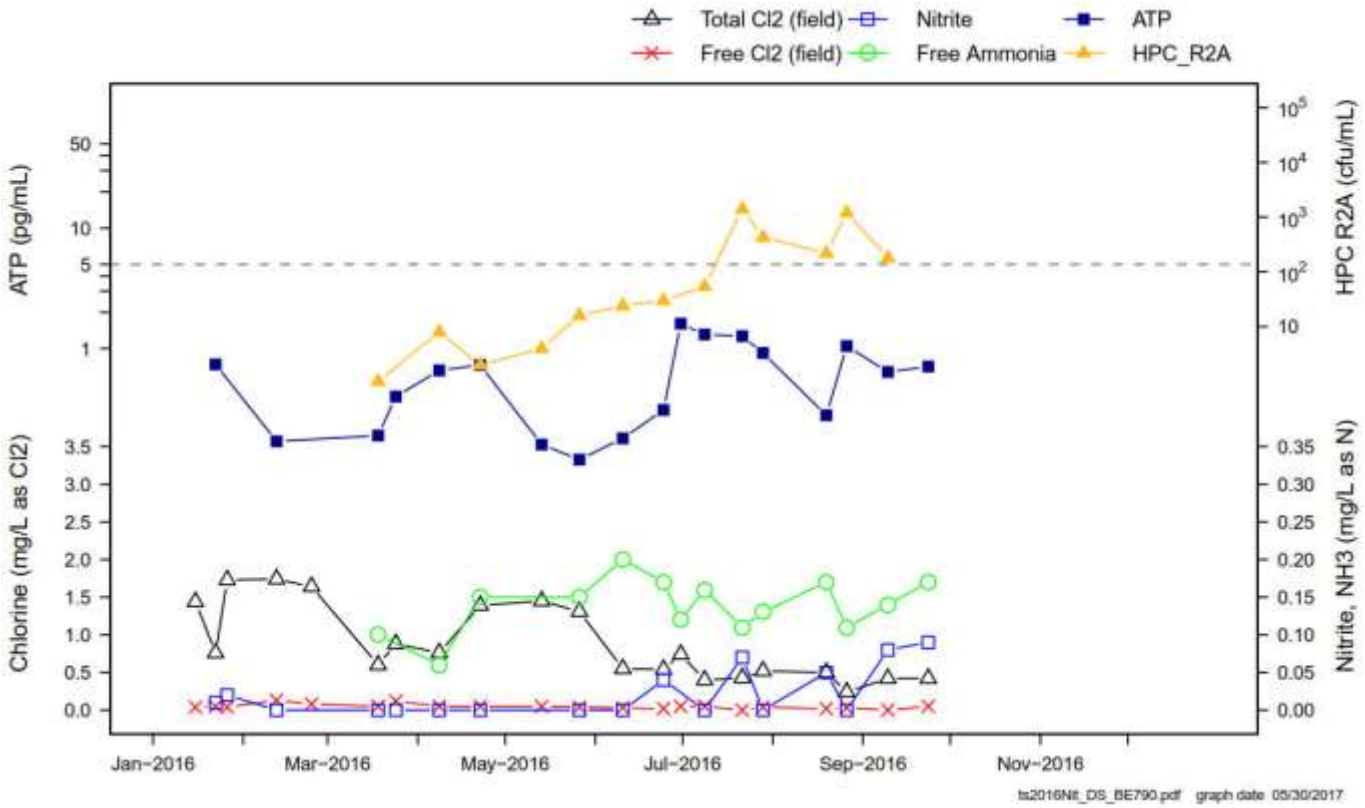
show data that often allows the user to quickly discriminate among supply source influences according to pH and anion levels (fluoride, sulfate, chloride, nitrate).

Annual nitrification multi-parameter time series trend plots

(chlorine, free ammonia, nitrite, ATP, and HPC) are updated weekly and facilitate observation of related trends among chlorine, ammonia, nitrite and biological signals that are critical for early nitrification detection.

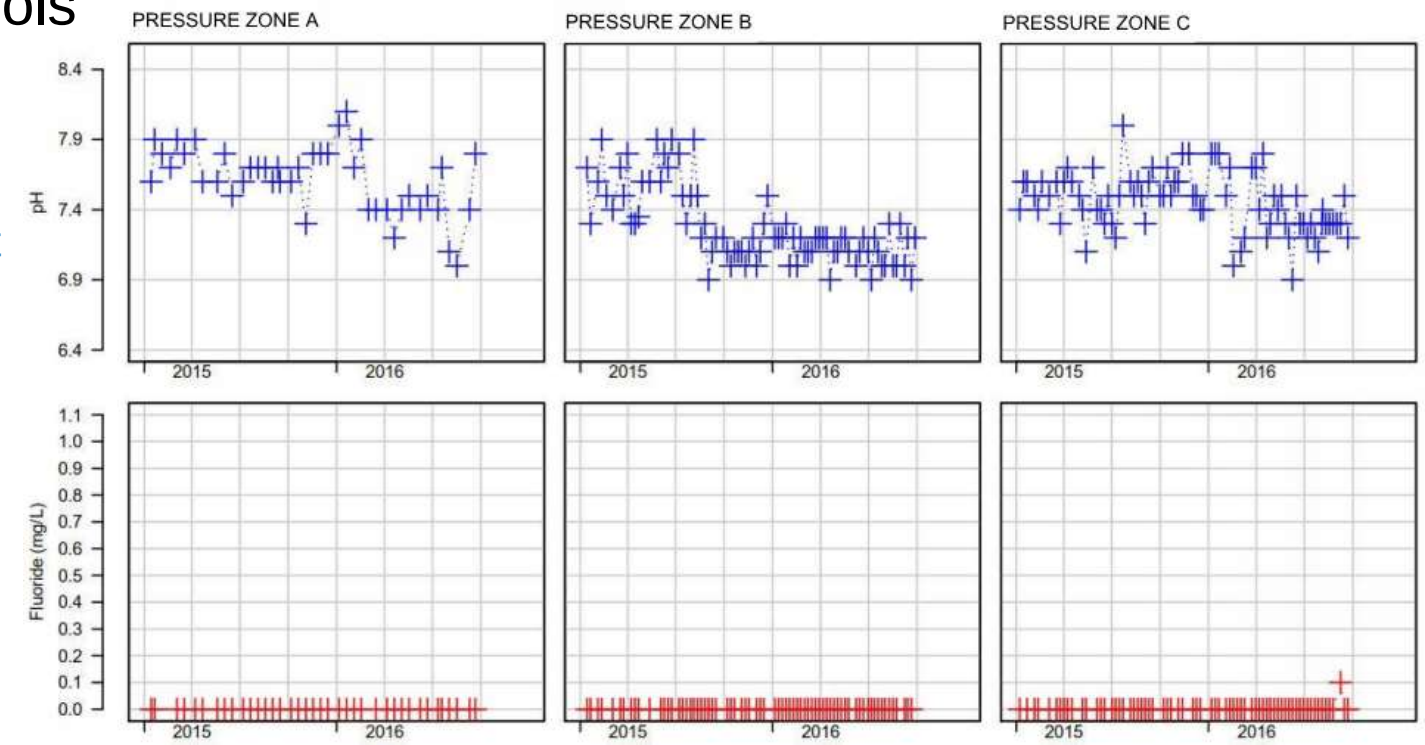
Develop visualization tools

Nitrification multi-parameter time series trend plot helps in early nitrification detection



Develop visualization tools

Historic multi-parameter trend plot allows quick identification of source water



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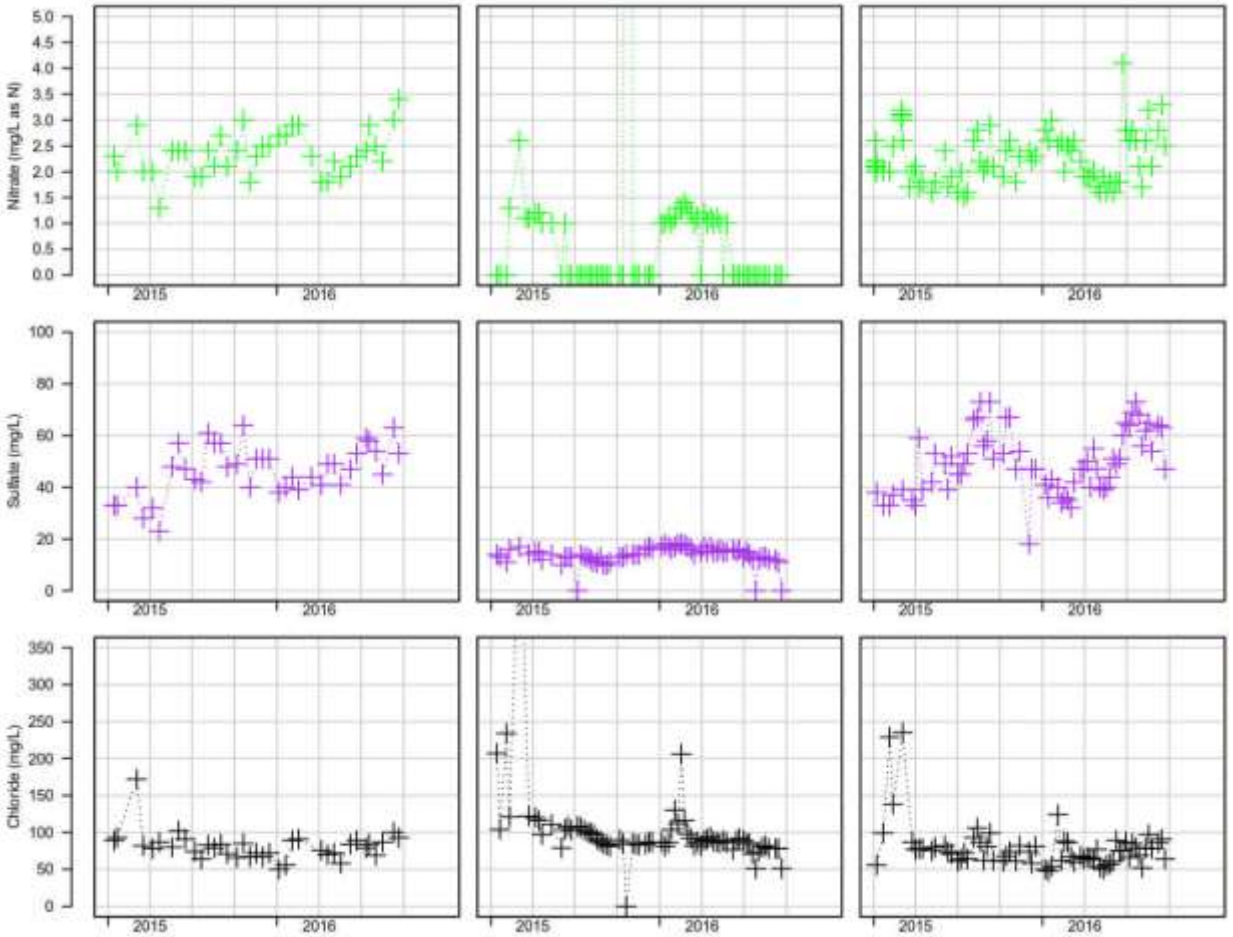

Findings and system improvements made to date:

Systemic adjustments such as raising the entry point chloramine residual and pH, and lowering entry point free ammonia, have improved overall chloramine residual health.

Additional improvements to distribution system chloramine residual health have resulted from targeted responses in problem areas (e.g., eliminating blending, improving tank mixing, and flushing hydrants).

Graphical data presentations accessible in the GIS and refreshed automatically help staff better understand the overall “picture” of the distribution system. Synthesizing information from many sources, these tools help inform operational decisions and support further system optimization.

Acknowledgements

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