Lead Service Line Replacement

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Lead and Copper Rule (LCR)

- National Primary Drinking Water Regulation (NPDWR) promulgated **June 7, 1991**
  - Addresses corrosion of lead and copper in drinking water
    - primarily from service lines and household plumbing
  - Maximum Contaminant Level Goals (MCLG)
    - Lead – 0 µg/L
    - Copper – 1.3 mg/L
  - Requires a treatment technique (optimized corrosion control) rather than a Maximum Contaminant Level (MCL)
  - Tap sampling results are compared to an action level
    - Lead - 15 µg/L
    - Copper - 1.3 mg/L
  - Action level for lead is a screen for optimal corrosion control as part of the treatment technique. It is based on treatment feasibility; NOT on a health threshold (applies to systems serving < 50,000 people)

LCR Sampling Protocol

- Goal – To sample at sites likely to have the highest lead levels in 1991
  - Select sites based on newest leaded solder and lead service lines which were considered major lead sources
  - Collect first draw samples from cold water kitchen or bathroom tap – minimum 6 hours standing time
- 1-Liter first-draw sample
- Residents may take samples, if instructions are provided by the water system
  - Water system cannot challenge results based on sampling collection errors
- Sensitive life stages are not considered in site selection. Sites are selected to assess performance of corrosion control treatment, not to assess impacts of adverse exposure

Actions Triggered Under Action Level Exceedance

- If the 90th percentile of a system's lead sampling results exceed the action level, a system must:
  - Optimize corrosion control (for systems < 50,000 people)
    - Identify and install optimal corrosion control treatment
    - Comply with State-specified optimal water quality parameters
  - Public Education
    - Mandatory language for pamphlets and brochures on lead
    - Deliver materials to all bill-paying customers
    - Deliver materials to organizations that serve sensitive subpopulations (e.g., schools, pediatricians)
  - Lead Service Line Replacement
    - replace the portion of the lead service lines system owns
    - offer to replace the customer's portion of service line at cost
    - lines where samples are below action level are also considered replaced
    - replace 7% of the lead service lines each year

LCR Requirements
Lead Service Line Replacement

- Systems affected – systems exceeding the lead action level (AL) after installation of corrosion control treatment (CCT) are in the lead service line replacement program (LSLRP)
- Duration – 15 years or until system meets lead AL in two consecutive 6-month monitoring periods
- What is considered “replaced”?
  - Sites where lead levels from all service line samples are at or below 15 ppb
  - Physical replacement of at least the portion under the system’s control (control = ownership in 2000 LCR Minor Revisions Rule)
  - Full replacement where home owner pays for removal of the portion of the line that they own

1991 LCR Definition of "Control"

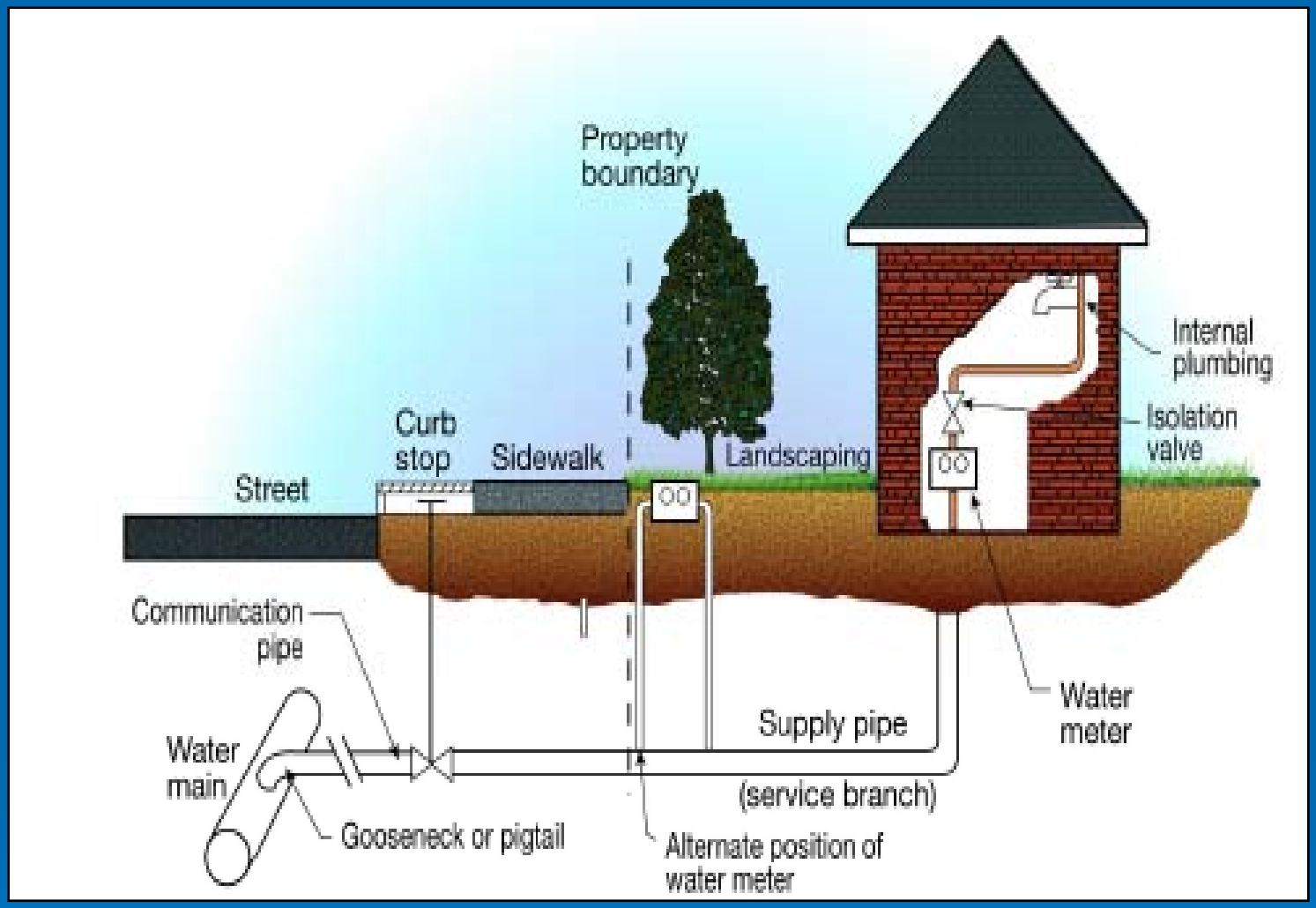
- Water system was required to replace the entire service line unless it could demonstrate that it controls less than the entire service line
- "Control" included:
  - Authority to set standards for construction, repair, or maintenance of the line
  - Authority to replace, repair, or maintain the line
  - Ownership of the line
- Provision was remanded by Court
  - Basis – Notice and Comment
  - Court did not address AWWA's substantive argument that EPA was without statutory authority to require replacement of private owned portions of service lines

Where Partial LSL Occurs

- Systems that exceed the lead action level after installation of corrosion control treatment ≈ **15** systems in the past two years
  - Sites with service line samples that exceed the lead action level (optional)
    - Sites where the homeowner is unwilling or unable to afford replacing their portion of the LSL
- "Voluntary" replacement – systems meets lead AL – much more common
  - Routine maintenance
  - Emergency repairs

LCR Requirements: Partial Lead Service Line Replacement

- Notify residents at least 45 days prior to partial replacement
  - Provide information on possibility of elevated short-term lead levels
  - Measures to minimize exposure
- After partial LSL replacement at a site
  - Collect sample representative of water in the partially-replaced LSL within 72 hours after replacement
  - Report results to owner and residents within 3 business days
- Sample is not intended to assess the effectiveness of the partial LSL replacement
  - Intended to reinforce pre-replacement notification
  - Sample would most likely come from remaining lead portion of line
  - Can be long gap between sample collection and receipt of results



60-67 ft total (utility 20-27 ft.) (Weston and EES 1990)

55 ft total (utility 25 ft.) (older areas)
68 ft total (utility 27 ft.) (newer areas) (AwwaRF 2008)

Partial Lead Service Line Replacement Studies

- Limitations
  - Many studies are voluntary replacements - not directly comparable to LCR
    - System meets lead AL
    - Many of the sites may meet AL
    - Lead levels likely to be lower at sites, which may limit reductions
  - Sampling Protocols
    - Many use first draw samples
    - Very few use long-term profile sampling to fully examine impact of partial LSL on lead levels

PLSL Studies for 2001 LCR Minor Revisions Rule

- Case Studies
  - Glasgow, Scotland – one site
    - First Draw and Random Daytime Draw samples
    - Very long service line – 10 meters replaced from 36 meter line
    - Lead levels >> Lead AL
    - Samples taken over 2-week period before replacement and one week, two months and four months after partial replacement
    - Average concentration at four months is 25% lower than before replacement
    - Lead levels still > AL

PLSL Studies for 2001 LCR Minor Revisions Rule

- Case Studies
  - Newport News – 1987 – nine sites
    - Samples collected at meter
    - Study predates LCR
    - Some sites > AL, others < AL
    - Samples taken – before replacement, just after replacement and two weeks after replacement
    - Lead levels at all sites two weeks after replacement <= before replacement

PLSL Studies for 2001 LCR Minor Revisions Rule

- Case Studies
  - Oakwood, OH – four sites
    - Multiple service line samples – 250 mL
    - Lead levels at sites < AL
    - Samples taken before replacement and over a 2-week period appr. 6 weeks after replacement
    - Lead levels at 3 of 4 sites were below the before replacement levels by second week of sampling
    - Fourth site only tested once at beginning of sampling period – slightly higher lead 8 ppb vs. 6 ppb

Recent PLSL Studies

- GCWW (Swertfeger et al, 2006)
  - 21 Sites – 5 no replacement, 5 PLSL, 6 PLSL w/Teflon sleeve, 5 full replacement
  - First draw (FD), 3-min flush, 10-min flush samples of 750 mL
  - Most before replacement samples > lead AL; pH adjusted from 8.5 to 8.8 prior to post-replacement sampling
  - Samples taken before replacement, week after replacement and monthly for a year
  - FD lead levels below pre-replacement levels within one month
  - Similar trend in 3-min flush samples taken at PLSL site in Figure 2 of article
  - Steady state average FD lead data: No replacement > PLSLR> PLSLR w/sleeve> FLSLR
  - FD lead levels at no replacement sites lower after pH adjusted from 8.5 to 8.8

Recent PLSL Studies

- AwwaRF 2008 (Sandvig et al)
  - Two sites – different utilities
  - First draw and profile sampling – sequential samples
  - One site > AL, one site < AL before replacement
  - Samples taken before, 1, 2, and 3 days after replacement and 1 and 2 months after replacement
  - Table 3.10 shows
    - Site < AL, 1st liter lead 2 months after replacement > before replacement, but still below AL
    - Site > AL, 1st liter lead 2 months after replacement < before replacement, but still above AL
    - Both sites, total lead based on all samples from profile showed a small reduction in total lead after two months

Recent PLSL Studies

- Guelph, Ontario, Canada (Muylwyk et al, 2009)
  - 2 sites
  - Profile sampling - 8 sequential 1-liter samples after 30-min stagnation
  - Sites > AL, no corrosion control at utility
  - Samples taken before replacement and after replacement at:
    - 1, 2, and 3 days
    - 1, 2, 3, 4 weeks
    - 2 and 3 month
    - Quarterly up to one year
  - Site 3
    - Spikes above before replacement levels up to week 4
    - Small reduction in maximum of first two liters after 1 year
  - Site 5
    - All samples below before replacement levels
    - Very large reduction in maximum of first two liters after 1 year

Recent PLSL Studies

- DC WASA (HDR Study – 2009)
  - Four sites have both pre and post-replacement samples from PLSL sites – all have some galvanized interior plumbing
  - Profile sampling
  - Samples taken before replacement and
    - 1 day after replacement
    - 2, 4, and 8 weeks after replacement
  - Results
    - G1: Some Pre-LSL samples > AL; 8 weeks results all < AL and PLSL < Pre-LSL
    - G2 : All in-house & service line Pre-LSL samples > AL; 8 weeks results PLSL > Pre-LSL in lead portion & PLSL < Pre-LSL in new copper portion
    - G3: Site < AL; 8 weeks results all < AL; and PLSL < Pre-LSL
    - M1: Some Pre-LSL > AL; 8 weeks results all < AL; and PLSL <= Pre-LSL

Full Lead Service Line Replacement

- AwwaRF 2008 (Sandvig et al)
  - Data from 13 sites in 4 different water systems
  - High lead concentrations observed at many sites in sequential samples for up to 3 days
  - Flushing for 15 min after replacement and again the next day did not adequately reduce lead levels
  - By 1 to 2 months after replacement,
    - Lead levels in all sequential samples were lower than pre-replacement lead levels OR
    - Lead levels were essentially the same at sites where lead levels were already relatively low
  - "Seeded" premise plumbing can be an issue

Full Lead Service Line Replacement

- HDR Study – 2009
  - Same four sites from partial replacement study later had remaining portion of line removed – all have some galvanized interior plumbing
  - Three of the four sites showed spikes above AL in interior plumbing samples within first week after the private portion of the line was replaced
  - Site G2 had very high lead/iron levels in some samples the first week after replacement
  - G2 had samples above the AL at 4 weeks and still did not have all samples below the AL at 8 weeks
  - Galvanized plumbing “seeded” lead still present

Full Lead Service Line Replacement

- GCWW (Swertfeger et al, 2006)
  - 5 sites with complete replacement
  - First draw lead levels below the action level at these sites
  - Can’t directly compare with pre-replacement lead levels at sites because of simultaneous increase in pH
  - Lowest steady state average first draw data was from the complete replacement sites

Standard Operating Procedure for Partial/Full LSL Replacement

- Can a procedure be developed to minimize spikes and duration of spikes that specifies
  - Cutting technique
  - Flushing protocol
    - Full
    - Partial
    - “Seeded” Interior Plumbing
  - Galvanic Corrosion
    - Can occur when new copper is joined directly with remaining lead portion
    - Inclusion of a dielectric between lead and copper pipes can mitigate galvanic corrosion