City Council

Copper Pinhole Leaks – Consultant Report

October 27, 2020

CITY OF FOLSOM

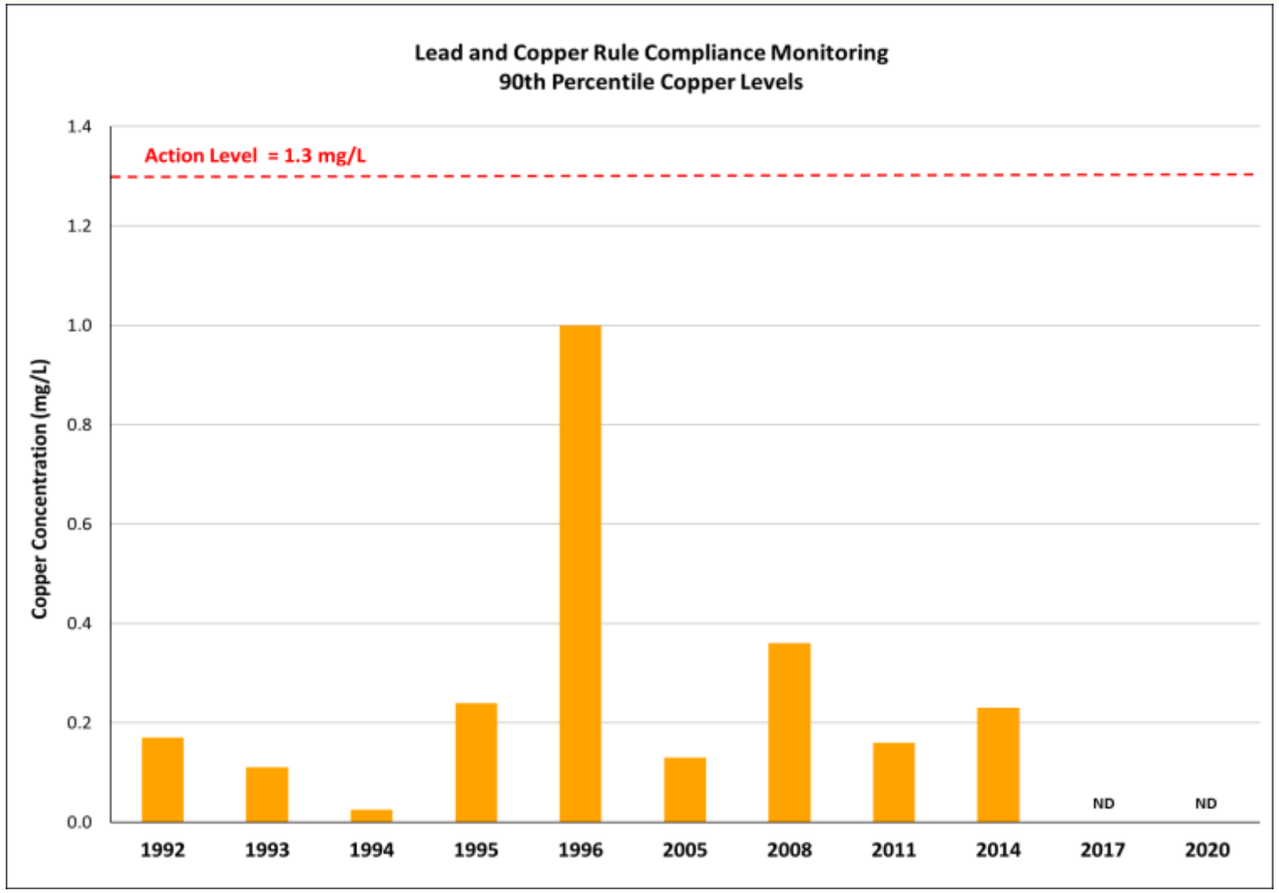
Consultant Analysis

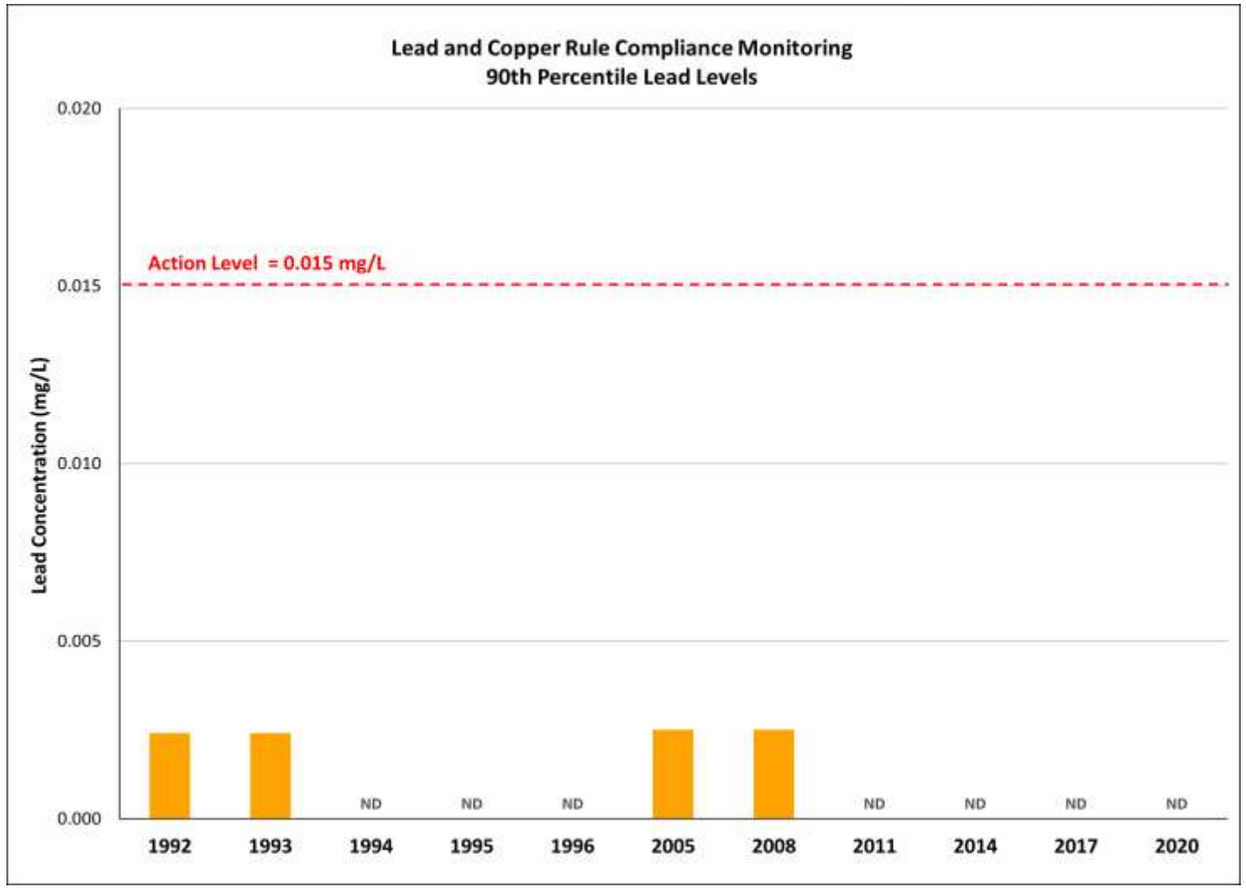
- Water Quality Analysis – Black & Veatch
  - Examined 10 years worth of City data
    - Chlorine, pH, sulfates, alkalinity, water hardness, metals
    - Regulatory compliance – State and Federal Drinking Water Standards
      - Specifically Lead and Copper Rule (LCR)
- Pipe Forensics Analysis – Virginia Tech
  - Pipe scale imagery
  - Associated elemental composition of the pipe scale
  - Percent composition of the scale

Lead and Copper Rule

- 1986 Safe Drinking Water Act
  - Lead free plumbing – less than 8% lead content
- 1991 Lead and Copper Rule
  - Ensure lead and copper not leaching into drinking water
  - City required to sample 30 homes built before 1986
  - City selected over 50 homes to sample
- 2014
  - Rule updated to less than 0.2% lead content
- City qualified for triennial monitoring due to good results
  - Recent LCR sampling occurred in July 2020

LCR Results





City is in compliance and below the maximum contaminant limits (MCL) under the LCR

Water Quality Analysis – Key Parameters

ANALYTE	UNITS	MIN	5TH PERCENTILE	AVERAGE	95TH PERCENTILE	MAX	SECONDARY MCL
pH [1]	Standard units	6.1	7.1	8.2	9.2	10.45	6.5-8.5
Alkalinity [2]	mg/L as $CaCO_3$	18	18	25	34	35	–
Hardness [2]	mg/L as $CaCO_3$	12	17	23	31	33	–
Total Dissolved Solids (TDS) [2]	mg/L	24	34	47	59	70	500
Calcium [2]	mg/L	3.5	4.6	6.3	8.3	9.3	–
Magnesium [2]	mg/L	1.1	1.1	2.0	3.0	4.8	–
Chloride [2]	mg/L	3.3	3.5	5.3	9.2	9.9	250
Sulfate [2]	mg/L	0.5	1.1	2.3	3.5	11	250
Chlorine Residual [4]	mg/L Cl_2	0.1	0.8	1.1	1.5	2.0	MRDL: 4.0
Total Organic Carbon, TOC [2]	mg/L	0.6	0.7	1.0	1.5	1.8	–
Calculated Corrosion Indicators							
Langelier Saturation Index, LSI [3]		-2.3	-2.1	-1.2	-0.3	-0.2	Noncorrosive

Secondary MCL: Secondary Maximum Contaminant Level
MRDL: Maximum Residual Disinfectant Level
[1] Data collected from online analyzers from 2016-2020
[2] Data collected from select grab samples from 2010-2020
[3] Data collected from select grab samples from 2016-2020
[4] Data collected from daily log sheets 2010-2020 at Tower Reservoir (located near entry point in the distribution system)

Water Quality Analysis - Findings

- pH typically in the 8-9 range with a low of 6 and a high of 10.4
- Source water is very pure:
  - Low alkalinity
  - Low hardness
  - Low calcium
  - Low total dissolved solids
- Chlorine residuals leaving treatment plant sufficient to maintain residual in the distribution system
- Limited buffering capacity of City's finished water due to source water purity
- Langelier Saturation Index (LSI) – corrosion indicator for water and appropriate to use for pH adjustments

Buffer Capacity

- Buffering capacity describes the water's ability to resist changes in pH
- Due to the City's water purity, only a small dosage of lime is needed to increase the pH of the City's water
- Treatment pH adjustment
  - Based on LSI (average is -1.2 for City's finished water)
  - Adjust lime dosage to keep LSI from decreasing
  - Successful in meeting LCR

Langelier Saturation Index

- LSI is a corrosion indicator used to adjust finished water quality parameters
- Determined using a calculation that includes pH, alkalinity, calcium, total dissolved solids (TDS), and temperature
- Due to the purity of the City's source water, the alkalinity, calcium and TDS are very low, which results in a negative LSI
- Negative LSI indicates water is deficient in minerals
- Positive LSI indicates water is over saturated with minerals
- Neutral LSI is in the range of 0.5 to -0.5
- City LSI average is -1.2

pH Analysis

- Seasonal fluctuations observed (pH lower in summer) in source water
- System pH can become variable
  - Water temperature
  - Interaction with pipe surfaces
  - Residual lime in distribution system reservoirs
- Finished water pH fluctuations begin in 2017
  - 2016 permit amendment for pH adjustment based on LSI
- Finished water pH typically around 8.5
- Due to LSI and low buffering capacity, pH became more variable

Pipe Scale Analysis

- 8 pipe samples delivered to Virginia Tech
- Physical tests conducted
  - Inductively coupled plasma mass spectrometry (ICP-MS)
  - Electron scanning microscopy with X-Ray energy dispersive system (EMS-EDS)
- Tests show elemental composition of pits and percent composition by weight
- Sulfide “spot test” ruled out sulfide reducing bacteria
- Tests indicate that the copper pipe is not defectively thin

Copper Pitting

- Pitting corrosion localized at specific sites
- Pitting involves removal of copper ions from the specific site
- Scale is blue/green in color
- Pit becomes more acidic when ions are removed
- Pit tries to draw in chloride and sulfate ions to balance electrons
- Process makes the pit salty (increases corrosivity)

Consultant Conclusions

- City's treated water meets State and Federal Regulations
- LCR compliance for optimal corrosion control
- Pits are likely copper oxide
- Copper is main element found with trace amounts of other elements, including aluminum
  - Aluminum concentrations of 0.5 % or more by weight can catalyze copper pitting in very clean water
- Aluminum below National Secondary Drinking Water Regulation of 0.20 ppm (water samples show "non-detect" leaving treatment plant)
- No evidence of microbial activity
- Sulfide reducing bacteria ruled out

Consultant Conclusions

- Water with low alkalinity, low calcium, pH above 9 and free chlorine could contribute to pitting:
  - With impurities in the pipe
  - With sediment in the pipe

“Impurities in copper pipes are natural and could be from manufacturing like microscopic burrs, ions other than copper included in the metal, or remnants of cleaning solutions. Storage, transportation, installation, and soldering could all introduce additional impurities, but research studies have shown that while impurities can provide a site to start pitting, their presence is not necessary for pitting to occur in all situations.”

Consultant Recommendations

- Add orthophosphate to the treatment process
  - Has been shown to inhibit pit initiation
  - Can help slow or even mitigate pit propagation
- Strive to maintain target pH of 8.5
- Start with small increments of orthophosphate
  - 0.1 parts per million (ppm) in the first week (10/8)
  - 0.2 ppm the second week (10/15)
  - 0.3 ppm the third week
- Samples from households in each pressure zone
- Maintenance dose based on results of sampling
- Continue to sample/monitor for Aluminum

Report a Leak, Learn More

- For questions or to report a pinhole leak:
  - Call 916-461-6190, or
  - Email waterquality@folsom.ca.us
- Pinhole Leak Webpage:
  - www.folsom.ca.us/pinholeleaks
- Community outreach:
  - News media
  - NextDoor
  - Facebook
  - Twitter
  - E-newsletter
  - City website
  - **Direct mailer survey**

QUESTIONS?