New Mexico Guidance for Probabilistic Modeling for Service Line Material Determination

I. Overview

The Lead and Copper Rule (LCR) is a key regulation under the Environmental Protection Agency (EPA) aimed at protecting public health by limiting lead and copper levels in drinking water. One essential aspect of this rule is identifying all service lines that are lead or Galvanized Requiring Replacement (GRR) and removing them to reduce the risk of having lead in drinking water. Therefore, one of the essential aspects of compliance is the creation and maintenance of a service line inventory.

A service line inventory is a comprehensive record maintained by water utilities that tracks the materials used in the service lines that deliver water from the main line to the customer's property. This inventory specifically identifies the presence of lead or copper pipes, as these materials can significantly impact the quality of drinking water and public health. All Community (C) and Non-Transient Non-Community (NTNC) public water systems must create a Service Line Inventory (SLI) and submit their initial SLI on October 16, 2024.

Service lines must be classified as one of four options:

Lead	A pipe that is made of lead, which connects the water main to the building inlet.
Galvanized Requiring Replacement (GRR)	A galvanized service line that is or ever was downstream of an LSL or is currently downstream of an unknown service line.
Non-Lead	The service line is determined not to be lead or GRR through an evidence-based record, method, or technique.
Unknown	The service line material is not known to be a lead, GRR, or non-lead, such as where there is no documented evidence supporting material classification.

Systems may use the EPA template that the State on New Mexico has adopted and approved.

Lead Service Line Inventory Spreadsheet	Spreadsheet to be used by community and non-transient, non-community public water systems in documenting their water system's Lead Service Line Inventories.

A service line inventory is a critical tool for ensuring compliance with the Lead and Copper Rule and for safeguarding public health. By accurately tracking and managing the materials used in water service lines, utilities can more effectively address issues related to lead and copper contamination, plan for necessary replacements, and maintain transparency with the public.

II. Probabilistic modeling

Public water systems are not expected to physically verify every service line, but they can instead identify a statistically sound subset and make a material determination based on that subset. To this effect system may use probabilistic modeling. Probabilistic modeling is a methodology that can be used to help water

systems complete their SLI without having to physically identify the material type for all material unknown service lines and to assess the accuracy of records, such as as-builts or service records. Water systems will take a statistically significant random sample of service connections where the service line material type is unknown and physically verify material type. Based on the results of that investigation, the water system can predict what the materials are for the remaining service lines and determine if their records are accurate. This process can be used for both the utility-owned and customer-owned service lines. However, this analysis is only a hypothesis of what the probability of the service lines are. If your system does find lead lines or has sample exceedances, an investigative follow-up should be clearly delineated in your workplan.

Probabilistic modeling can be used to:

- Predict what service line material is most likely for unknowns, which can then be used to fill in the SLI spreadsheet for each connection.
- Assess the reliability of construction and planning records that may or may not be accurate.
- Determine what characteristics (e.g., age of structure, location, etc.) are most associated with lead or GRR service lines.

Probabilistic modeling cannot be used to:

- Determine a definitive material composition for each material unknown service line.
- Predict the degree to which a specific region of the distribution system differs from service line material averages across the entire system.
- While probabilistic modeling can be used for multiple tasks, this guide will only focus on the process of using probabilistic modeling to predict material type to complete the SLI. Probabilistic Modeling is only one step in the SLI process, which is one requirement of the LCRR. For more information on the LCRR see the New Mexico Environment Department (NMED) LCRR webpage at: https://www.env.nm.gov/drinking_water/lcrr/.

III. Using probabilistic modeling workplan for service lines with unknown material

The following probabilistic model's goal is to make a statistical hypothesis on what the materials are for unknown service lines across an entire service area with only a representative material verification pool.

If your system does decide that using a probabilistic model is the right fit for your system, or decides to use a different methodology, then the system must submit a workplan to be approved to the NM Drinking Water Bureau (DWB). If you are utilizing this methodology, then the DWB has provided systems with a workplan template as an attachment to this guidance called: "Workplan for Probabilistic Modeling for Service Line Material Identification and Verification". Both guidance and template are available on NMED's LCRR template and document webpage: https://www.env.nm.gov/drinking_water/lcrr-templates-and-documents/.

To ensure NMED acceptance of the system's results, be sure to document all steps through the probabilistic modeling and verification process. A flow chart of steps outlined below is available on page 7 of this guide.

IV. Steps for Probabilistic Modeling workplan by sections.

1. Workplan Section 1: Preliminary material identification

Determine service line materials for as many connections as possible based on year connected to water system and records review.
Resources for material identification can be found on NMED's LCRR inventories website: https://www.env.nm.gov/drinking_water/lcrr-inventories/.

2. Workplan Section 2: Service Line Information

For many water systems, service line ownership is split between the utility and customer and may be different materials. If this is the case, it is likely that the number of service line materials considered known after preliminary investigation may be different for the different ownership types.

Utilities can use probabilistic modeling for both the utility owned and customer owned portion of the service line. If the utility and customer owned portions that are considered material unknown and to be used for probabilistic modeling are different, then the probabilistic modeling process should be done separately for the utility and customer owned sections.

To determine the number of service lines of unknown material, subtract the number of known service lines from the total. This is the number that will be used to determine how many service lines need to be physically verified.

3. Workplan Section 3: Determine randomization and selection methodology

Water systems may use different selection methodologies based on their water system size designation.

a) Water systems designated as small and very small (3,300 or less population served) may use a randomization and selection process across all unknown material service lines.

b) Water systems designated as medium or larger (greater than 3,300 population served) should use a stratification method.

   i. One method of stratification is described below (excerpt from guidance published by Kentucky Division of Water). For more information please refer to the full guidance provided by the Kentucky Division of Water at https://eec.ky.gov/Environmental-Protection/Water/Drinking/DWProfessionals/ComplianceDocuments/DOW%20Statistical-guidance-service-line-inventory-FINAL.pdf

4. Steps for stratification method for medium or large systems (greater than 3,300 population served)

1) Separate out any service lines that have been verified via records review. These will not be part of the statistical method.
2) Take all the *Unknown* and *previously physically verified* service lines:

a. Move or filter them into a separate dataset from the service lines identified via records review.
b. Organize them into groups, called strata (singular: stratum), based on date of construction (age). Have at least 3 strata. The exact strata set may vary by water system, but a suggested breakdown is:
    Stratum 1: Buildings constructed before 1940
    Stratum 2: Buildings constructed 1940-1949
    Stratum 3: Buildings constructed 1950-1969
    Stratum 4: Buildings constructed 1970-present.
c. Choose a stratification method that adequately represents the entire distribution system, without being overly complex.

3) Organize the information this way:
    a. Identify which service lines fall into each stratum of Step 1.
    b. Based on the number of service connections in each stratum, allocate a portion of the total number of samples needed. For example, if the "1940-1949" stratum has 30% of the total service connections served, then 30% of the required physical inspections come from that stratum.
4) Selection within each stratum must be uniformly random and not selected based on any specific criteria which can introduce bias. In other words, each service line within a stratum must have an equal chance of being chosen for verification.

5. Workplan Section 4: Randomization and Selection Process

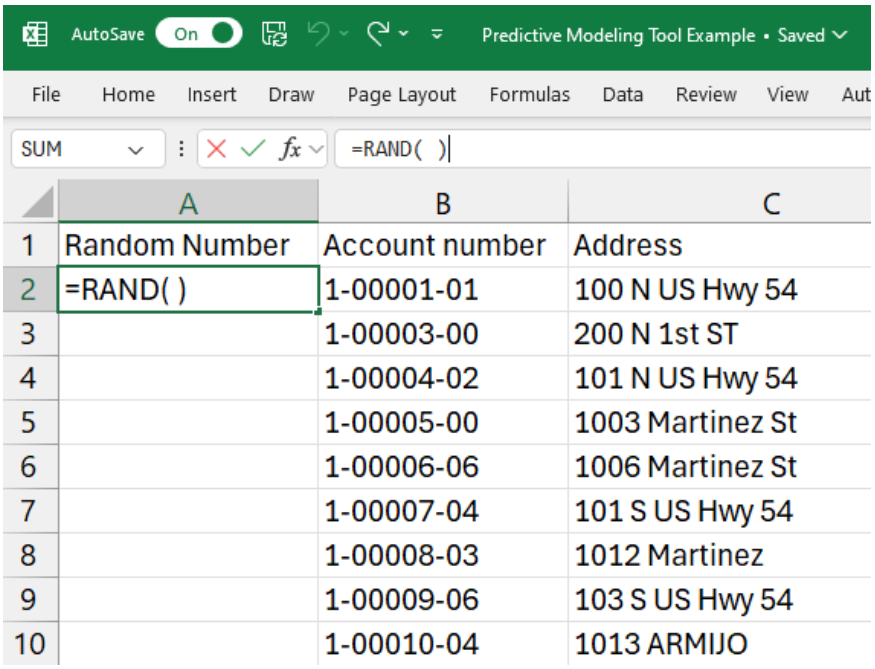
Based on the number of unknown material service lines, determine the minimum number of service lines that need to be verified by using the table below. A confidence level of 95% is achieved when verifying the minimum number using the table. Because it may not be possible to physically identify each of the randomly selected connections, the table below contains columns with an extra 10% and 20% to add to the number to randomly verify. Choosing a higher percentage numbers will ensure that your systems has extra alternative sites incase accessibility is not possible, or any other availability issue occurs, therefore is highly recommended that you choose an above minimum sample site number.

Table A. Number of unknown service lines and minimum number to verify.

Number of Unknown Material Service Lines	Minimum Number to Verify	Number to verify with extra 10% above minimum	Number to verify with extra 20% above minimum
Fewer than 1,500	20% of unknown lines	22% of unknown lines	24% of unknown lines
1,500	306	337	367
1,600	310	341	372
1,700	314	345	377
1,800	317	349	380
1,900	320	352	384
2,000	322	354	386
2,200	327	360	392
2,400	331	364	397
2,600	335	369	402

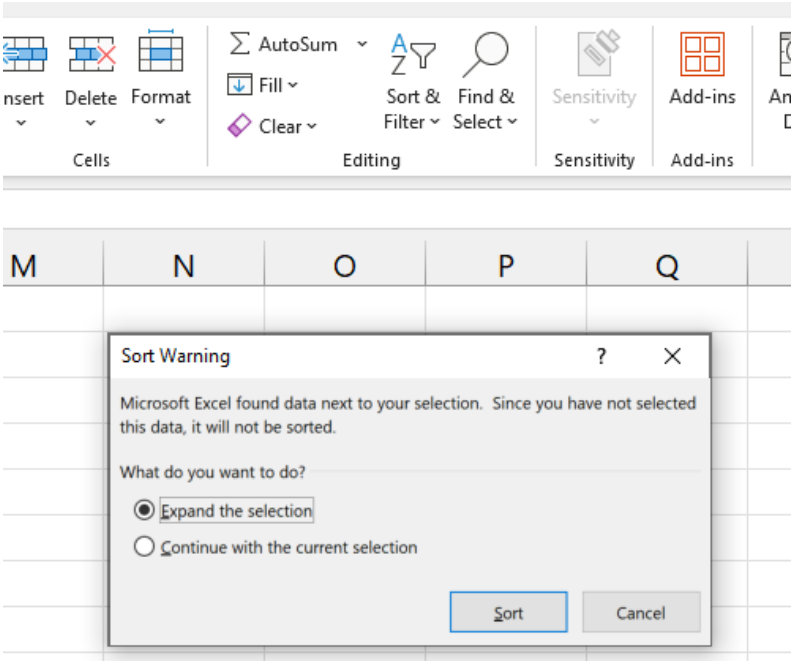
2,800	338	372	406
3,000	341	375	409
3,500	346	381	415
4,000	351	386	421
4,500	354	389	425
5,000	357	393	428
6,000	361	397	433
7,000	364	400	437
8,000	367	404	440
9,000	368	405	442
10,000	370	407	444
15,000	375	413	450
20,000	377	415	452
30,000	379	417	455
40,000	381	419	457
60,000	382	420	458
90,000	383	421	460
225,000 or more	384	422	461

Create a list of material unknown connections in a spreadsheet, such as Microsoft Excel. Then use a random number list generator online to create a list of random numbers to copy and paste in that column or use the formula "=RAND( )" to generate a random number between 0 and 1, which can be seen below:



If using the "=RAND( )" function in Excel, that formula can be dragged down to all the other rows by putting the curser on the bottom right corner of the selected cell until the curser turns into a thin solid + sign and then clicking and dragging down to the other rows.

Sort the table by this column to randomize the order of the connections. To do this in Excel, select the column by clicking on the column header ("A" in this example), finding the Sort & Filter function under the Home tab in the Editing section, as seen below. When the Sort Warning pops up, select "Expand the selection" and then Sort.



Select the number of rows based on the number of service lines that must be verified as determined from the table on page 3. These locations are the service lines whose material type must be physically verified.

If using the "=RAND( )" function in Excel, the random number for each service line will change when edits are made to the table. Consider adding numbering (1, 2, 3, etc.) to a column to keep track of the order of the randomly selected service lines.

Note: All unknown material service lines must have an equally random chance of being selected. Intentionally selecting connections that are believed may be lead will bias the results.

6. Workplan Section 5: Field verification

Multiple methods can be used for physical verification. Please refer to EPA's "Guidance for Developing and Maintaining a Service Line Inventory - Chapter 5: Service Line Investigation Methods" available at DWB website: [Guidance for Developing and Maintaining a Service Line Inventory].

7. Section 6: Analysis of verification results

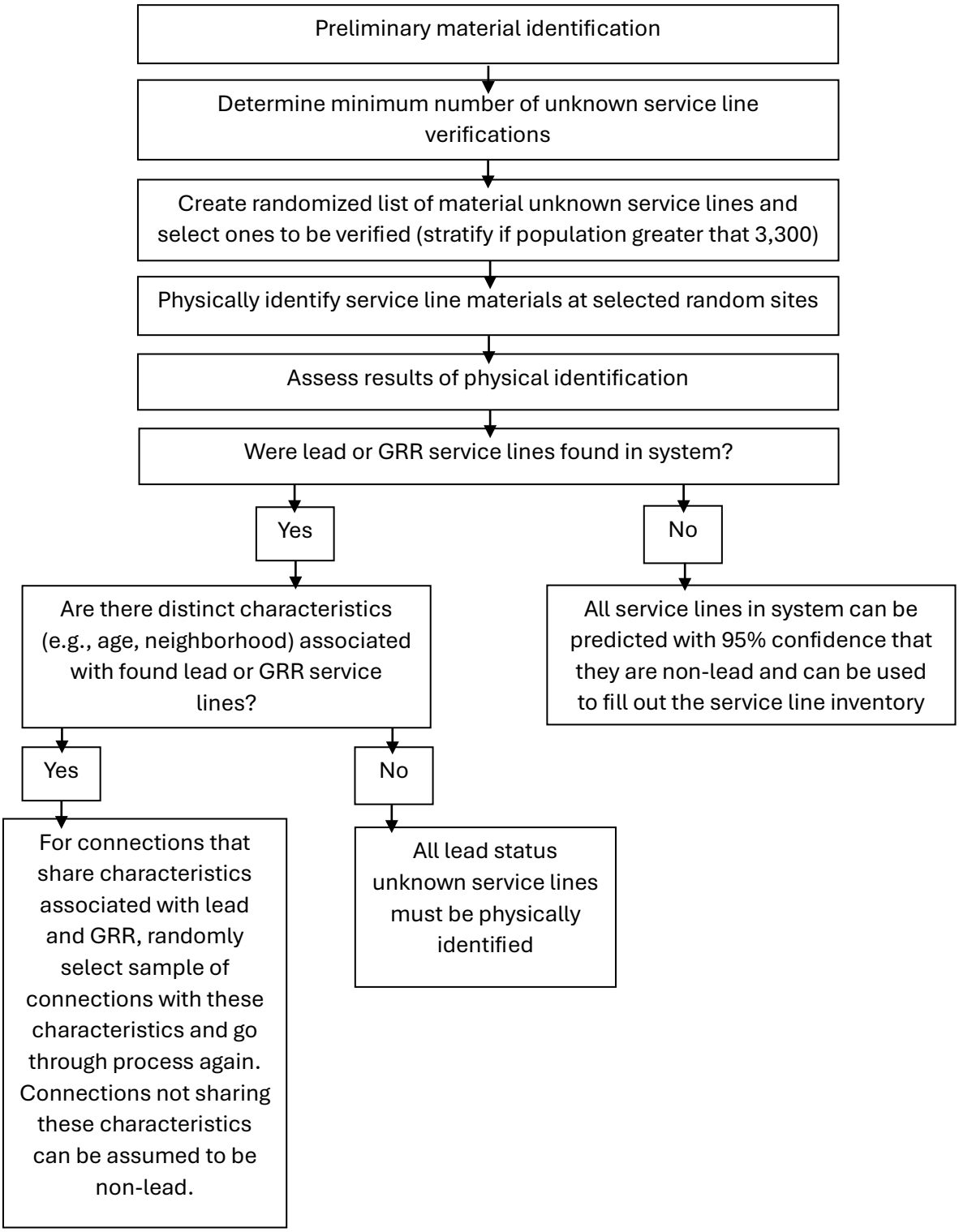
If no lead or GRR service lines are found during physical verification:
The water system can use the results of the physical verification to predict with 95% confidence that the rest of the service lines of an unknown material type in the system are also free of lead and GRR service lines. The service line inventory can be filled in for the remaining service lines as non-lead.

If lead or GRR service lines are found during physical verification:

Determine what characteristics are associated with service lines found to be lead or GRR (e.g., neighborhood, date of connection, contractor, etc.). Service lines deemed to not share these characteristics (and share characteristics with other verified non-lead service lines) can be assumed to be non-lead and entered to the inventory as such.

Service lines deemed to share characteristics with found lead and GRR service lines should go through this same probabilistic modeling verification process again, including selecting a random subsampling of those connections and physically verifying the required amounts based on Table A. The results of this round of physical verification can be used to further determine the prevalence of lead and GRR in the water system and characteristics associated with lead and GRR service lines. All connections with these further defined characteristics should be physically verified. Unknown material service lines that do not share these further defined characteristics can be classified as non-lead in the service line inventory.

Flow Chart for conducting a probabilistic model.



Resources and additional information

New Mexico Environment Department Lead and Copper Program webpage:
https://www.env.nm.gov/drinking_water/lead-and-copper-program/

New Mexico Environment Department Lead and Copper Rule Revisions documents:
https://www.env.nm.gov/drinking_water/lcrr-templates-and-documents/

EPA Lead and Copper Rule Revisions webpage:
https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule

Federal Regulations on Lead and Copper Rule Revisions:
https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-141/subpart-I

Technical Assistance Providers

Southwest Environmental Finance Center at UNM; https://swefc.unm.edu
Phone: 505-333-9667 Email: swefc@unm.edu

New Mexico Rural Water Association; https://nmrwa.org/
Phone: 505-884-103 Email: info@nmrwa.org

Rural Community Assistance Corporation (RCAC); https://www.rcac.org/
Phone: 916-447-2854 Email: registration@rcac.org

References

BlueConduit “Principles of Data Science for Lead Service Line Inventories and Replacement Programs A white paper prepared for the Association of State Drinking Water Administrators (ASDWA)”. September 2020. https://www.asdwa.org/wp-content/uploads/2020/09/ASDWA-BlueConduit-White-Paper-on-Data-and-LSL.pdf

Colorado Department of Public Health and Environment “Initial Service Line Inventory Development”. September 2023. https://drive.google.com/file/d/1LMnXqiOVyqXWRZcTxGkzoBl0q2t0lWnF/view

Kentucky Division of Water “Guidance for Using a Statistical Method to Complete a Service Line Inventory”. October 2023. https://eec.ky.gov/Environmental-Protection/Water/Drinking/DWProfessionals/ComplianceDocuments/DOW%20Statistical-guidance-service-line-inventory-FINAL.pdf

Michigan Department of Environment, Great Lakes, and Energy “Service Line Material Verification Minimum Requirements”. February 2024. https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/DWEHD/Community-Water-Supply/Lead-Copper/Minimum-Service-Line-Material-Verification-Requirements.pdf