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An Ohio Corrosion Control Case Study

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15th Annual EPA Drinking Water Workshop: Small Systems Challenges and Solutions



Ohio Site Public Water System

- Medium-Sized CWS
- 2,268 Service connections serving 8,100 people.
  2,046 service connections are private
- Produces 700,000 gpd
- Source: Mahoning River
- 41.2 miles of water main lines.
- Oldest sections are from the early 1900's

Private Service Line Lead Probability		
Possibility of Lead	**Private #**	**% of System**
No Lead	1467	71.7%
High Probability	579	28.3%

The City does not own any service lines other than its own municipal buildings, parks and fire stations.

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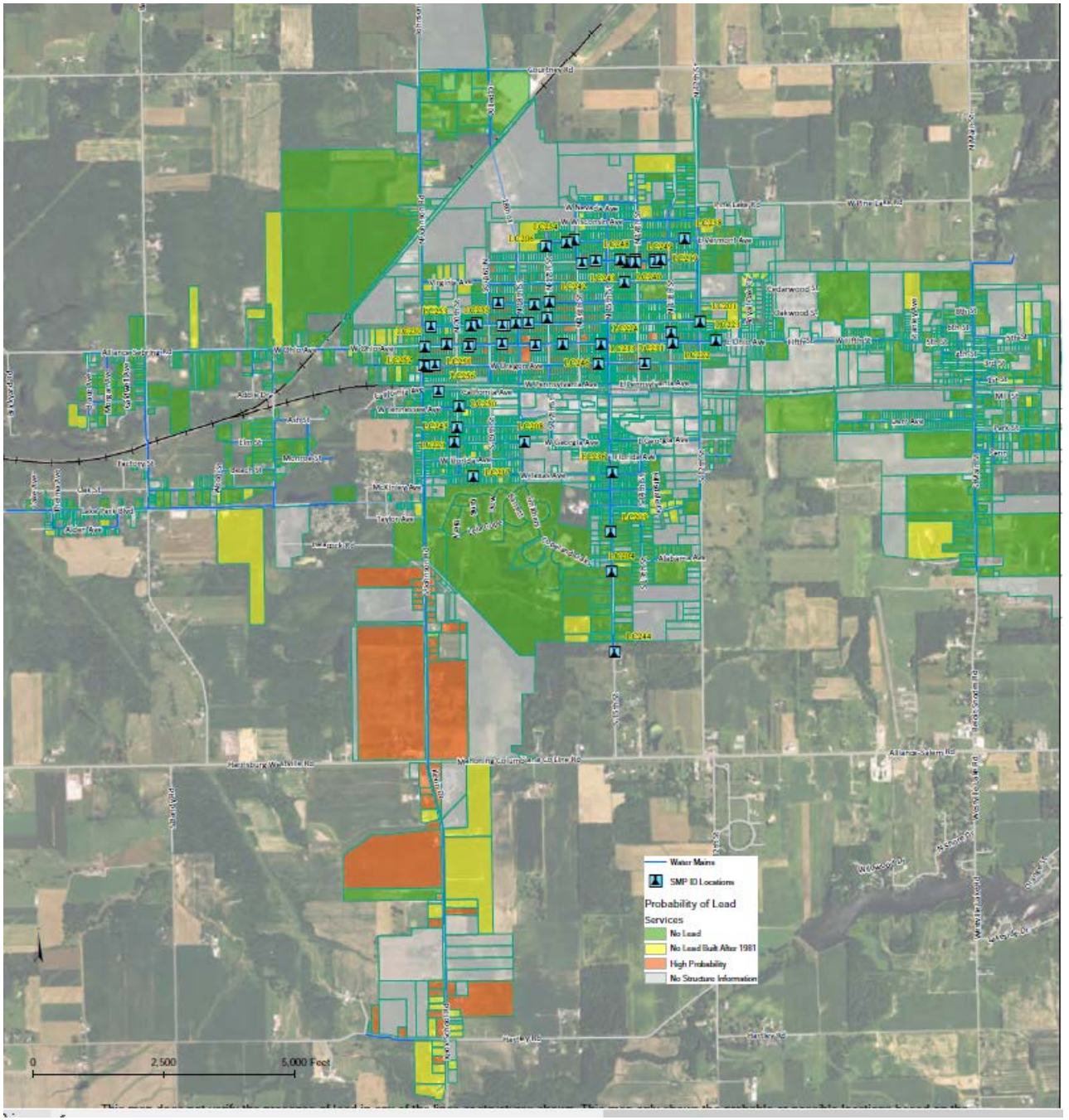
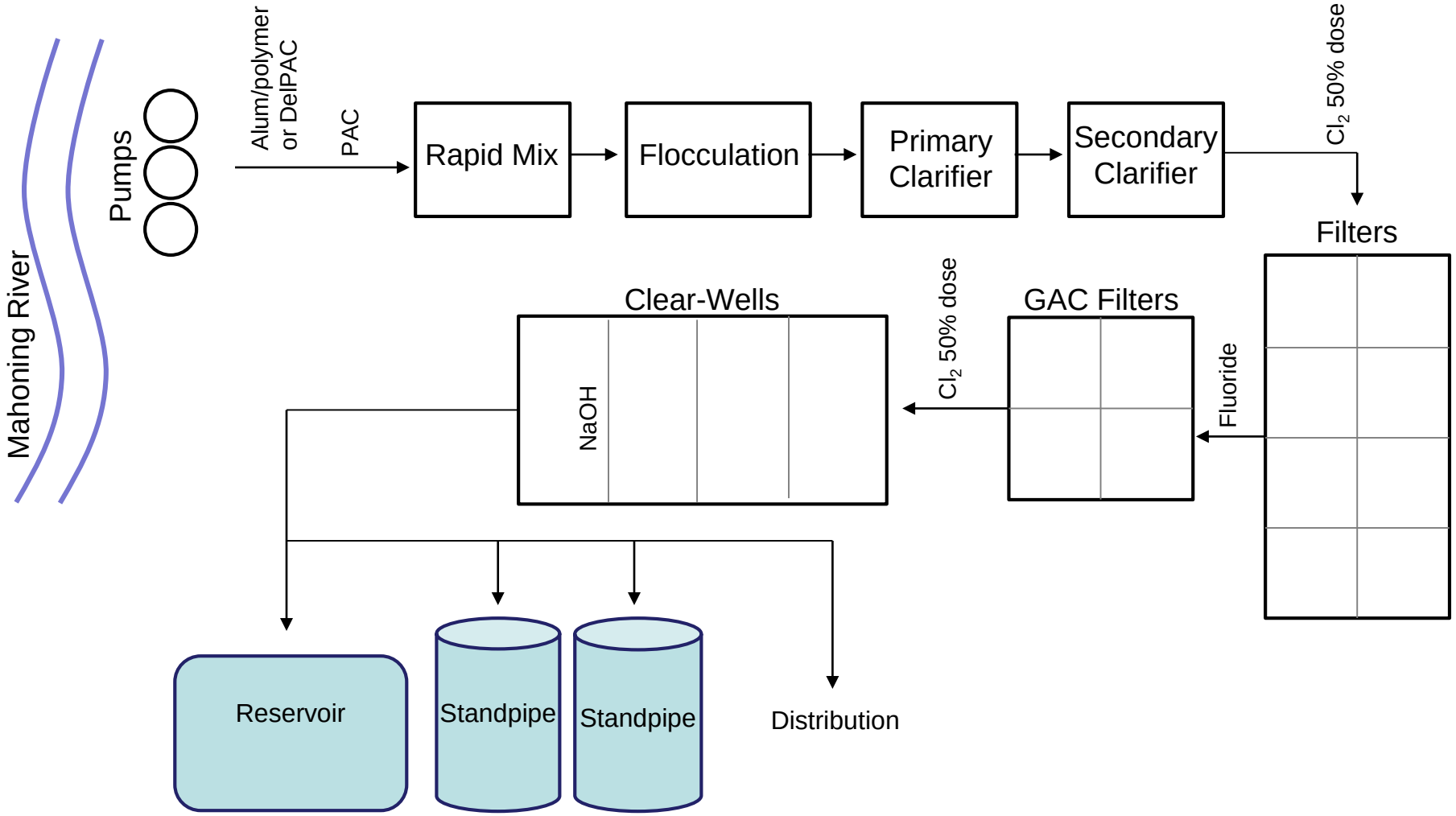
Probability of Lead with LCR Sampling Locations

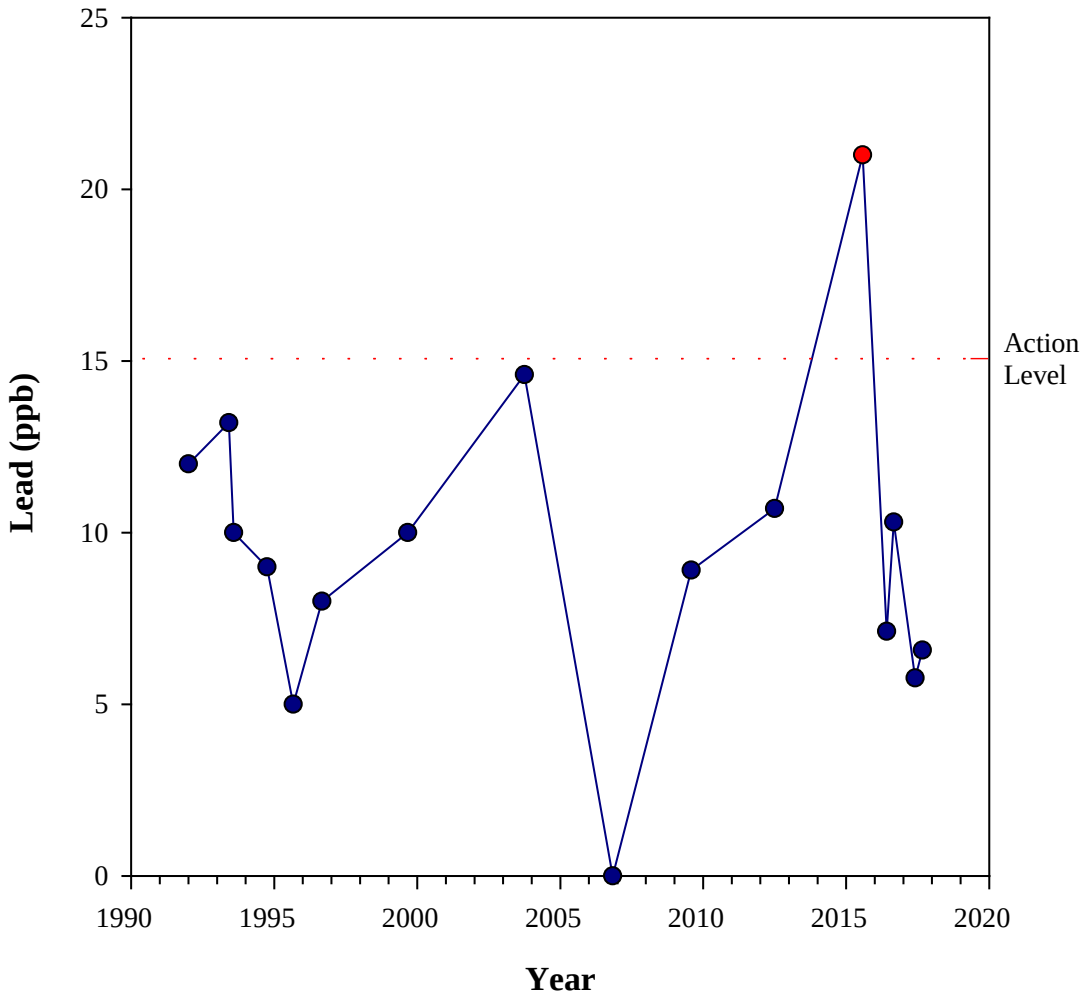


Treatment Train



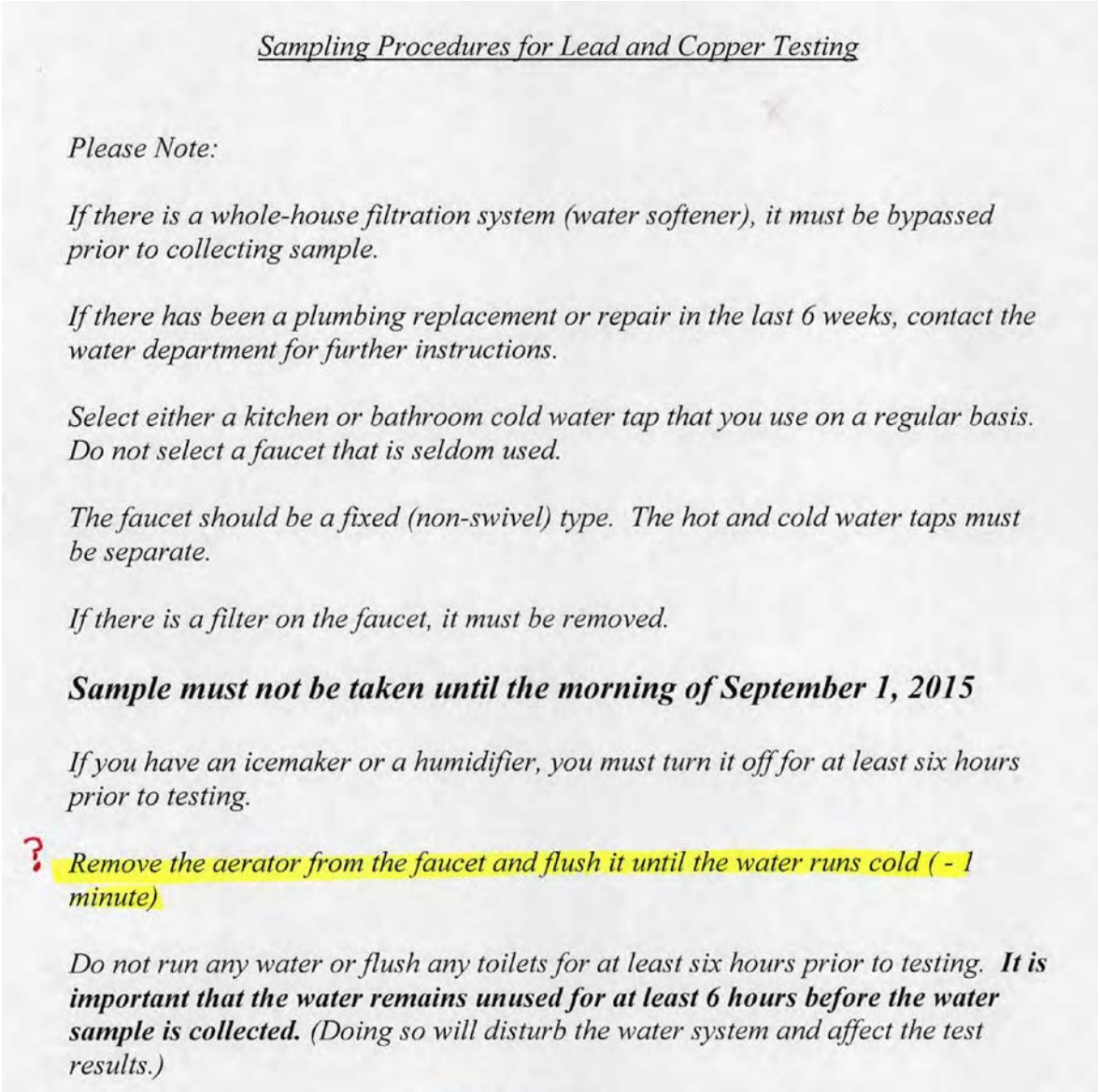
LCR Lead Action Level History
90th Percentile Lead

- 90th percent lead value exceeded 15 ppb during the June-September 2015 monitoring period
- Sample 20 sites (although more used in past)



Incorrect Sampling Procedure

- EPA procedure requires no intentional flushing before 6 hour stagnation.



Sampling Procedures for Lead and Copper Testing

Please Note:

If there is a whole-house filtration system (water softener), it must be bypassed prior to collecting sample.

If there has been a plumbing replacement or repair in the last 6 weeks, contact the water department for further instructions.

Select either a kitchen or bathroom cold water tap that you use on a regular basis. Do not select a faucet that is seldom used.

The faucet should be a fixed (non-swivel) type. The hot and cold water taps must be separate.

If there is a filter on the faucet, it must be removed.

Sample must not be taken until the morning of September 1, 2015

If you have an icemaker or a humidifier, you must turn it off for at least six hours prior to testing.

? *Remove the aerator from the faucet and flush it until the water runs cold (- 1 minute)*

Do not run any water or flush any toilets for at least six hours prior to testing. ***It is important that the water remains unused for at least 6 hours before the water sample is collected.*** *(Doing so will disturb the water system and affect the test results.)*

Corrosion Control Treatment

- Prior 2010, caustic feed and calcium carbonate saturation state (Marble test)
- Had not exceeded AL so corrosion control not formally established
- Lead AL exceedance in late 2015
- Resumed caustic soda (NaOH) feed in January, 2016
  - Raise pH

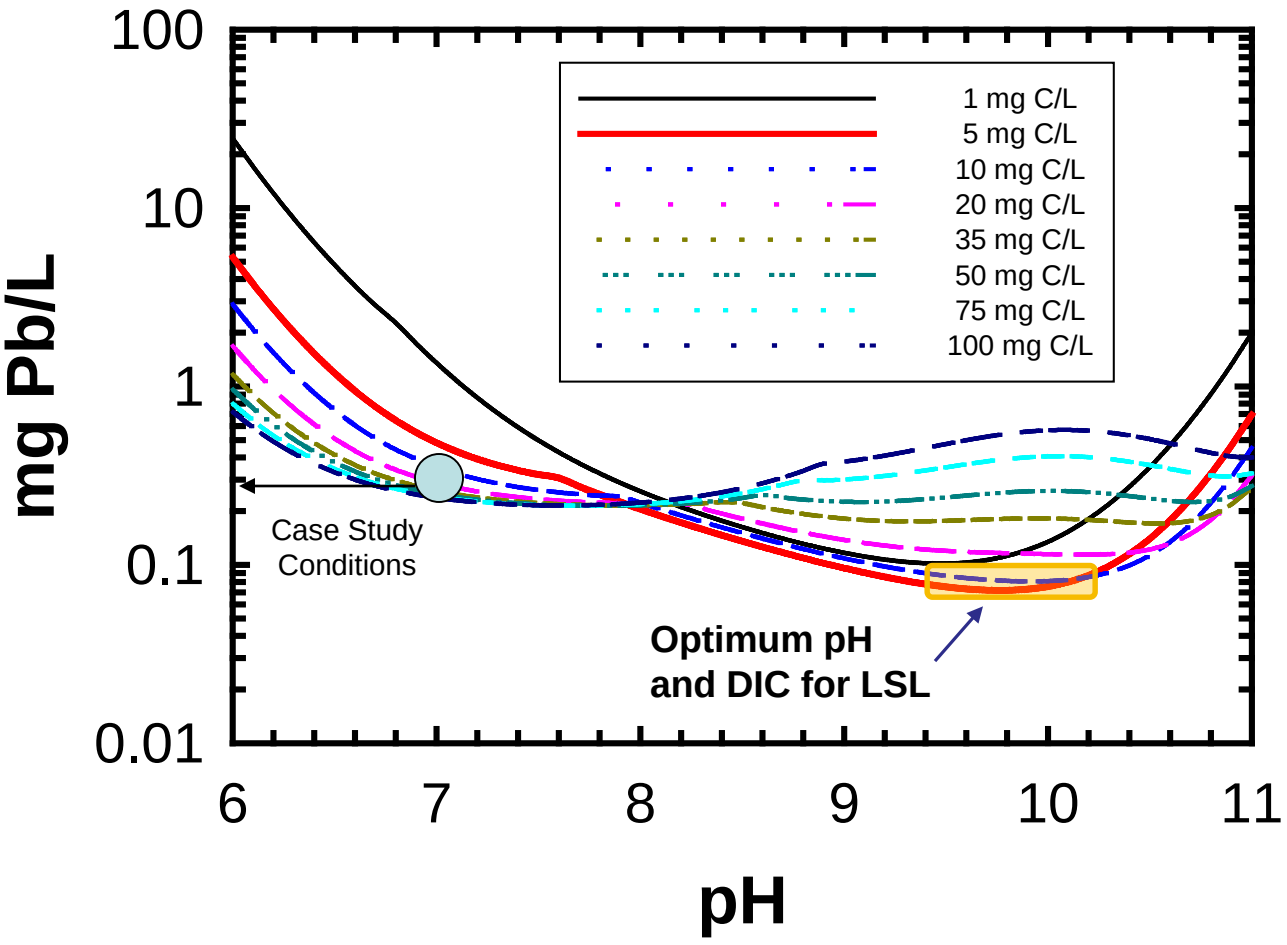
Average Water Quality Over Time

	2015	Std.dev	2016	Std.dev	2017	Std.dev
pH	6.97	0.27	7.59	0.27	7.56	0.11
Alkalinity	141	37	155	39	141	43
Lowest Temp	13.5	7.9	14.1	7.6	9.1	5.5
Lowest Free Chlorine	1.08	0.28	1.22	0.44	0.98	0.45
Average Turbidity	0.12	0.03	na	na	0.08	0.02
Hardness	224	49	219	43	201	55

Theoretical Lead Solubility

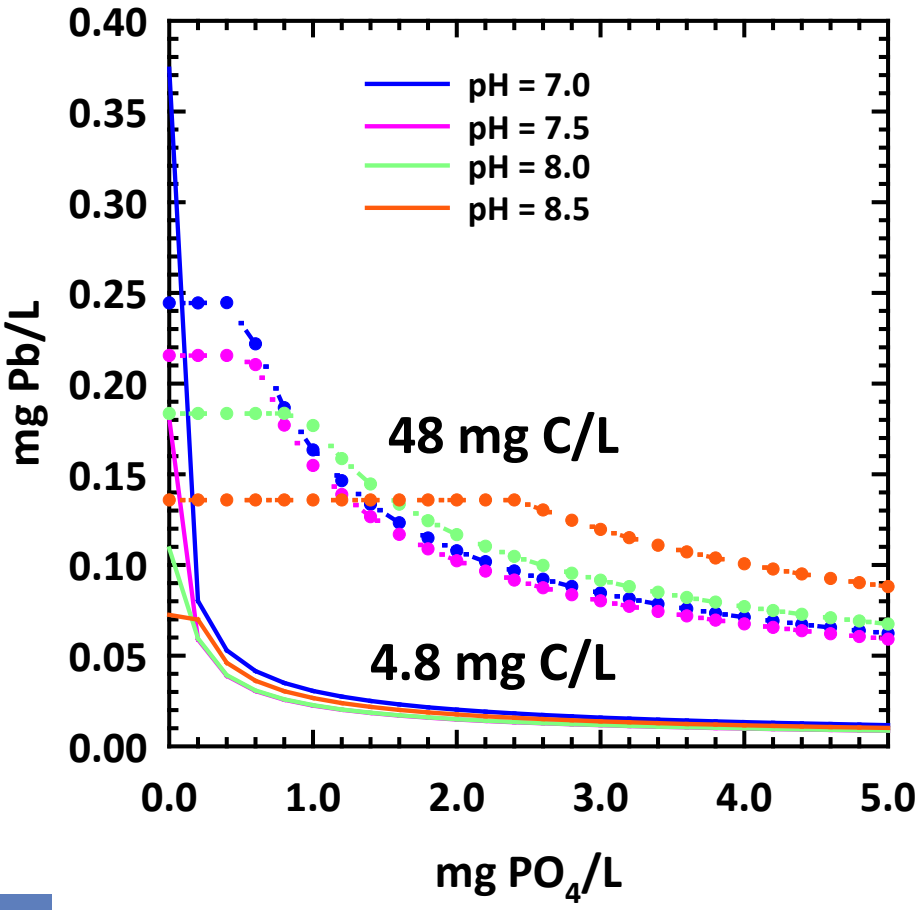
Carbonate Passivation

Low DIC/High pH Strategy More Difficult with LSLs than Leaded Solder or Brass



Point of Diminishing Returns for Orthophosphate Addition

Effectiveness Depends on Dose, DIC, pH and "Cleanliness" of Pipe Surface



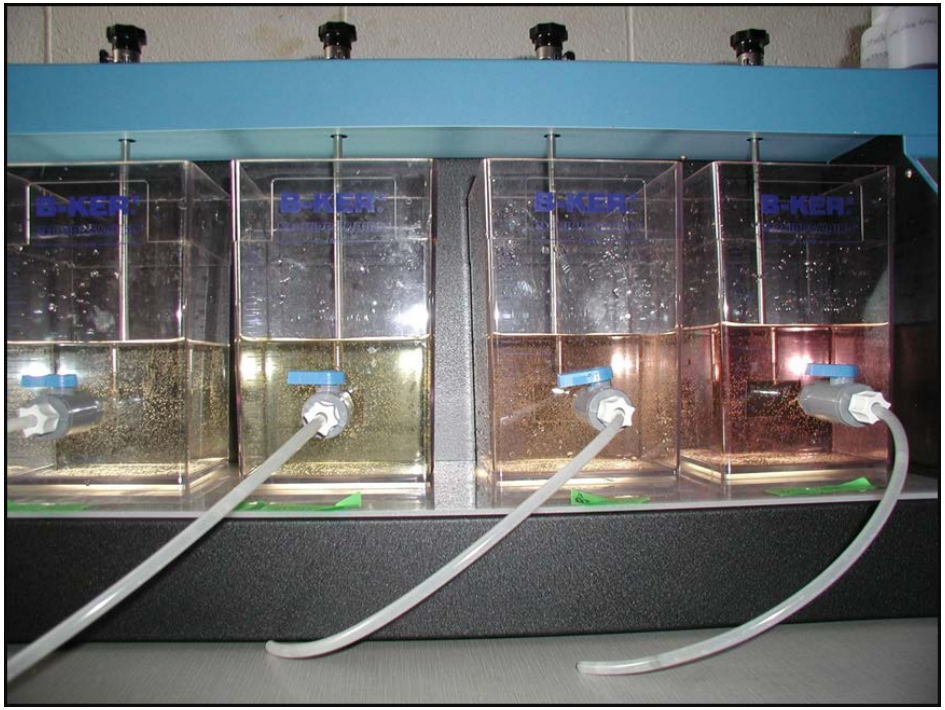
PWSs with LSLs should have optimized corrosion control treatment *in terms of minimizing Pb release and exposure*.

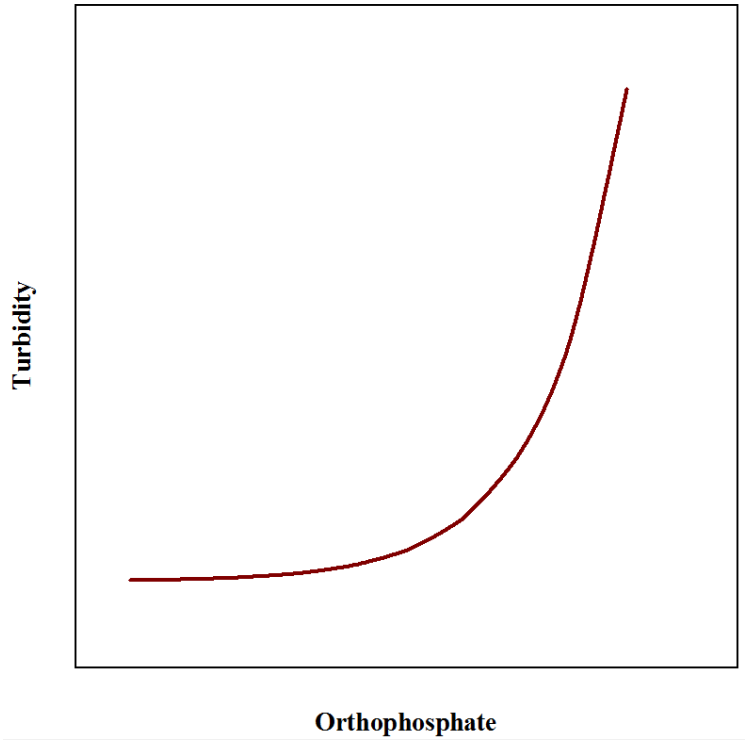
- **pH less critical at low TIC**
- **pH less critical at high PO_4**
- **Point of diminishing returns higher with high TIC**
- **Faster Pb reduction at high PO_4**

Typical UK Dosages: 4-6 mg/L

*Assumes hydroxypyromorphite, $Pb_5(PO_4)_3OH$

Unintended Consequences of Orthophosphate Addition





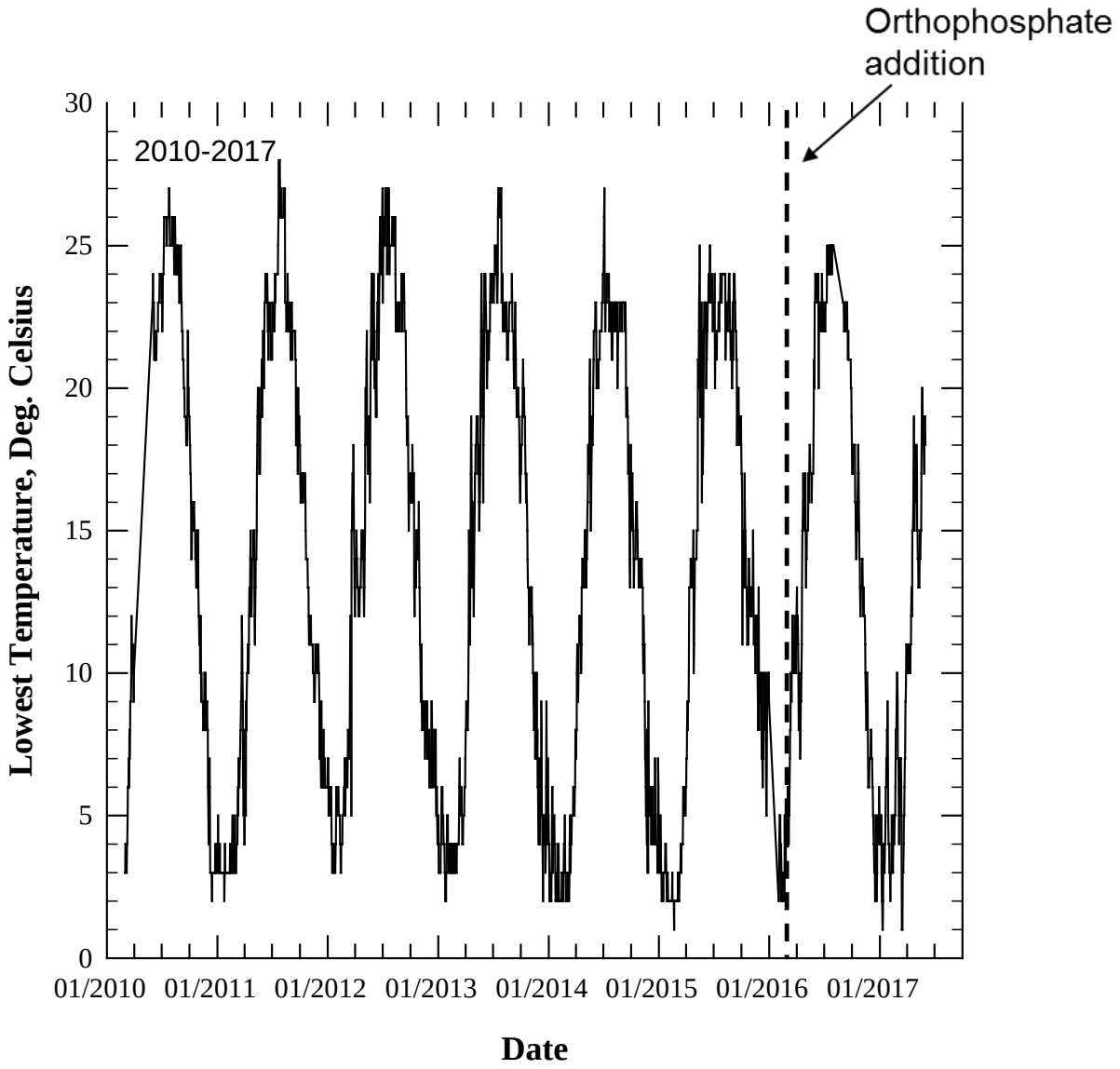
Corrosion Control Treatment

- Began feeding orthophosphate in March, 2016.
- Initial goal (OEPA Order): pH > 7.2 (> 7.5 preferred)
- Initial goal (OEPA Order): > 2 mg PO_4/L

- Goal pH: 7.2-7.7 (Prefer 7.5-7.7)
- Goal orthophosphate: 3±0.3 mg/L
  - Fluctuate feed depending on season
- Goal Chlorine: 1.2-1.5

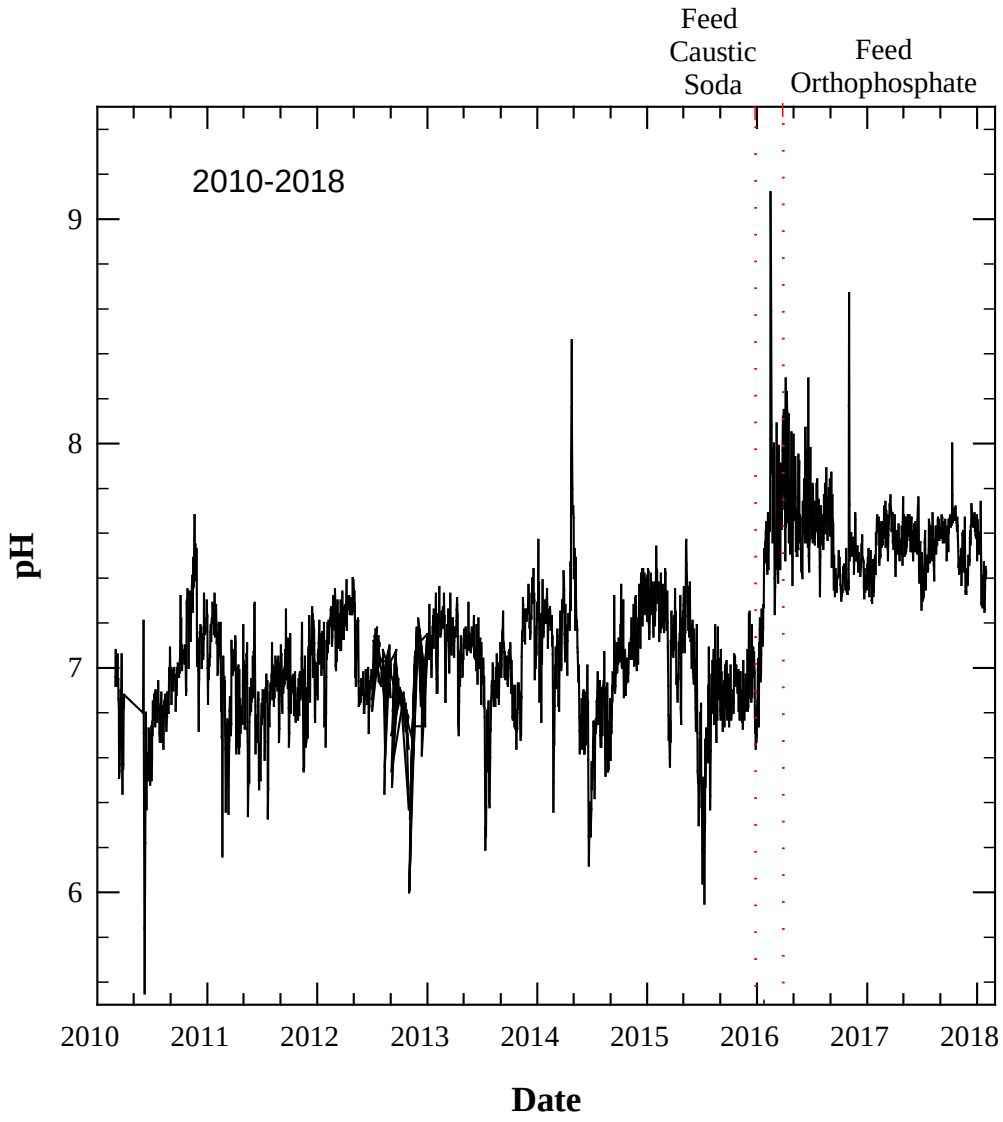
Temperature

Finished Water



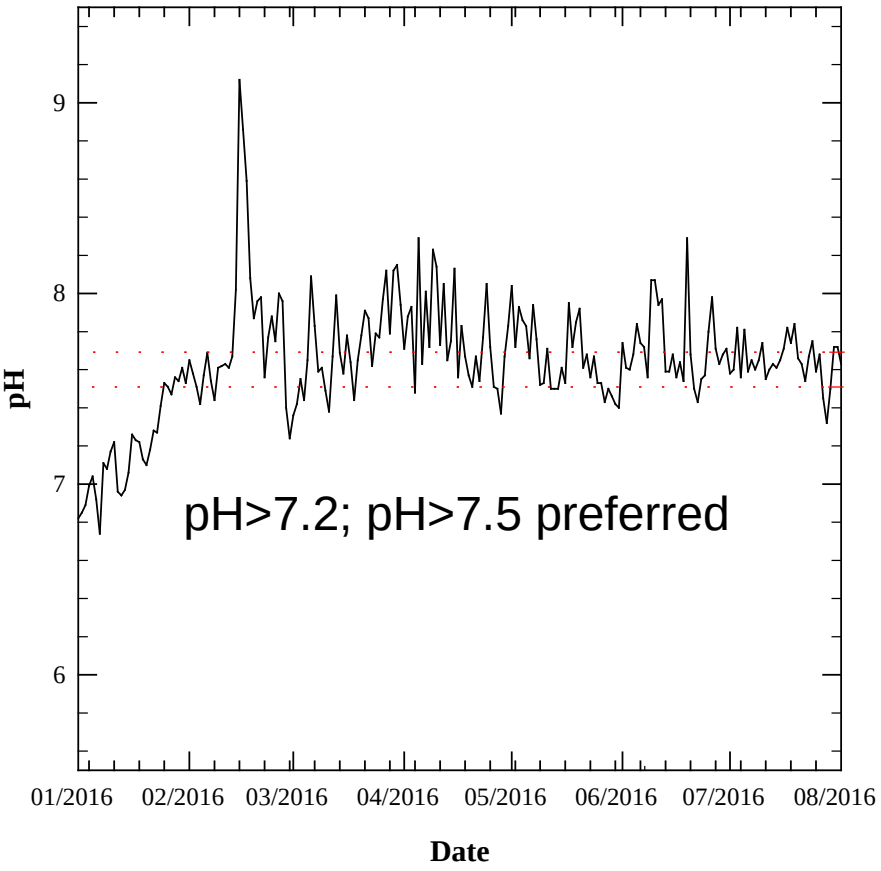
Historic pH

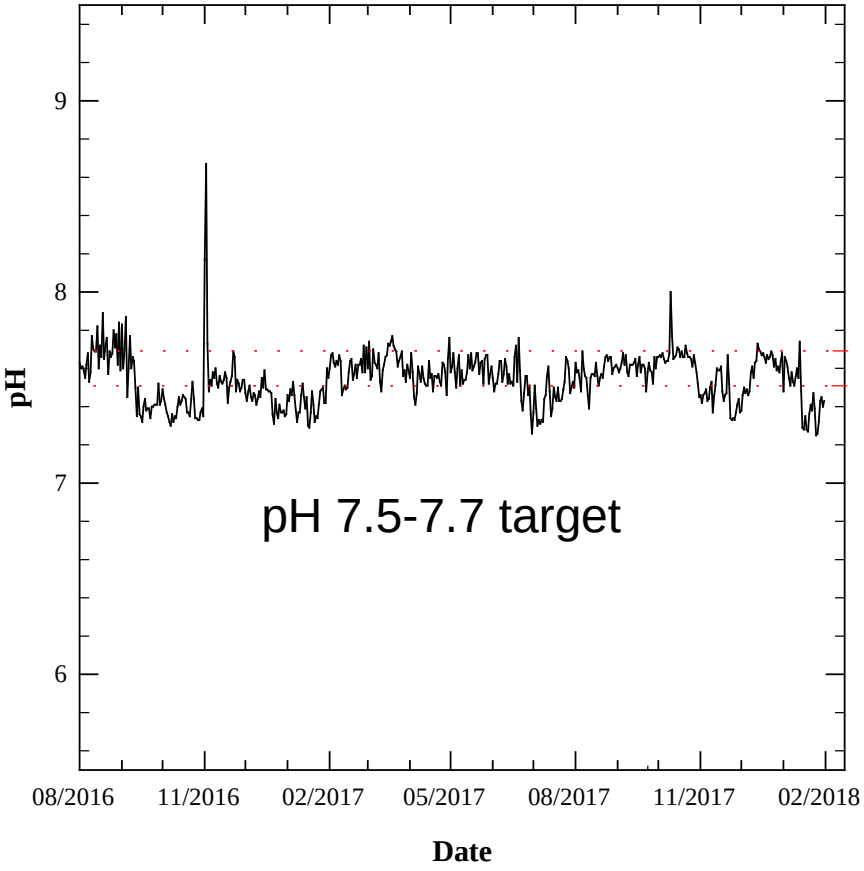
Finished Water (Plant Tap)



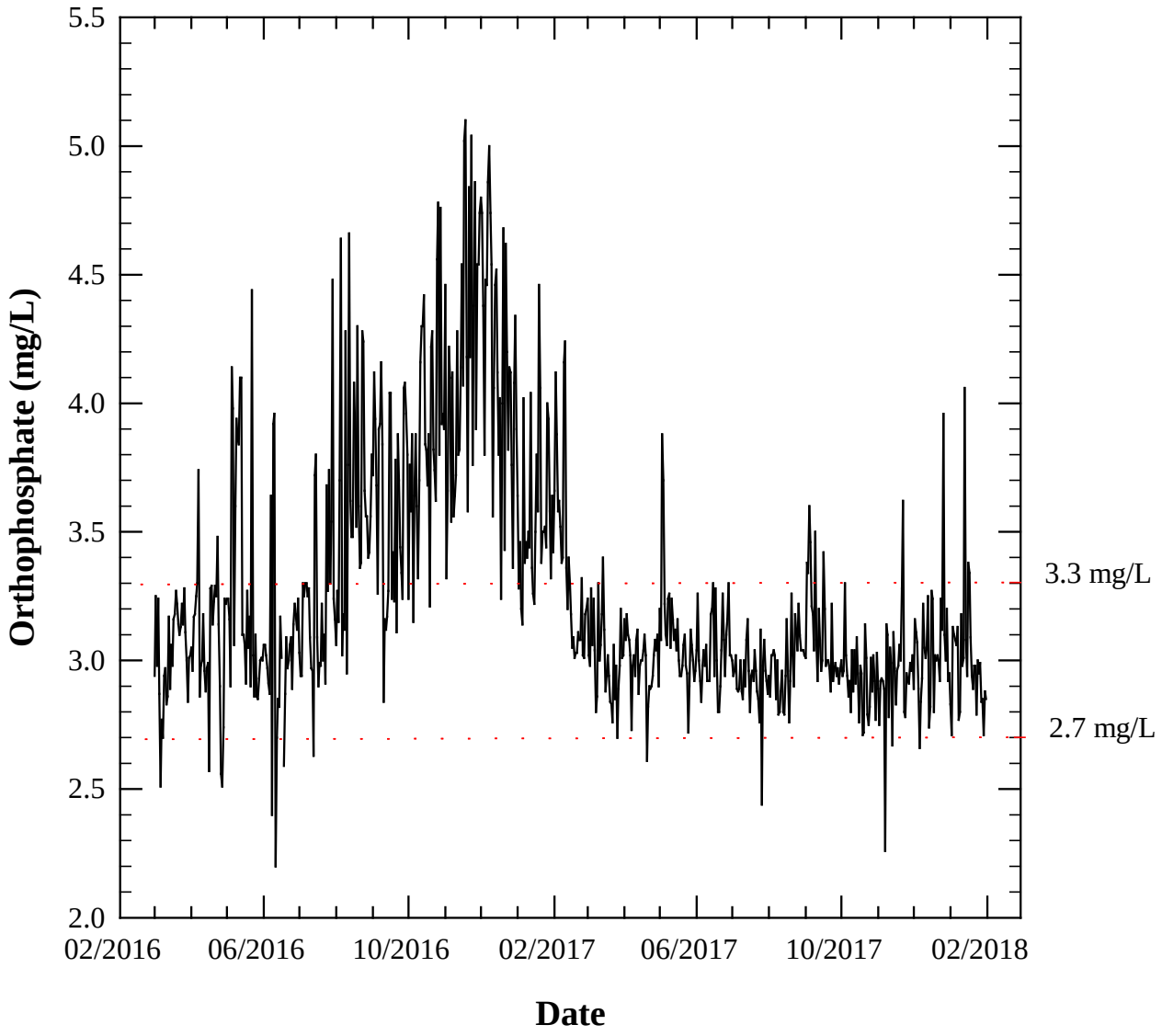
After Beginning CCT

A closer look





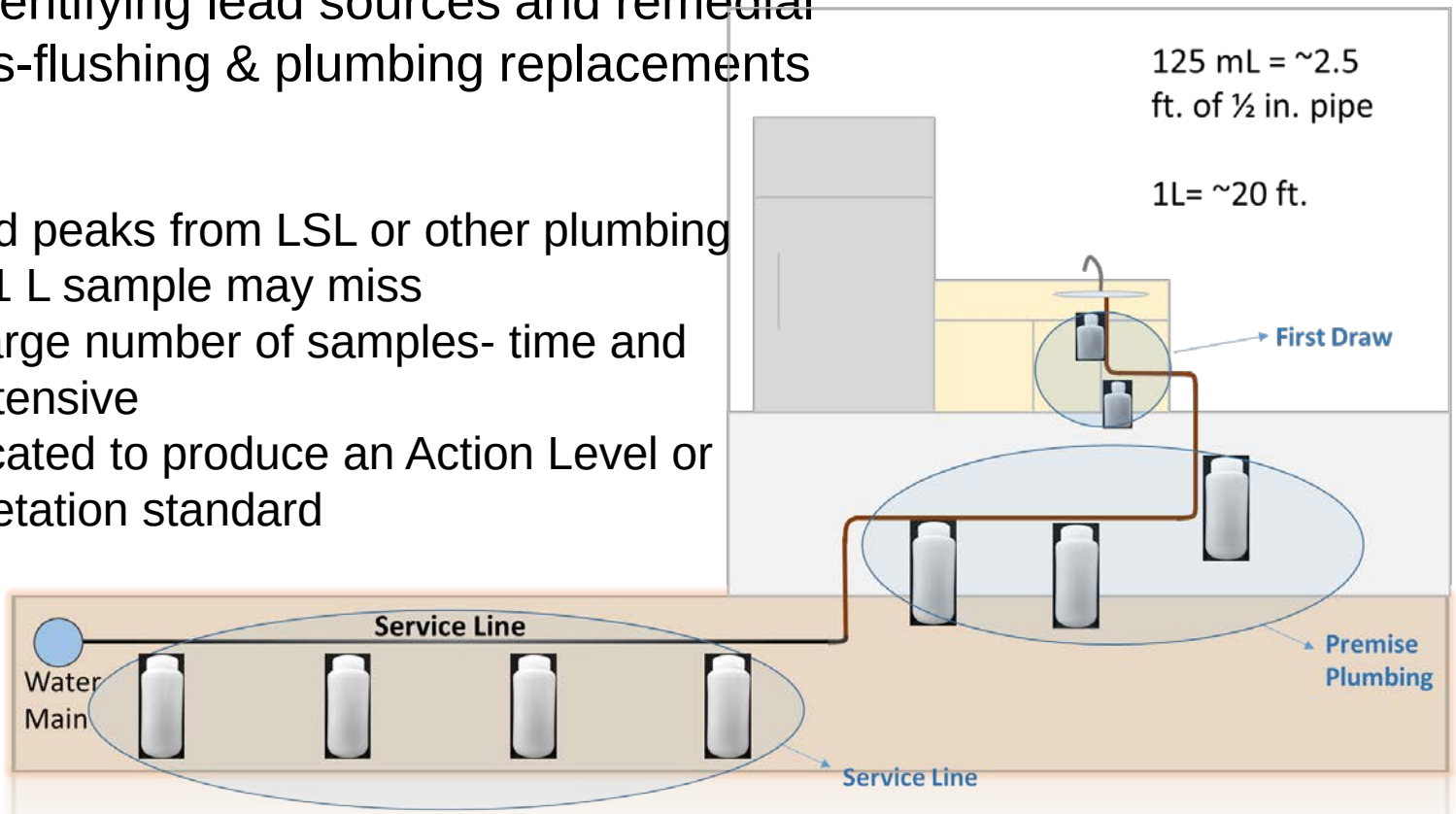
Orthophosphate



Sequential Sampling

- Series of samples taken after stagnation
- First samples typically 125-250 mL
- Later samples 1 L (uniform plumbing)
- Correlate sample volumes to plumbing sections
- Useful for identifying lead sources and remedial actions-flushing & plumbing replacements

- Captures lead peaks from LSL or other plumbing that a 1 L sample may miss
- Requires a large number of samples- time and cost intensive
- More complicated to produce an Action Level or interpretation standard

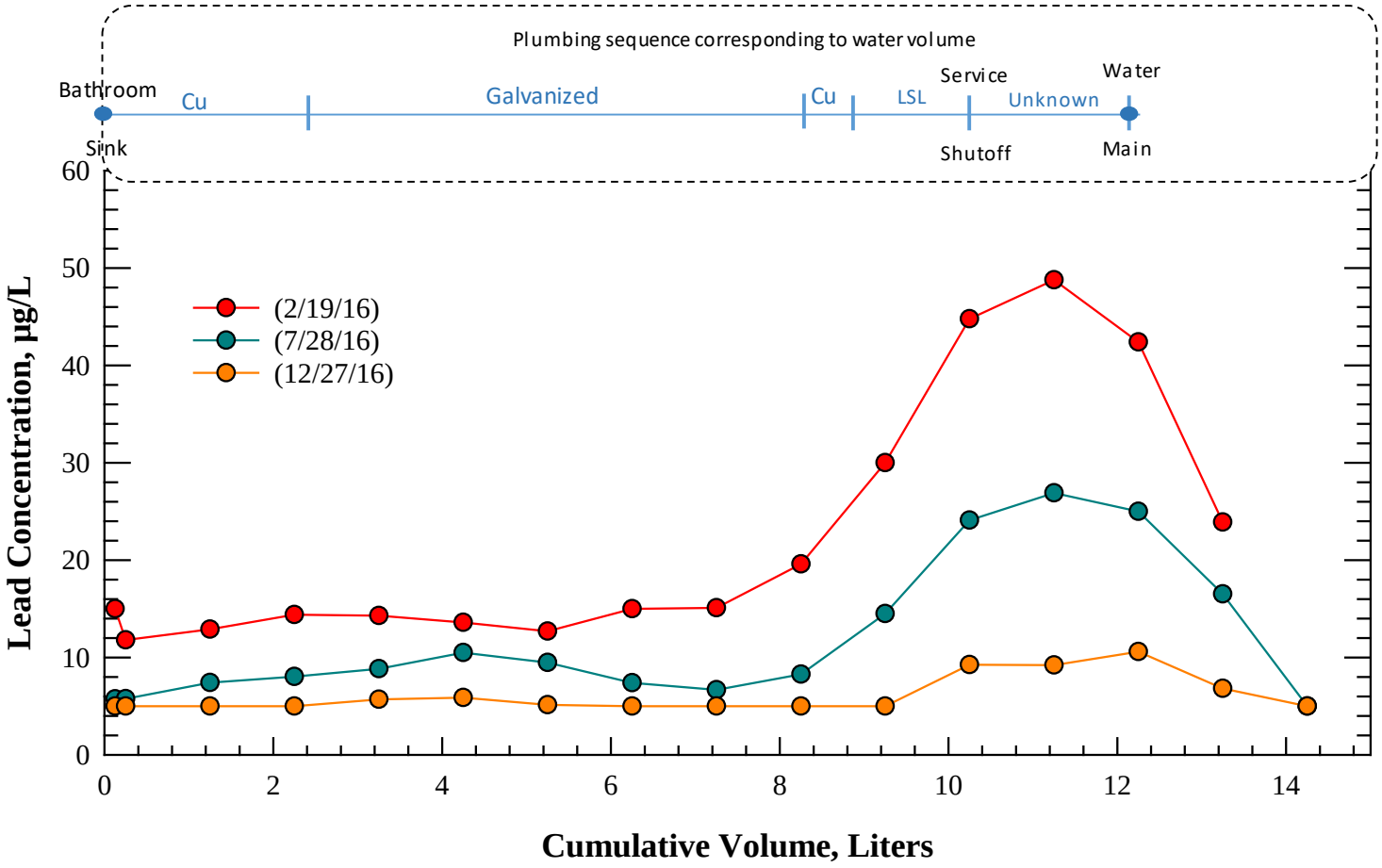


Sequential Sampling

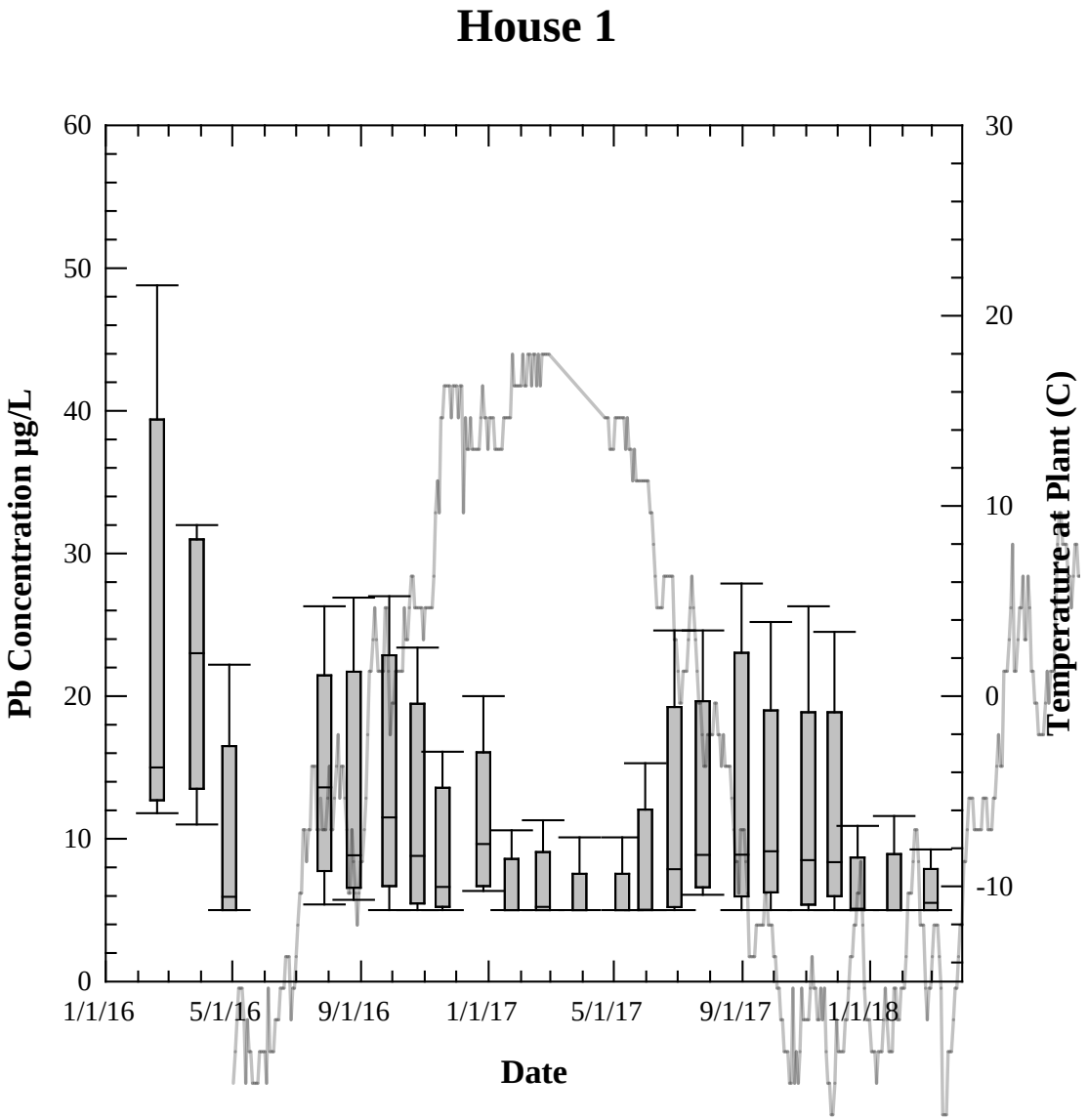
- Required by OEPA
- Eighteen different homes in sampling pool
- 5 to 8 homes sampled on a monthly basis for 25 months+
- Many homes dropped out of pool
  - Non-LSL homes
  - LSL removed
  - Home vacant
- 2- 125 mL samples followed by 1 L samples depending on on-site plumbing assessment
- Lead, copper and zinc measured

Lead Sequential Profiles

House 1

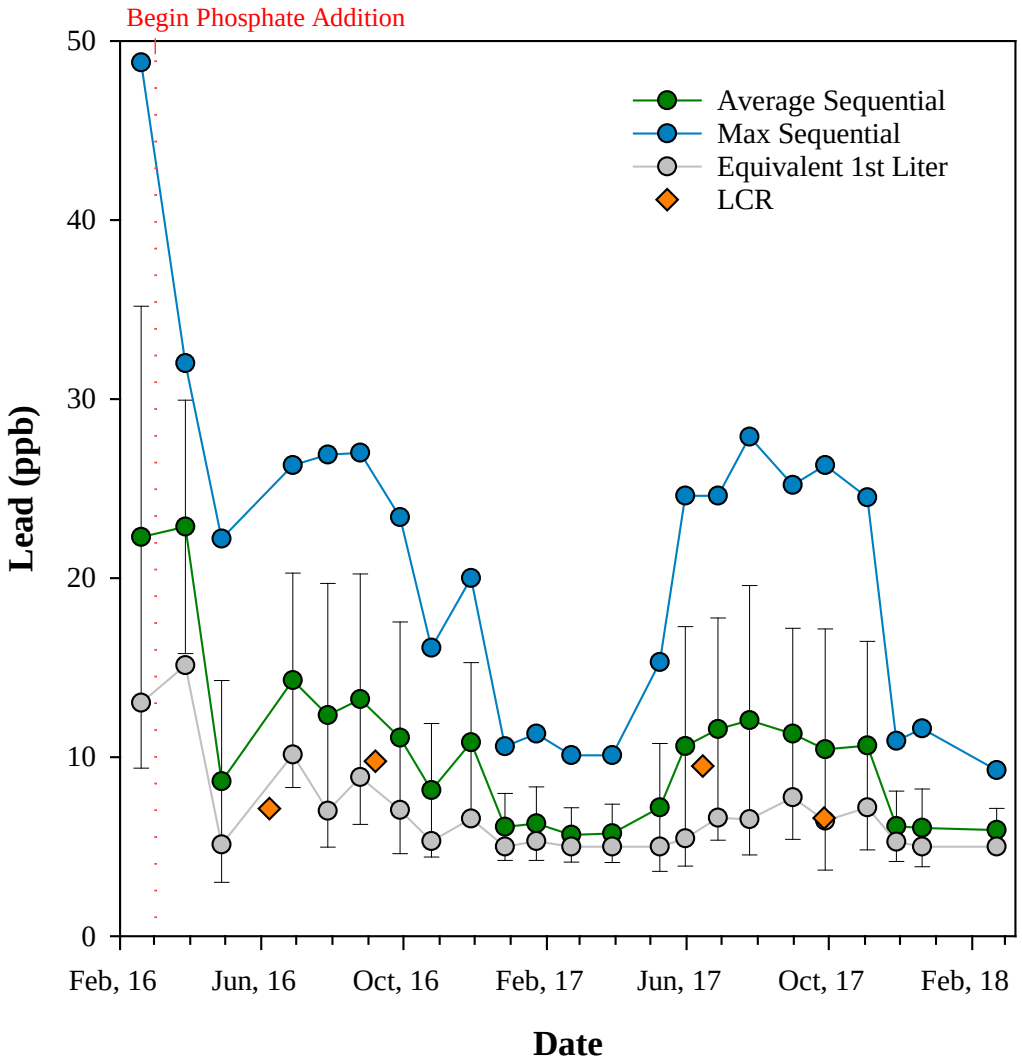


Lead Distribution of Each Sample Round and Temperature

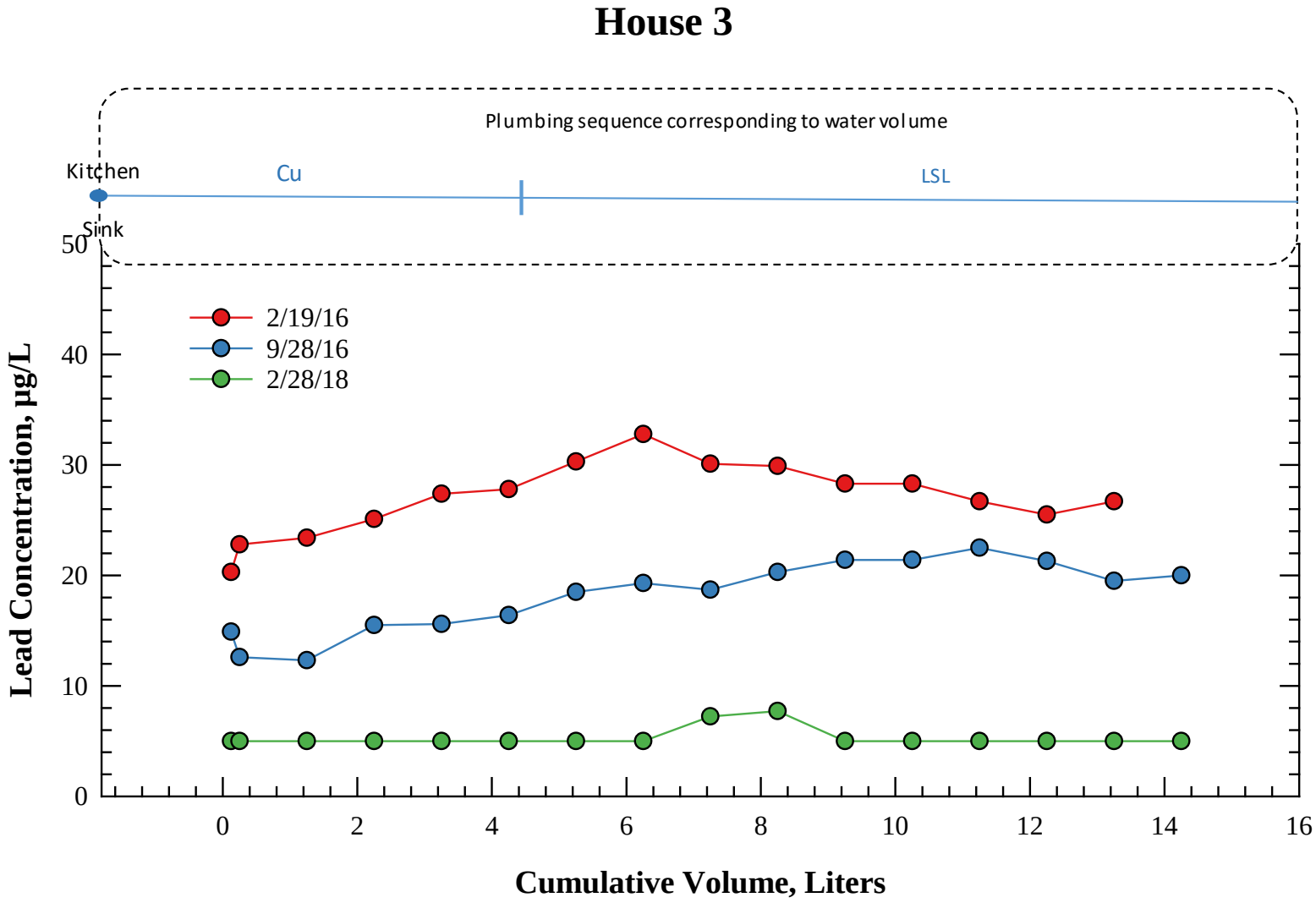


LCR and Sequential Sampling Results

House 1



Lead Sequential Profiles



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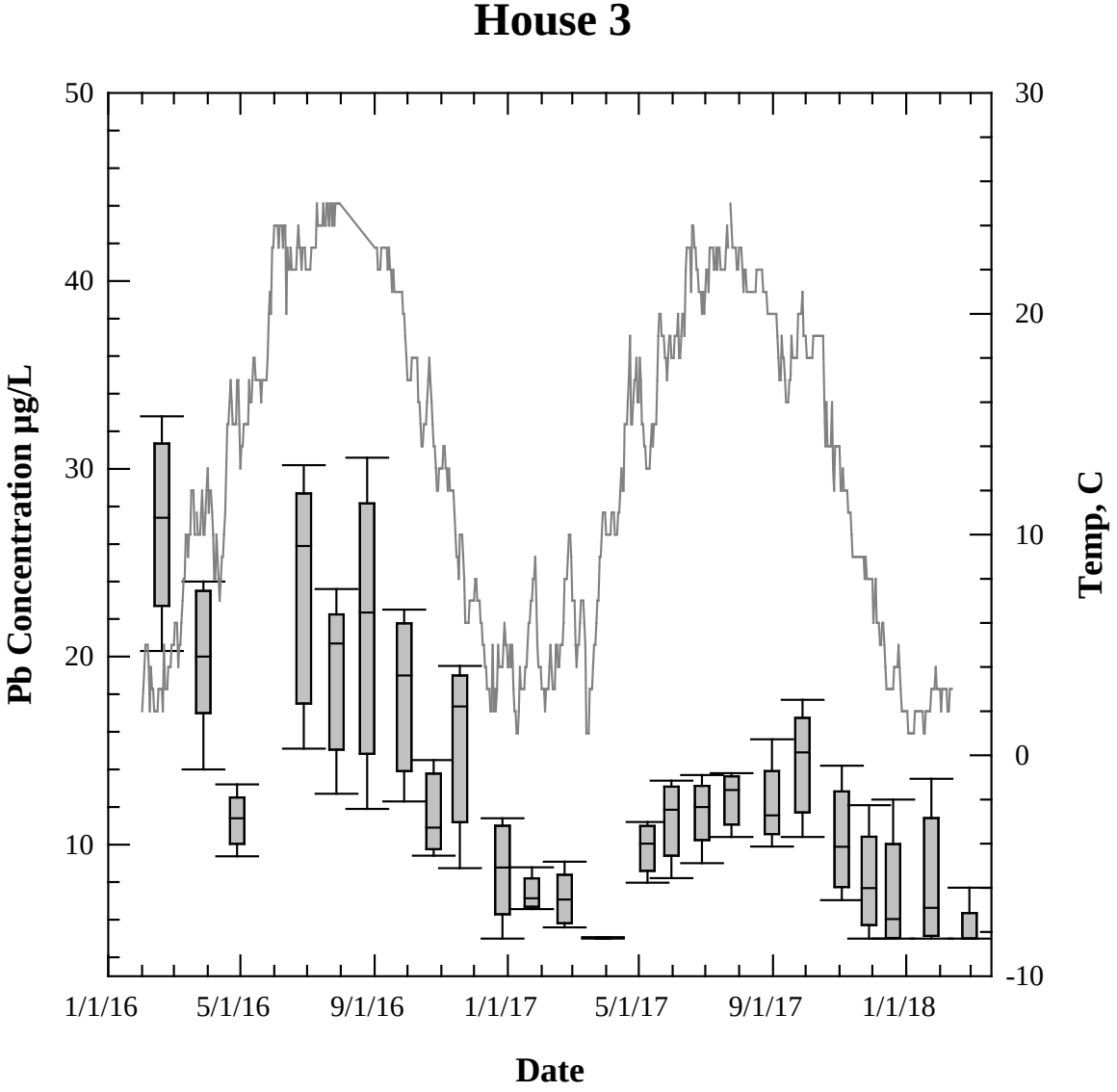

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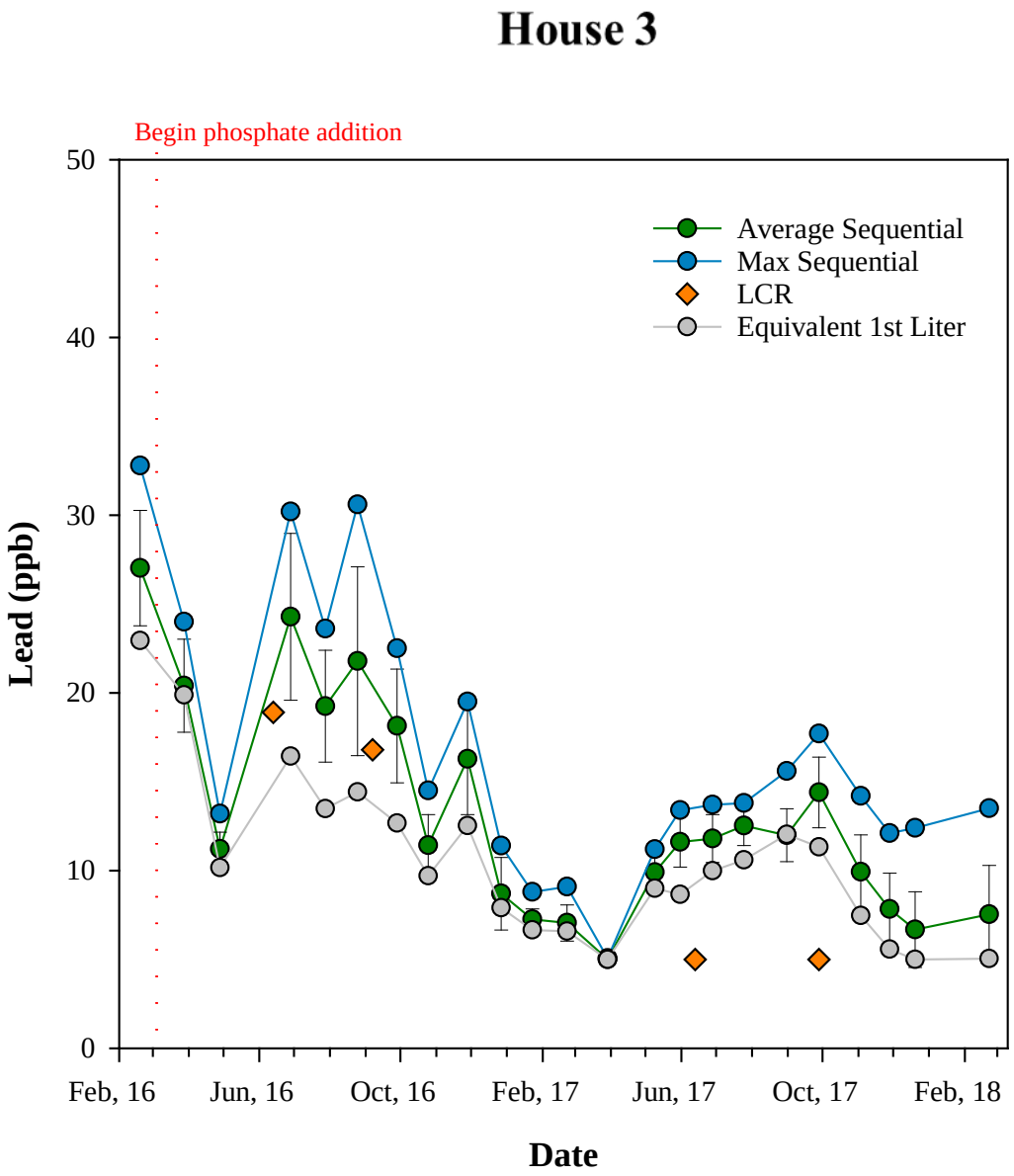
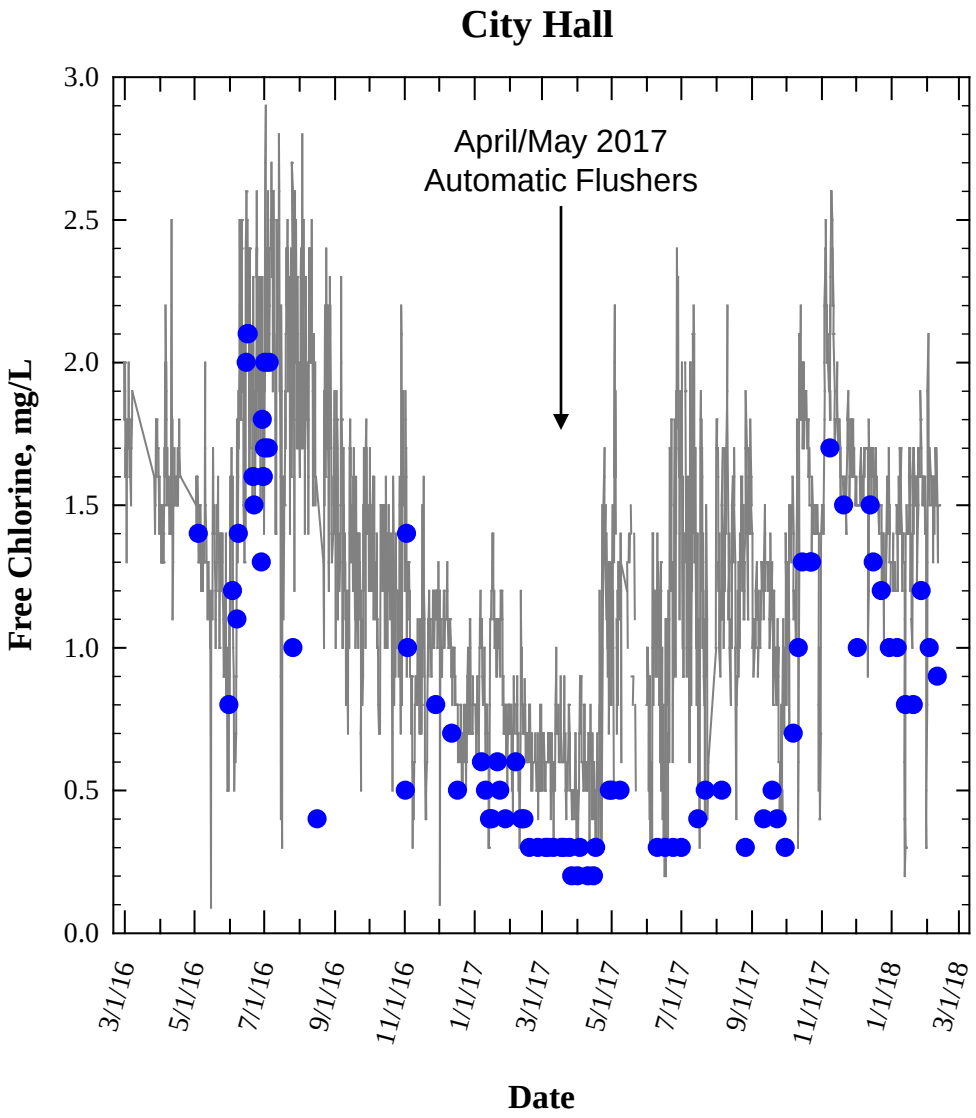


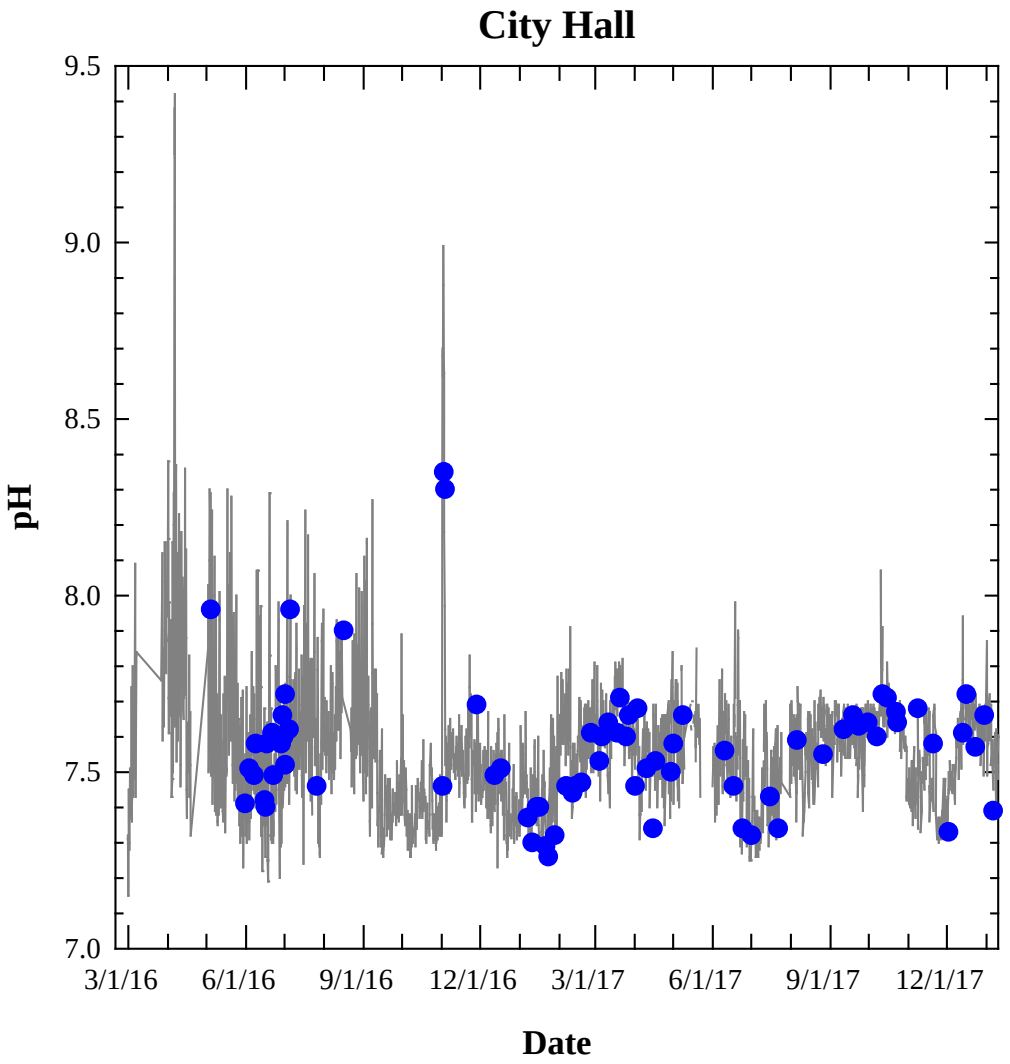
Plant Tap and Distribution

Free Chlorine



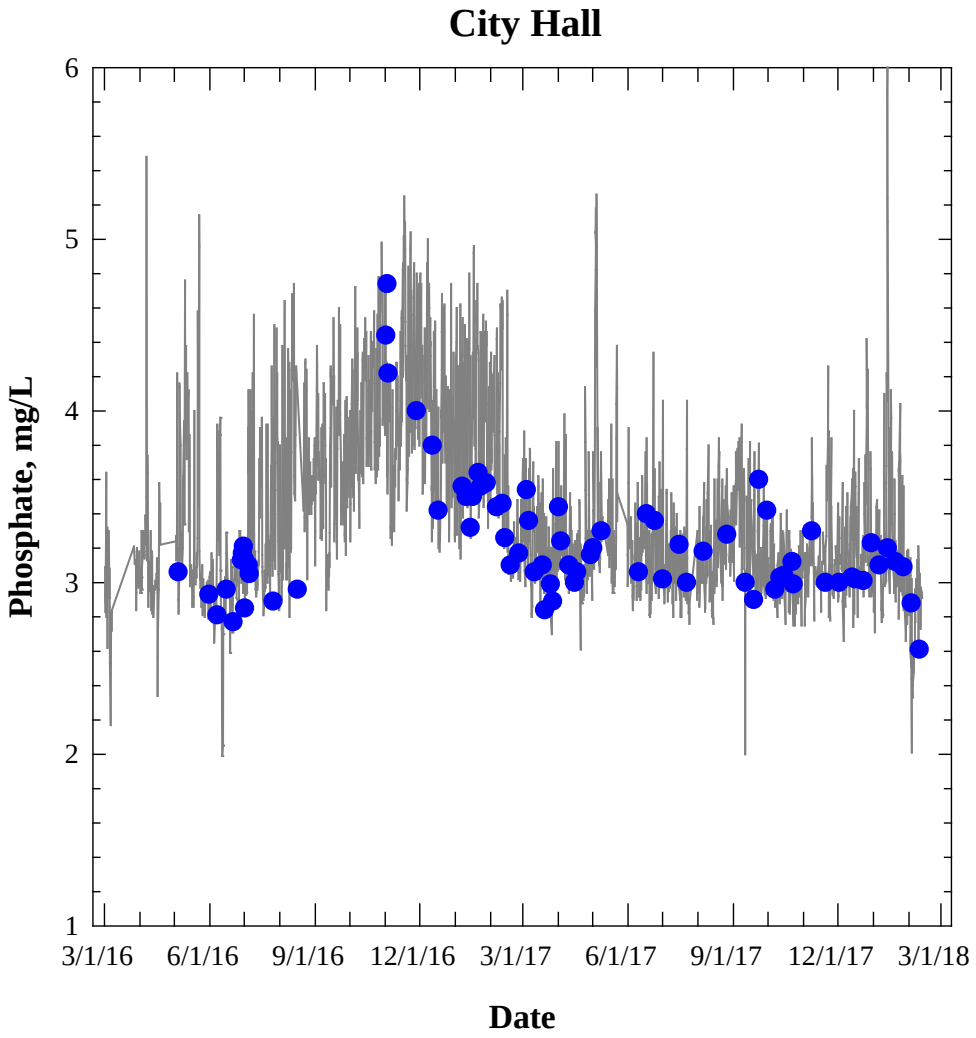
Plant Tap and Distribution

pH



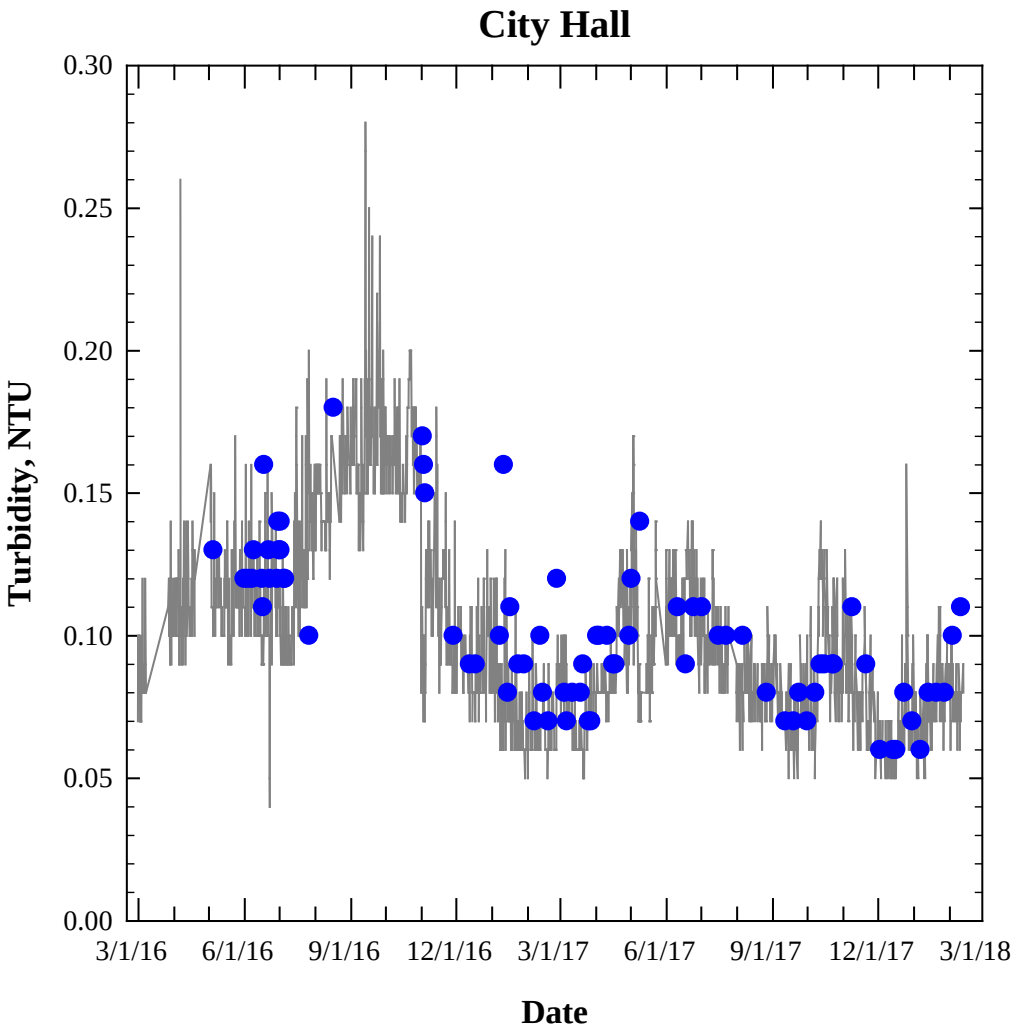
Plant Tap and Distribution

Orthophosphate



Plant Tap and Distribution

Turbidity



Conclusions

- Medium-sized community water system with fluctuating source water exceeded lead action level (pH adjustment)
- Orthophosphate addition (3 mg PO_4/L goal) and pH adjustment (7.5 goal) were implemented
- Jar testing was used to screen for unintended consequences (precipitation of phosphates)
- Sequential sampling (and LCR sampling) was used to assess overall corrosion control progress with time
- Seasonal fluctuations in lead were observed
- Lead levels decreased with time
- Unintended consequences of orthophosphate treatment were not observed

United States Environmental Protection Agency

Notice

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Questions?

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Corrosion Control Treatment

MOR Data 2010-July, 2017

- Some water quality parameters are missing data from 2016.

	2010-2015	Range	Jan 2016- Sep 2016	Range	Sep 2016- July 2017	Range
Highest pH	5.68-8.51	2.8	7.32-9.42	2.1	7.28-8.99	1.71
Alkalinity	6.25-238	232			62-168	106
Average Turbidity	0.04-0.27	0.23			0.05-0.15	0.1
Lowest Free Chlorine	0.2-3.5	3.3	0.3-2.4	2.1	0.3-1.6	1.3

- Water quality variability was high.
  - Source water may be responsible for operational difficulty and high range in alkalinity.
- Low operational variability is essential to maintaining a corrosion control program