# The Lead and Copper Rule
# Cedar Rapids' Journey to Compliance

Barb Wagner, Cedar Rapids Water Department
Shelli Lovell, Central Iowa Water Association
John North, Iowa Association of Water Agencies

# Iowa's Drinking Water: Could Flint Happen Here?

- In the early 1990s, Cedar Rapids' was in violation of the new standard for lead in drinking water. The exceedance was:
  - Major, extensive & over a prolonged period of time
  - Both similarities & dissimilarities between events in Flint and Cedar Rapids
- This presentation will discuss:
  - Scope and nature of the Cedar Rapids' lead corrosion phenomenon
  - Our response – Initial and long-term
  - How we ultimately achieved compliance
  - Lessons learned
- This presentation will also discuss:
  - Our "dirty laundry" – what we should have done better or differently
  - Our "points of pride" – what we did right

# Lead and Copper Rule (LCR)

National Primary Drinking Water Regulation (NPDWR)
Promulgated on June 7, 1991

- Addresses corrosion of lead and copper in drinking water primarily from lead service lines and household plumbing (brass fixtures)

- Maximum Contaminant Level Goals (MCLGs)
  - Lead - 0 ug/l (micrograms per liter)
  - Copper – 1.3 mg/l (milligrams per liter)

- Requires a treatment technique (optimized corrosion control) rather than a Maximum Contaminant Level (MCL)

- Tap Sample results are compared to an Action Level (AL) standard
  - Lead - 15 ug/l (or 0.015 mg/l)
  - Copper - 1.3 mg/l

- Action level for lead is a screen or indicator for optimal corrosion control. It is based on treatment feasibility; NOT on a health threshold

# Regulatory Standard for Lead in Drinking Water

- Prior to June 1991
  - Maximum Contaminant Level (MCL) for Lead - 50 ug/l
  - Sampled at the point of entry into water distribution system
  - Lead rarely detected and compliance generally not an issue
- Subsequent to June 1991
  - Action Level for Lead – 0.015mg/l (or 15 ug/l)
    - Monitoring – At representative locations in distribution system deemed to be highest risk
    - Minimum # of samples based on population (CR minimum - 100 samples)
    - 90% of all sample results had to be less than the AL of 15 ug/l
  - Sampling Protocol: Conditions/locations most conducive for lead corrosion
    - Homes with lead service lines
    - Homes constructed between 1982-1986
    - First-draw samples after period of prolonged non-use (6 hours minimum)

# Lead and Copper Rule
# Regulatory Intent and Goals

- Universal Concerns re: Detrimental Health Effects of Lead
  - Young children
  - Pregnant women
  - All consumers
- Lead and Copper Rule
  - Provide a protective standard for water as it **consumed or used**
  - Complement other new standards for lead content (e.g. solder, brass fixtures)
- Potential Sources of Lead (corrosion or leaching)
  - Lead Service Lines
  - Lead Solder Joints
  - Brass Fixtures – faucets, water meters et al.

# Exceedance of the Action Level Actions Triggered

- If the 90th percentile of a systems lead sampling results exceed the Action Level for lead, a system must:
  - Optimize corrosion control
    - Identify and install optimal corrosion control treatment
    - Comply with State-specified optimal water quality control parameters
  - Public Education
    - Mandatory language for pamphlets and brochures on lead
    - Media notice (radio, TV and newspaper)
    - Deliver informational materials to:
      - All customers
      - Organizations that serve sensitive subpopulations (e.g. schools, pediatricians)
  - Triggered Lead Service Line Replacement
    - Required if unable to achieve compliance (via corrosion-control treatment strategy)
    - Replace the portion of the lead service lines owned by the water utility
    - Offer to replace the customer's portion of the service line at cost
    - Replace 7% of lead service lines each year

# Cedar Rapids Water System

- Water Service Line Materials - Prior to about 1945 to 1947
  - Lead line – From Main to Stop Box (Utility owned and responsibility)
  - Galvanized Pipe – From stop box to house (Property owner's responsibility)

- Monitoring Sites for LCR Compliance in 1992
  - Homes with lead service lines
    - Older homes in core or older, central area of Cedar Rapids
    - Higher percentage of lower-income families

  - Homes constructed between 1982-1986
    - New home construction concentrated in two new developments on fringes of CR
    - Predominantly middle to higher income families

# Cedar Rapids Water System

- Corrosion Control Strategy – Prior to 1992
  - Finished water chemistry
    - Shallow alluvial wells, lime softening and chloramination
    - pH @ 9.3
    - Addition of Polyphosphates as a corrosion inhibitor
    - A slightly positive Langelier Index (i.e. water tends to deposit protective coatings)
- Immediately prior to first round of compliance monitoring
  - General Assumption: Protective biofilm/deposition layer was in place
  - Conducted preliminary monitoring
    - Limited number of samples (about 20)
    - Majority taken from homes with lead service lines
    - No indication of significant lead corrosion and/or possible compliance issues

# CRWD – First Round of Compliance Monitoring

## January – July 1992

- Regulatory Compliance Requirements
  - Minimum of 100 samples
  - Locations and conditions (first-draw, 6 hours of non-use) most conducive to lead corrosion
  - 90th percent value for lead test results must be < 0.015 mg/l
- Lead Monitoring Results
  - Samples – 105 locations
  - 90th percent value - 0.055 mg/l (Or 2.7 times higher than the A.L.)
  - # of samples exceeding A.L. – 59 (Or 56% of all samples)
  - Average Value – 0.027 mg/l
  - Median Value – 0.017 mg/l
  - Maximum Value – 0.174 mg/l
- Front Page of USA Today as a "Top Ten City for Lead Levels in Drinking Water"

# CRWD's Initial Response

- Hired a consulting engineer
- Continued to monitor representative sites
- Conducted bench tests to evaluate water chemistry adjustments
- Consulted with Iowa DNR
- Implemented new finished water chemistry in November 1992
  - Switched from polyphosphates to zinc orthophosphate ($ZnPO_4$)
  - Added zinc orthophosphate at a higher than normal dose
  - Lowered finished water pH to 8.3 (from prior 9.3 target)
- Second round of compliance monitoring completed in Nov-Dec, 1992
- We shared test results with home owners

# Lead Compliance Monitoring Results through Round # 2

| | Round # 1<br>Jan-Jun, 1992 | Round # 2<br>Nov – Dec, 1992 |
|---|---|---|
| # of samples | 105 | 101 |
| 90th Percentile Value | 0.055 mg/l | 0.042 mg/l |
| # exceeding the A.L. | 59 | 50 |
| Mean Value | 0.027 mg/l | 0.029 mg/l |
| Median Value | 0.017 mg/l | 0.015 mg/l |
| Maximum Value | 0.174 mg/l | 0.428 mg/l |

# Lead Compliance Monitoring Results through Round # 3

| | Round # 1<br>Jan-Jun, 1992 | Round # 2<br>Nov – Dec, 1992 | Round # 3<br>December 1994 |
|---|---|---|---|
| # of samples | 105 | 101 | 103 |
| 90th Percentile Value | 0.055 mg/l | 0.042 mg/l | 0.026 mg/l |
| # exceeding the A.L. | 59 | 50 | 15 |
| Mean Value | 0.027 mg/l | 0.029 mg/l | 0.011 mg/l |
| Median Value | 0.017 mg/l | 0.015 mg/l | 0.002 mg/l |
| Maximum Value | 0.174 mg/l | 0.428 mg/l | 0.472 mg/l |

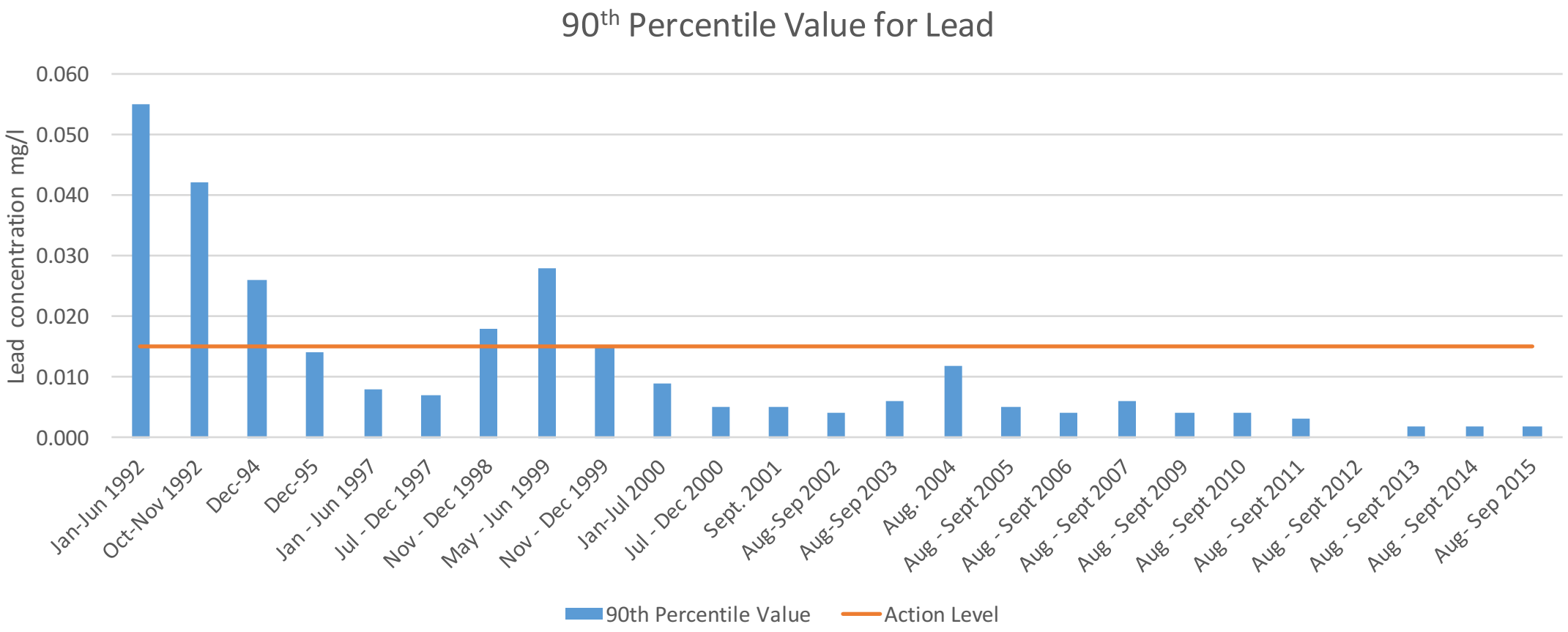
# Lead Compliance Monitoring Results through Round # 4

| | Round # 1<br>Jan-Jun, 1992 | Round # 2<br>Nov – Dec, 1992 | Round # 3<br>December 1994 | Round # 4<br>December 1995 |
|---|---|---|---|---|
| # of samples | 105 | 101 | 103 | 100 |
| 90th Percentile Value | 0.055 mg/l | 0.042 mg/l | 0.026 mg/l | 0.014 mg/l |
| # Exceeding the A.L. | 59 | 50 | 15 | 10 |
| Mean Value | 0.027 mg/l | 0.029 mg/l | 0.011 mg/l | 0.006 mg/l |
| Median Value | 0.017 mg/l | 0.015 mg/l | 0.002 mg/l | 0.003 mg/l |
| Maximum Value | 0.174 mg/l | 0.428 mg/l | 0.472 mg/l | 0.027 mg/l |

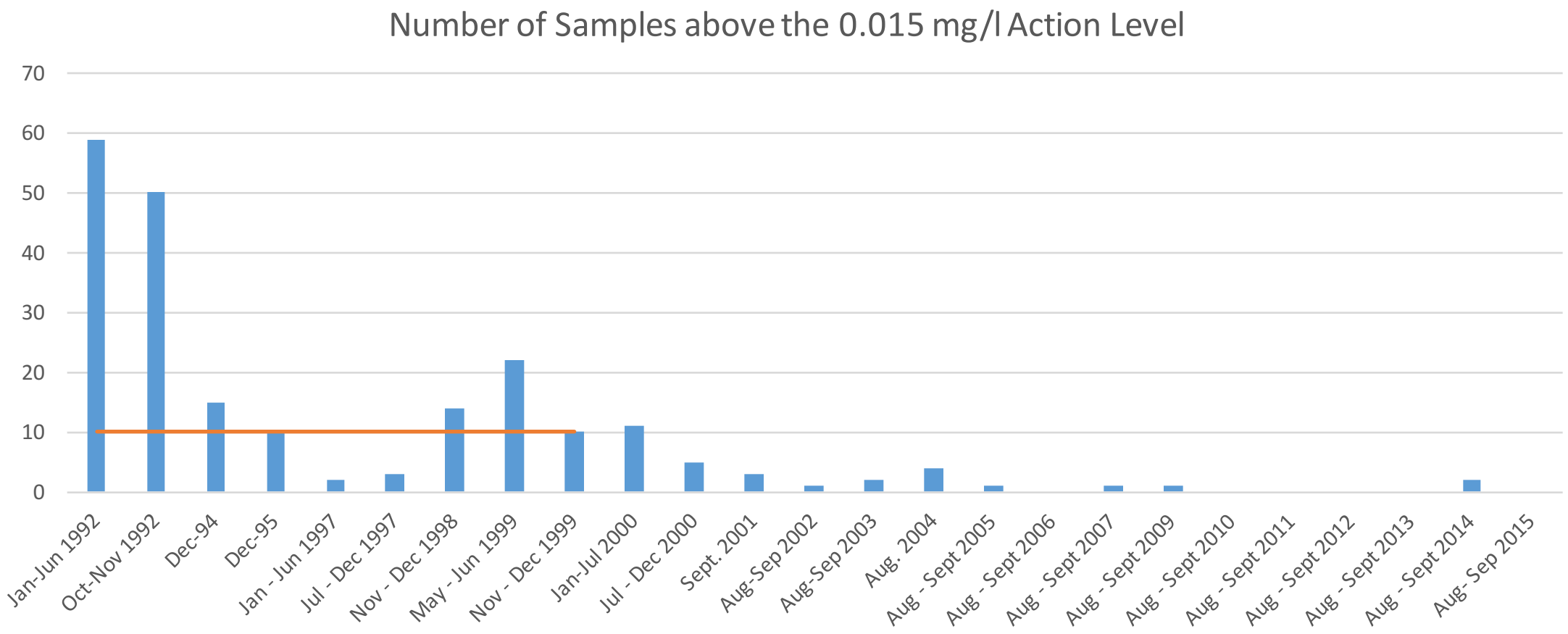
# Exceedance Excursions
# Rounds # 7, # 8 & # 9

| | Round # 7<br>Nov- Dec, 1998 | Round # 8<br>May - June, 1999 | Round # 9<br>Nov- Dec 1999 | Round # 10<br>Jan- July 2000 |
|---|---|---|---|---|
| # of samples | 100 | 100 | 100 | 191 |
| 90th Percentile Value | 0.018 mg/l | 0.028 mg/l | 0.015 mg/l | 0.009 mg/l |
| # Exceeding the A.L. | 14 | 22 | 10 | 11 |
| Mean Value | 0.008 mg/l | 0.012 mg/l | 0.006 mg/l | 0.004 mg/l |
| Median Value | 0.002 mg/l | 0.004 mg/l | 0.003 mg/l | 0.002 mg/l |
| Maximum Value | 0.201 mg/l | 0.133 mg/l | 0.071 mg/l | 0.090 mg/l |

# Lead Compliance Monitoring Summary 1992 through 2015



# Lead Compliance Monitoring Summary 1992 through 2015



# CRWD's Research and Response
# Extensive and Prolonged Distribution System Monitoring

- Research and Monitoring at "High-Risk" Homes
  - Homes with lead service lines or constructed between1982 -1986
  - First-Draw lead & copper samples
  - Water chemistry profiles
  - Two or more locations in same home
  - Analysis of multiple, sequential one – liter samples
    - Lead service lines: Capture & analyze water in direct contact with lead service line
    - 1982-86 Homes: Lead corrosion at the faucet or elsewhere in home's plumbing system?
  - Analysis of Samples – Unfiltered & filtered (Soluble or particulate matter?)

- Monitoring throughout Distribution System to ensure:
  - No degradation of general water quality parameters
  - No loss of disinfectant and/or bacterial growths
  - Appropriate dispersion of corrosion inhibitor – $ZnPO_4$

# CRWD's Research and Response
# Extensive and Prolonged Loop Studies

- 8 - 10 Loops constructed to simulate home's internal plumbing system
  - Approximately 25 feet of copper piping with and w/o solder joints
  - Faucets
  - Solenoid valves/timers for controlled "flow usage or flushing"
- Research focus or "variables" studied
  - Water chemistry
  - Corrosion inhibitors
    - Different Products: Polyphosphates, Zinc Orthophosphate, Phosphoric Acid, et al
    - Different Manufacturers or formulations of same "generic" product (especially ZnPO4)
    - Different concentrations of same product
- Research and Monitoring Activities
  - Water chemistry profiles
  - Monitoring of first-draw lead & copper samples
  - Analysis of sequential one – liter samples
  - Analysis of Samples – As collected (unfiltered) then filtered

# CRWD's Research and Response Distribution System

- Implemented Policy: Remove lead service lines at every opportunity
  - Street projects
  - Water line replacement projects
  - Water main and service line breaks
- Encouraged home owners: Replace your portion of service line (galvanized)
  - Major projects: CRWD solicited unit cost quotes for service line replacement work
  - For financially strapped customers:
    - CRWD underwrote the service line replacement costs incurred by the customer
    - Customer repaid the CRWD over five years via a surcharge on their utility bill

# CRWD's Research and Response
# Extensive Public Relations & Information Efforts

- Our Commitments or Guiding Principles:
  - Protection of Public Health is Paramount
  - Be fully open and honest
  - Be as responsive as possible to public inquiries and concerns
- Mailings and Distribution of Informational Materials
  - EPA Mandated Information and Language
  - Additional Information about:
    - Scope and nature of the lead corrosion problem
    - Current activities
    - Strategic plan for identifying & implementing "treatment regimen for optimal corrosion control"
- Targeted Mailings and Outreaches
  - Schools, day care centers, et. al.
  - Pediatricians and other health care providers
- Coordinated and worked closely with:
  - Linn County Health Department
  - Local news media, especially the CR Gazette
  - Iowa Department of Natural Resources
- Regular Status Reports to City Council (televised)

# Lessons Learned – Scientific & Research Findings

- Water chemistry and lead corrosion are complex
  - Multiple factors may affect or contribute to lead corrosion
  - There are no simple explanations or causes
  - There are no easy answers
  - There are trade-offs (e.g. Zinc creates a compliance challenge for WPC)
- Possible factors that might affect lead corrosion
  - Raw water source – surface water, shallow or deep wells
  - Type of water treatment (minimal treatment or lime softening or other method)
  - pH of the finished water
  - Stability of finished water (slightly depositing versus slightly corrosive)
  - Corrosion Inhibitor – type and feed rate
  - Disinfection method – chlorination or chloramination

# Lessons Learned – Scientific & Research Findings

- Switch in water chemistry & corrosion inhibitor
  - Is a slow, long-term endeavor
  - May experience "spikes" during the transition
- Lead Service Lines were **not** a major source or contributor in CR
  - Demonstrated via analysis of samples in prolonged, direct contact with lead
  - High test results due to newly installed faucets and/or recent plumbing work
- Preponderance of high results were from homes constructed 1982-1986
- Brass fixtures and/or solder joints were likely the primary "culprits" in CR
- Occasional high results likely due to lead particles (i.e. not soluble lead)

# Other Questions, Observations & Musings

- Some brass (manufacturers, lots etc.)might be more susceptible to corrosion
  - Monitoring of similar sites showed consistent & significantly different levels of lead
    - Monitoring of immediately adjacent homes - same contactor, age and brand of faucets
    - Monitoring of multiple faucets in same home to include side-by-side units in a master bathroom
  - Replaced a “problem” faucet – new unit in compliance within 30 days
  - Anecdotal evidence that some imported brass might have been more susceptible to lead corrosion
  - Quality of plumbing workmanship a possible factor (excessive, loose solder?)

- Apparent variation in efficacy of $ZnPO_4$ from different manufacturers

- Zinc Orthophosphate has some aesthetic issues
  - Discoloration of plumbing fixtures
  - Discoloration of toilet tanks

# Other Questions, Observations & Musings

- Was the treatment regimen change the “right, long-term” decision?
  - No compliance issues @ other Iowa cities with comparable water treatment regimens
  - Lament: Not able to research why the prior treatment regimen/inhibitor failed

- Explanation for efficacy of the new treatment regimen/corrosion inhibitor?
  - $ZnPO_4$ provides a more effective protective layer than polyphosphates?
  - Readily available lead and lead particulate matter were leached/flushed over time?
  - Or some combination of the above factors?
  - Or other unknown factors?

# Other Questions, Observations & Musings

- Cedar Rapids expended an enormous amount of money & time in researching/resolving its lead corrosion problem (Est. @ $1.0 Million plus)
- In a "perfect world", a more beneficial use would be removal of lead-based paint from homes

- CRWD compiled a significant amount of monitoring data, observations and information regarding CRWD's lead corrosion challenges
- Lament is that we did not have the time and resources to do so in a fully comprehensive, methodical manner that would facilitate research of the lead corrosion phenomenom (e.g. scientific publication)

# Lessons Learned – “Crisis Management”

- Best Approach
  - Recognize that Protection of Public Health is the ultimate goal
  - Be open and honest
  - Admit when you don’t know
  - Citizen Concerns: Listen, acknowledge concerns and demonstrate empathy
  - Communicate, communicate, communicate!
  - Do the “Right Thing for the Right Reason”
- Allow appropriate individuals to make the appropriate decisions
  - Primary focus should be the problem(s) and solution(s)
- Recognize that others will call into question your individual or team’s
  - Professional competency
  - Honesty and integrity

# Lessons Learned – A "Self-Critique"
# What we did wrong or wish we could have done better

- We were too complacent! Prior to compliance monitoring, we should have:
  - Been more questioning – Is this the optimal finished water chemistry & corrosion inhibitor?
  - Done more sampling – Do we have a problem?
- We put ourselves in a position where we had to make decisions "on the fly"
  - What is the optimal water chemistry and corrosion inhibitor for CR?
  - Will the "quick and dirty" bench studies work on a system-wide scale?
  - Did we make the right or best decision for the long-term??
- "The Crisis was managing us – We were not managing the Crisis!"

# A “Self-Critique” What We Did Right!

- After our wake up call, We
  - Acknowledged the situation
  - Made Protection of Public Health our primary focus
  - Marshalled all of our resources
  - Worked as a team and were relentless and determined in our efforts
- We deferred to Medical Professionals re: potential health issues
  - Linn County Health Director: “Three primary causes of elevated lead levels are lead-based paint, lead-based paint, and lead-based paint”
- CR City Leaders and Citizens
  - Deferred to us on technical matters ***
  - Priority – Researching and resolving the problem ***
  - Minimal finger-pointing, posturing and “CYA” activity ***
  - Allowed us an opportunity to regain their TRUST ***

*** There were some exceptions

# The CRWD "Response Team"

- Citizens of Cedar Rapids
  - Mayor and Council, especially Mayor Serbousek & Councilman Lyle Hanson
  - Customers, especially those that served as sample sites
- Cedar Rapids Water & WPC Departments
  - Laboratory – Tom Noth, Roger Pfeiffer, Barb Wagner
  - CRWD Staff – especially customer service and plant maintenance crew
  - Cedar Rapids WPC Laboratory – completed all the metal analyses
- Local Agencies – Linn County Health, CR Gazette & local news media
- Iowa DNR – Dennis Alt, Roy Ney and Diane Moles

# Ways to Reduce Potential Exposure to Lead in Drinking Water

- Always flush line before drawing water for consumption purposes (drinking, preparation of food or baby formula)
  - After prolonged periods of non-use: Flush until water is as cold as it is going to get
  - During periods of normal use: Flush long enough to purge the water in direct contact with the faucet
- **Never Use Hot Water** for consumption purposes (drinking, preparation of food or baby formula)
  - Hot water will leach lead much faster than cold water
- Questions about your drinking water
  - Consumer Confidence Report (Water Quality) – Posted on line
  - Contact your water utility