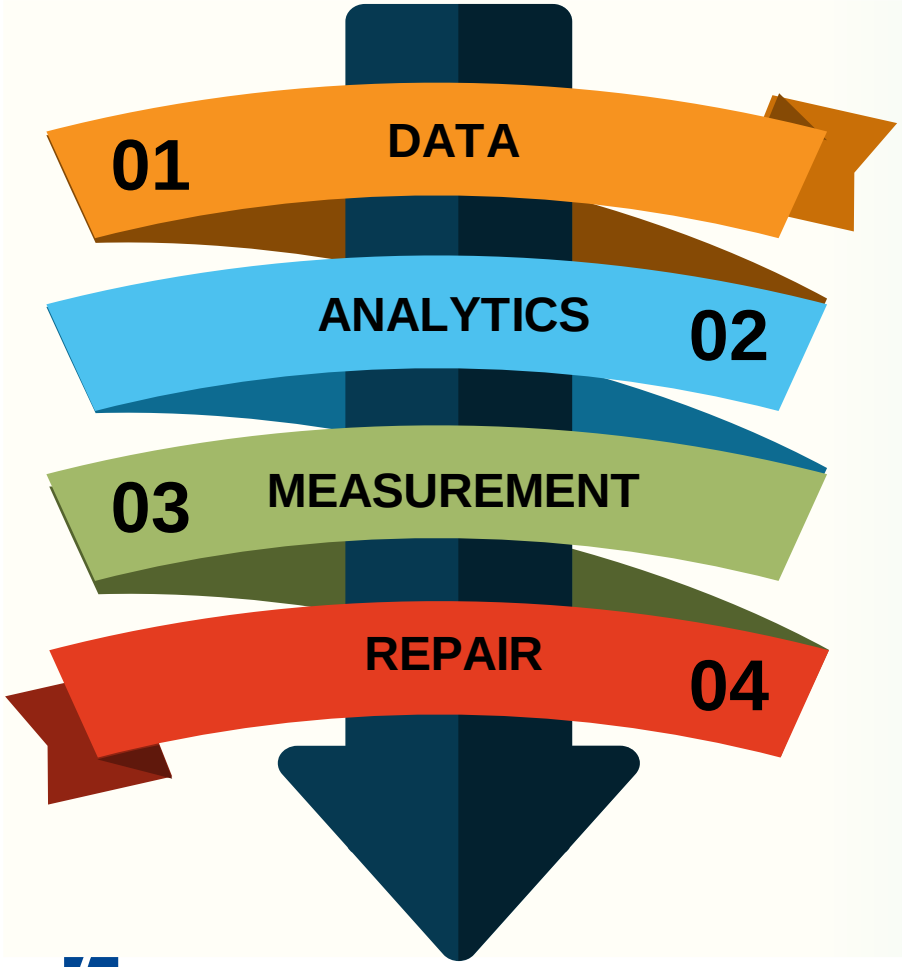
DM&S - PIPELINE EF'S: LARGE LEAK DT METHOD; RISK-BASED LEAK SURVEY & UNKNOWN LEAKS

2021 Winter Workshop (R. 15-001-08)— Jan 21, 2021

Decision Tree to Detect Large Leaks & Mitigation Strategy



COLLECT FIELD DATA

Leverage data collected during routine leak survey

DATA ANALYTICS

Algorithms identify leaks with highest probability to be “large” (10 CFH +)

MEASURE SUBSET OF LEAKS

Measure ~20% of DM&S leaks detected

PRIORITIZE LARGE LEAKS FOR REPAIR

~2% of DM&S leaks are “large”

BENEFITS

1. **Directly Measure only ~20% of leaks**
2. **Minimize cost of implementation**
3. **Maximize Accuracy of Buried Leak Emission Estimate**

Decision Tree (DT) Variables

- Data is collected at the time leaks are detected and graded
- Ground-level methane concentration measurements are recorded for each type of surface with elevated methane concentrations
- Separate threshold values are used for each surface type
- Leak Flow Rate is later measured if leak meets DT thresholds for any of the 4 defined surface types

Unpaved

Paved (Crack)

Bar-Hole

Sub-Structures

Leak Flow Rate Measurement

- System operation validated using controlled releases prior to daily use
- Standardized Measurement Procedure
- Identify leak area size/boundaries
- Plan grid layout (when needed)
- Perform Surface-Expression/Tarping Flow Measurement process
- Calculate leak flow rate

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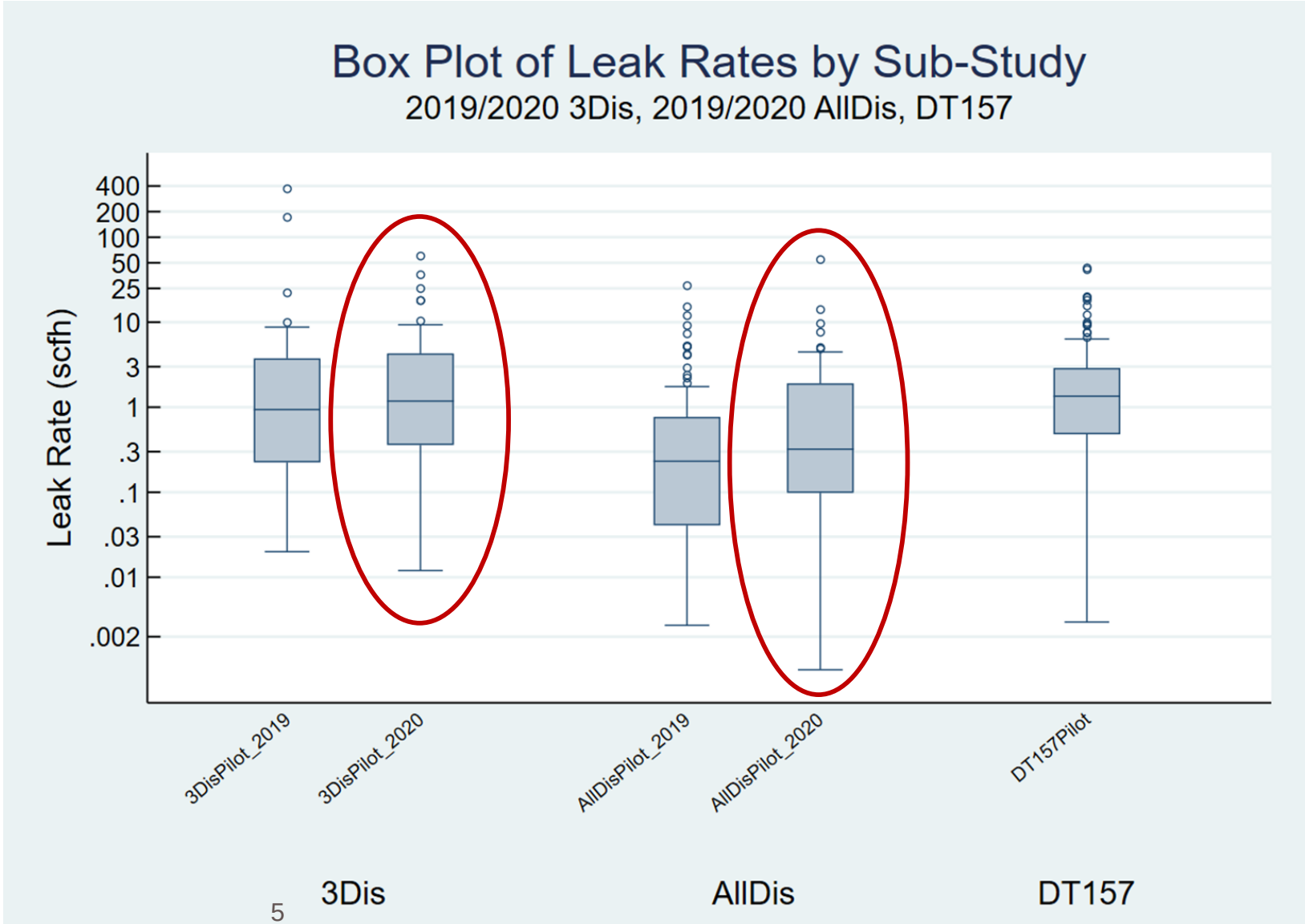
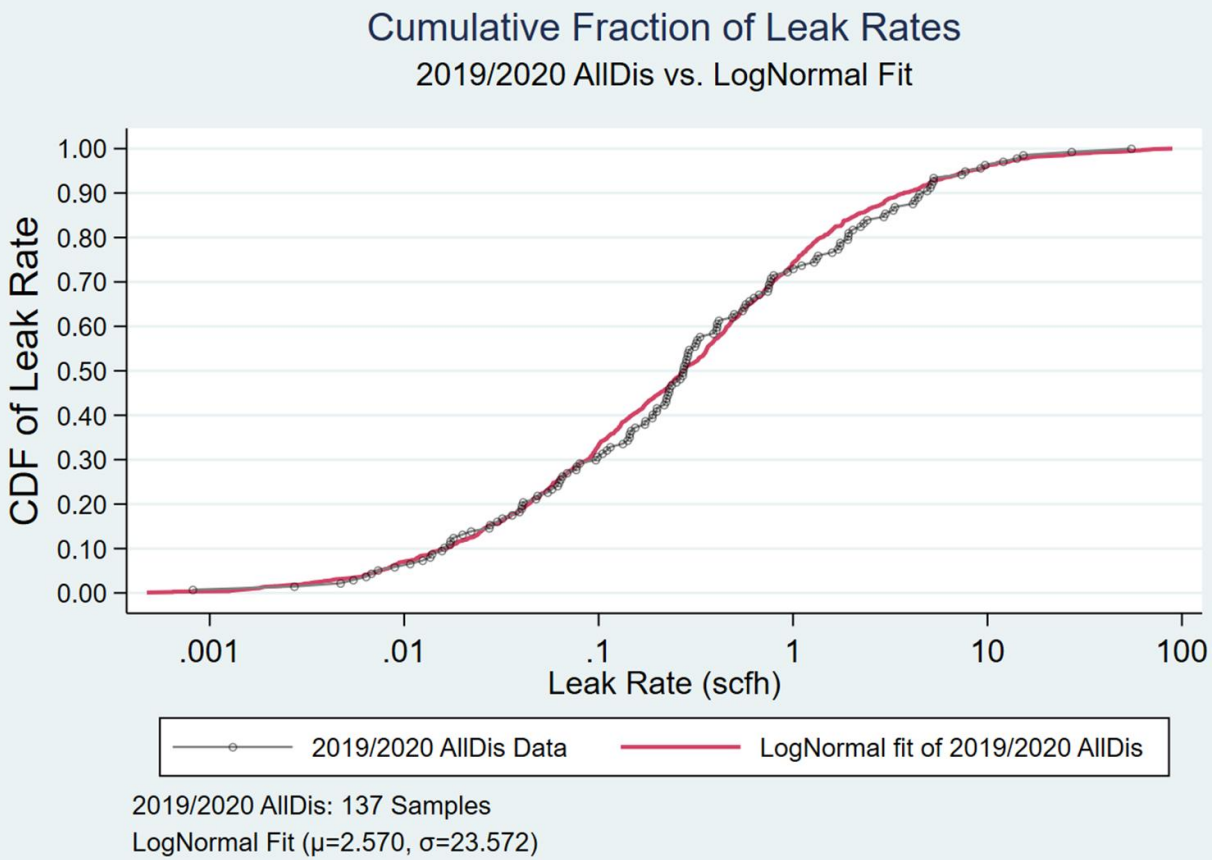
New 2020 Data Added to DT Study

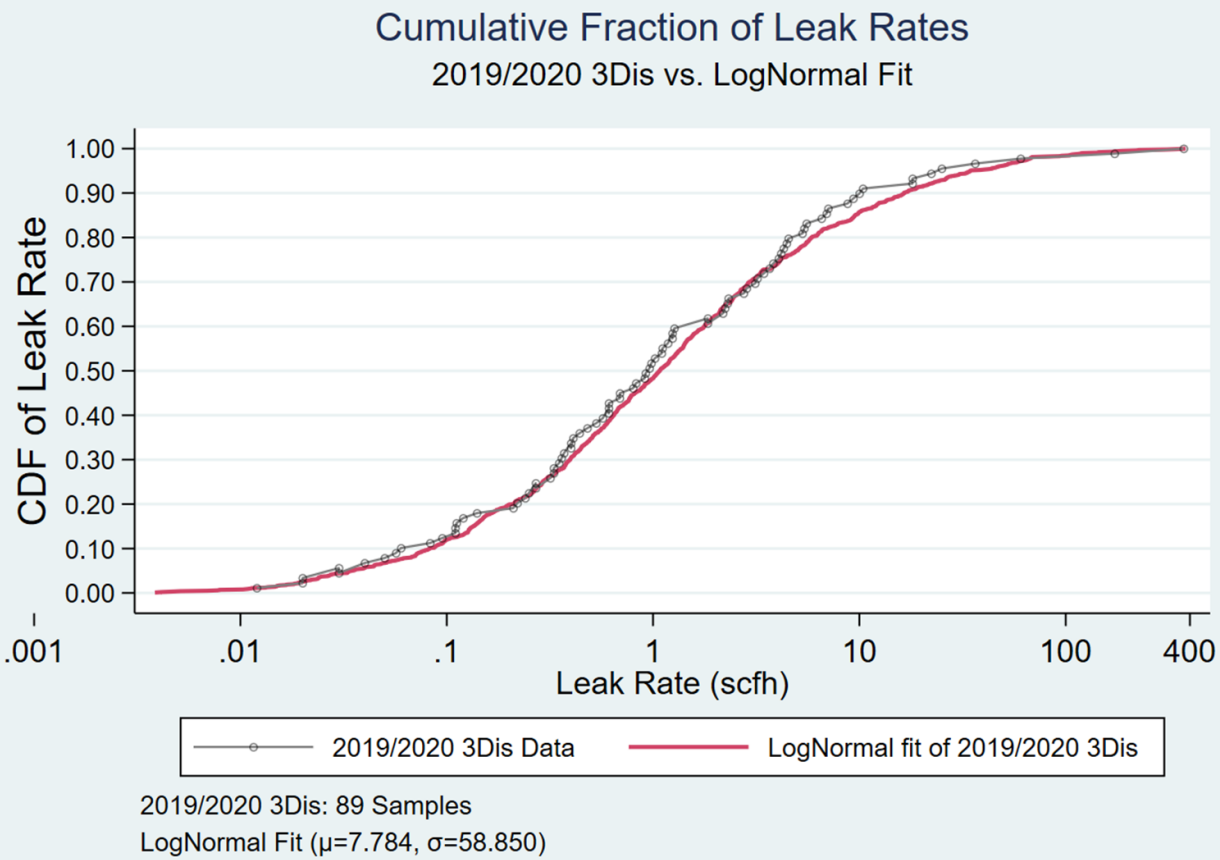
- Data added for 92 leaks raising total from 291 to 383 samples
- 2019/2020 Data Shown side-by-side for:
  - System-Wide Random Sample - “AllDisPilot”
  - 3-District Pilot Study samples - “3DisPilot”
- New 2020 data sets are very similar to the 2019 data sets



Distribution Plots for All-District and 3-District Pilot (2019 & 2020 combined)



2019/2020 AllDis: 137 Samples
LogNormal Fit (μ=2.570, σ=23.572)



2019/2020 3Dis: 89 Samples
LogNormal Fit (μ=7.784, σ=58.850)

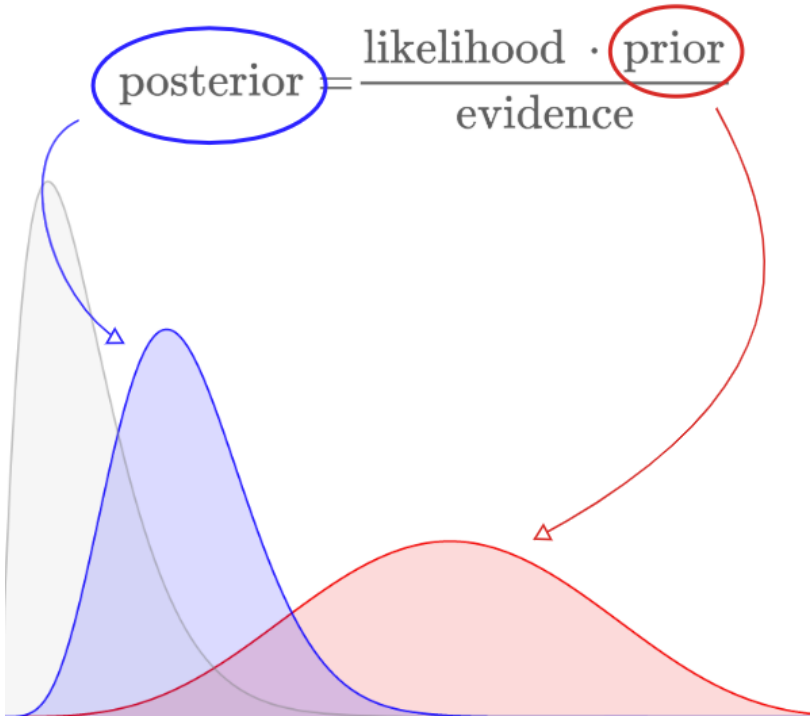
Bayesian Probabilistic Decision Tree Analysis

- Phase 1 (2019) and Phase 2 (2020) Probabilistic DT model output results for Negatives (True/False, i.e. Not a Large Leak)
  - **False Negatives (FN): 1.1%** (2019) **0.9%** (2020)
    - This is the probability that a leak > 10 SCFH will not meet the DT criteria
    - These are the leaks > 10 SCFH that are missed
    - This is an outstanding result, acceptable by the most-stringent standards
  - **True Negatives (TN): 98.9%** (2019) **99.1%** (2020)
    - This is the probability that a leak <10 SCFH will not meet the DT criteria
    - These are the leaks <10 SCFH that are not measured.
    - 99% confidence these leaks are not large leaks!

  Note: These add to 100%. Represents ~80% of system leaks

- Probabilistic DT model output results for Positives (True/False) (i.e. May be a Large Leak)
  - **False Positives (FP): 89.7%** (2019) **86.6%** (2020)
    - This is the probability that a leak < 10 SCFH will meet the DT criteria
    - These are the Grade 2&3 leaks that are measured and found to be < 10 SCFH
  - **True Positives (TP): 10.3%** (2019) **13.4%** (2020)
    - This is the probability that a leak > 10 SCFH will meet the DT criteria
    - These are the Grade 2&3 leaks that are measured and found to be ≥10 SCFH
    - Estimate 2% of Grade 2 & 3 leaks are ≥10 SCFH

  Note: These add to 100%. Represents ~20% of system leaks



Company-Specific Distribution Leaker Emission Factors

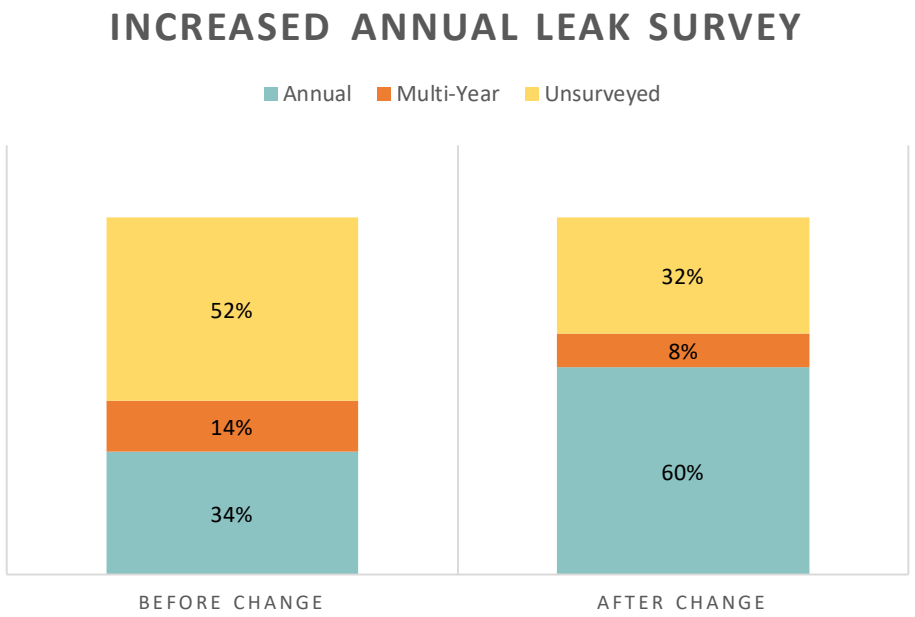
- Emission Factors (EFs) derived using a combination of the appropriate bootstrap population leak rate means and the Bayesian Decision Tree error table percentiles (95% confidence)
- Result of robust methodology, data analysis, and quality data
- EFs are refined over time as more data is collected and layered on
- Methodology provides for detection of changes in system leak rates

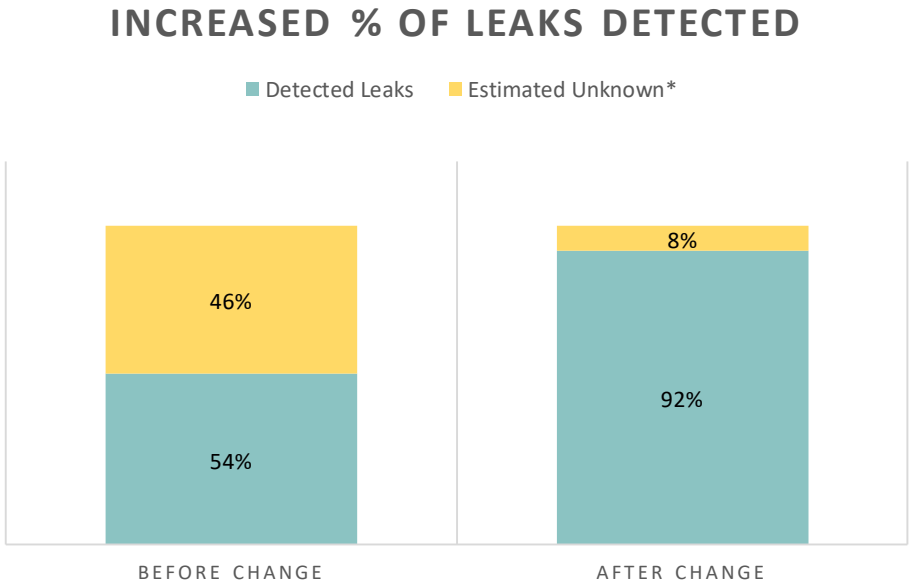
Situation Number	Field Situation Description	Phase 1 EFs (2019)	Phase 1+2 EFs (2020)
1	Measured methane concentration(s) triggers DT < 10 SCFH category & leak rate not measured (typical situation) - Use when DT is Not Triggered	2.27 SCFH	1.96 SCFH
2	Measured methane concentration(s) trigger DT ≥ 10 category & leak flow rate not measured (used for all Hazardous leaks and when flow rate is not measured) - Use when DT is Triggered	7.37 SCFH	7.74 SCFH
3	No methane concentration(s) or leak rate measurement (used during implementation period and when data issues arise) - Use when DT data is not available	4.30 SCFH	4.21 SCFH
4	Measured methane concentration(s) trigger DT >10 category & measured leak flow rate is <10 SCFH - Use the actual leak flow rate for each leak measured	Use actual leak flow rate measurement	
5	Measured methane concentration(s) trigger DT >10 category & measured leak flow rate is ≥ 10 SCFH - Use the actual leak flow rate for each leak measured	Use actual leak flow rate measurement	

Company-Specific Emission Factor Research

- **Objective:** Develop Company-Specific emission factors for buried Mains and Services
- **Milestones Reached:**
  - Develop Company-Specific DM&S EFs
    - Statistical Random Sample Across Service Territory – Completed
    - Develop Large Leak Decision Tree Model – Completed
    - 2nd Statistical Random Sample Across Service Territory - Complete
  - OTD (7.17.d) - framework for Company-Specific EFs is in progress, scheduled for completion Q1 2021
  - Completed statistical and probabilistic analysis of project data
    - Validation of random direct measurement of system leaks
- **Next Steps:**
  - Complete Large Leak DT Implementation (SoCalGas)
  - Continue to refine EFs with new data
  - OTD - finalize and publish Company-Specific EF development framework and methodology

Accelerated Leak Survey based on Emissions Risk





* Number of leaks are estimated in areas not surveyed in the report year

OBJECTIVE

- Reduce duration of leaks and number of unknown leaks at lowest cost

SOLUTION

- Change leak survey interval of vintage pipe materials to annual due to higher leak rates
- Detect, Prioritize and Repair Large Leaks

RESULTS

- Reduced inventory of Unknown leaks
- Reduced leak duration & emissions from Known and Unknown Leaks
- Provides for More Accurate Emissions Estimates

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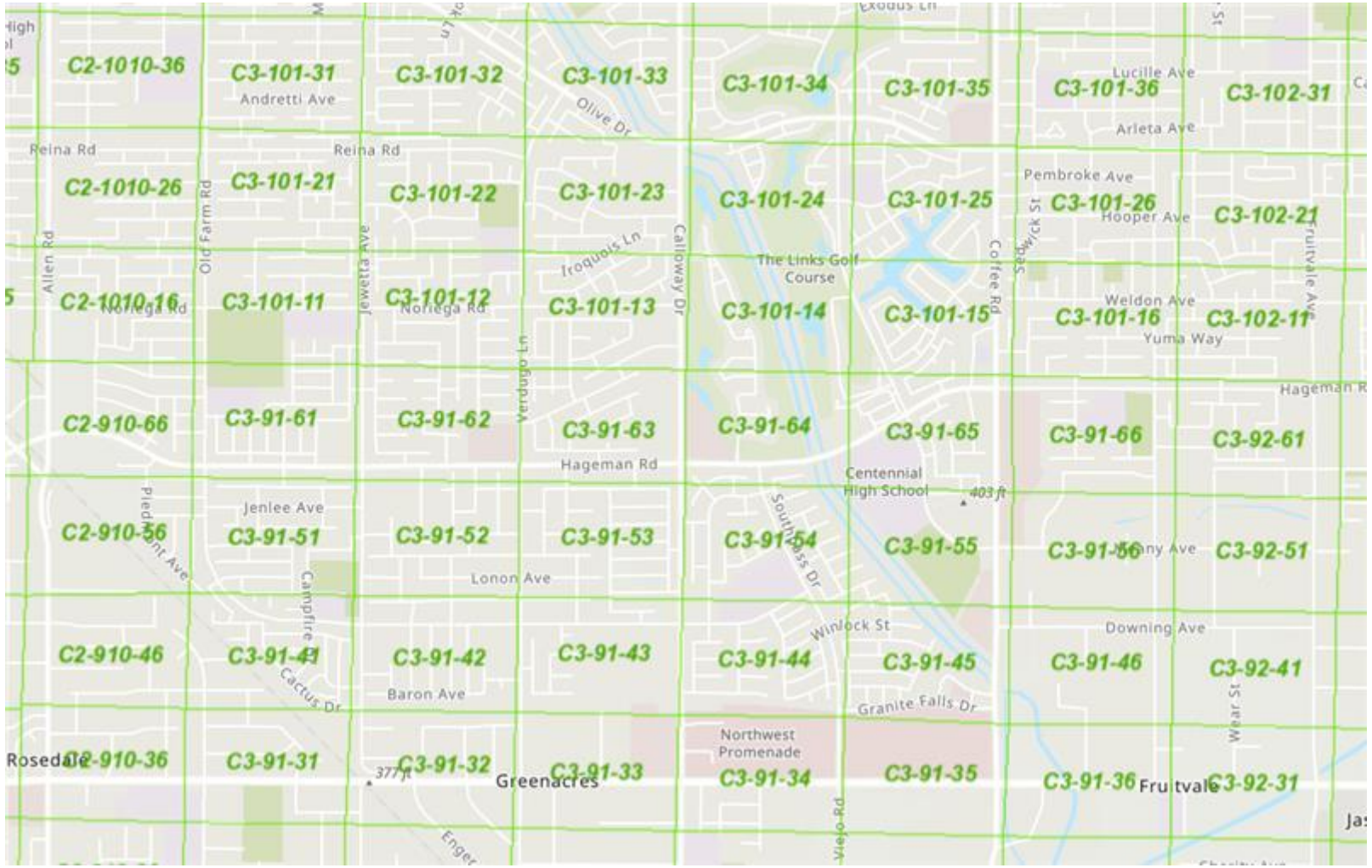
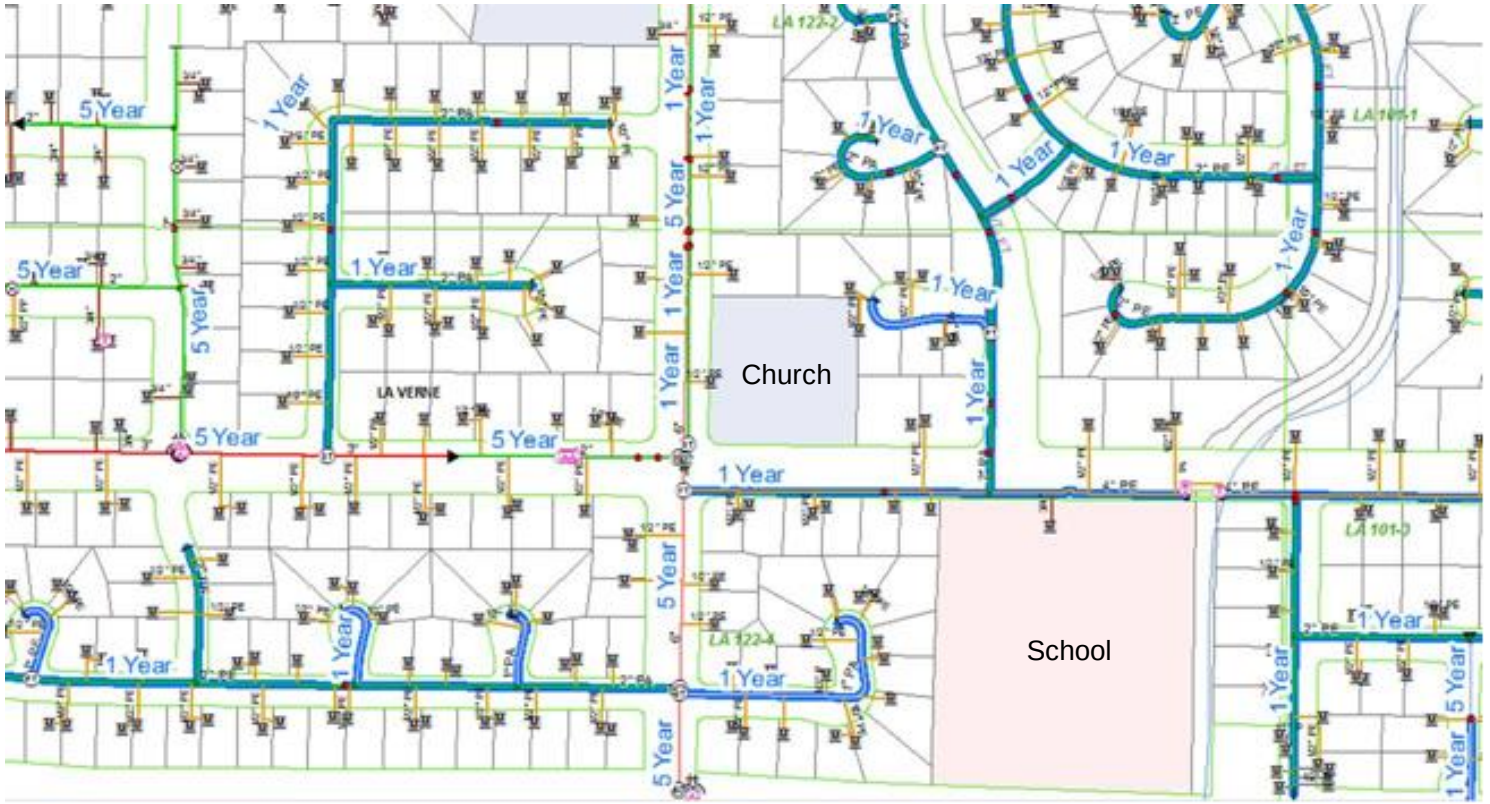
Leak Survey Maps



- Provides breakdown of survey volume for given areas by material category
- Used to group survey activities into geographic areas for work scheduling
- Provides geographic area units for tracking regulatory compliance

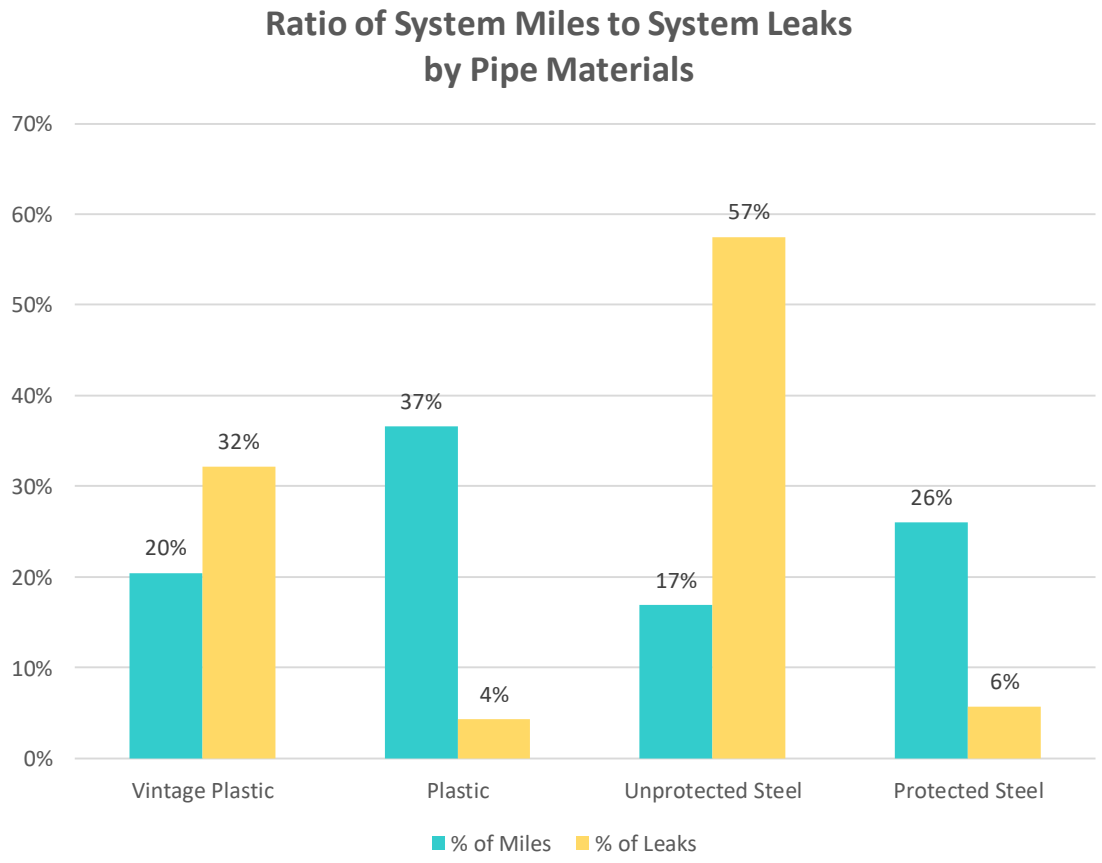
Risk-Based Factors Drive Leak Survey Cycle Assignments

- Pipeline Material factor
  - Driven by PHMSA and CPUC Safety Regulations
    - General minimum survey intervals
  - Pipeline Integrity Risk Management factor
    - Driver for Vintage Plastic Annual Survey
  - SB-1371 Environmental Risk Management factor
    - Driver for Unprotected Steel Annual Survey
    - Vintage Protected Steel Annual Survey
- Population Density factor
  - Driven by PHMSA and CPUC Safety regulations
    - Aka “Business Districts”
  - Pipeline Integrity Risk Management factor



Comparison of Leaks to Pipe Materials Ratios

- Unprotected Steel pipelines represent 17% of the inventory, but accounts for 57% of all pipeline leaks
- Vintage Plastic pipelines represent 20% of the inventory, but accounts for 32% of all pipeline leaks
- Modern pipeline materials represent 63% of the pipeline inventory, but contribute only 10% of all pipeline leaks



Questions?

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