Accelerated Detection and Repair of large leaks

Emission Calculations

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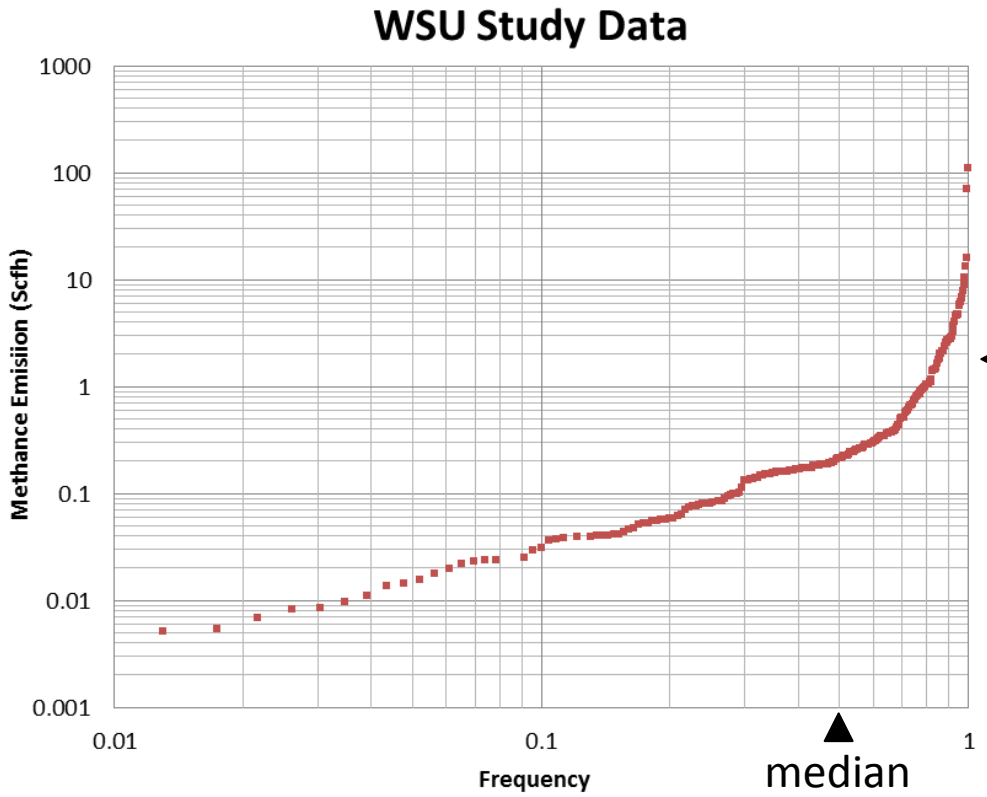
Together, Building a Better California

The concept of Super Emitters

- Methane emissions in distribution system are driven by a relatively small number of large leaks named Super Emitters.

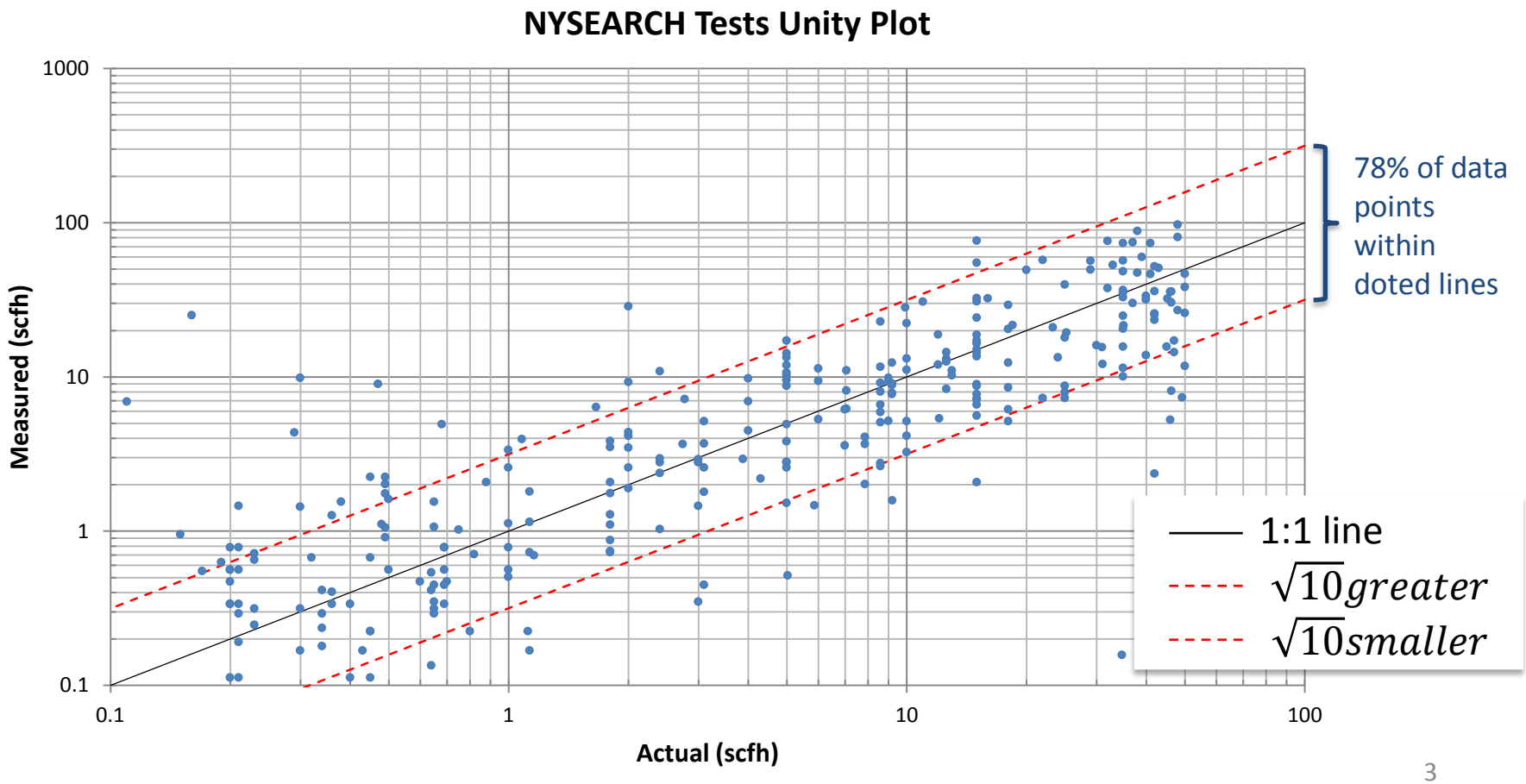


WSU study : Only 2% of leaks were > 10 scfh but accounted for 56% of total emissions

- Opportunity for substantially reducing methane emissions by accelerating detection and repair of large leaks.

The opportunity

- Large leaks are **easy to detect** with mobile surveys (Picarro).
- Leak flow rate quantification is still challenging with mobile devices but:
  - Solid data coming from NYSEARCH study is now available



Proposed Method

1. Drive Picarro car on an accelerated basis (eg. once a year)
2. Filter out any indications <10 scfh (Picarro's algorithm)
3. Investigate and repair leaks associated with large indications (>10 scfh)
4. Savings from two sources:
   a) Accelerated detection and repair of "super emitters"
   b) Reduction of Emission Factors for other leaks

Accounting for uncertainties: Bayesian approach

1. What is the probability for a SE to be detected as a SE

$$P\langle A|B\rangle = \frac{P\langle B|A\rangle * P(A)}{P(B)}$$
$$= \frac{P\langle B|A\rangle * P(A)}{P\langle B|A\rangle * P(A) + P\langle B|\bar{A}\rangle * P(\bar{A})}$$

Where:
A = an actual leak that is > 10 scfh
B = detected by Picarro as > 10scfh

2. What is the emission factor of a leak detected as a SE

$$EF(B) = \mathrm{P}\langle A|B\rangle * EF(A) + (1 - P\langle A|B\rangle) * EF(\bar{A})$$

Nysearch data leads to:

Term	Values
$P(B\|A)$	76%
$P(A\|B)$	42%
$P\langle B\|\bar{A}\rangle$	12%
$P\langle A\rangle$	10%
$P\langle \bar{A}\rangle$	90%

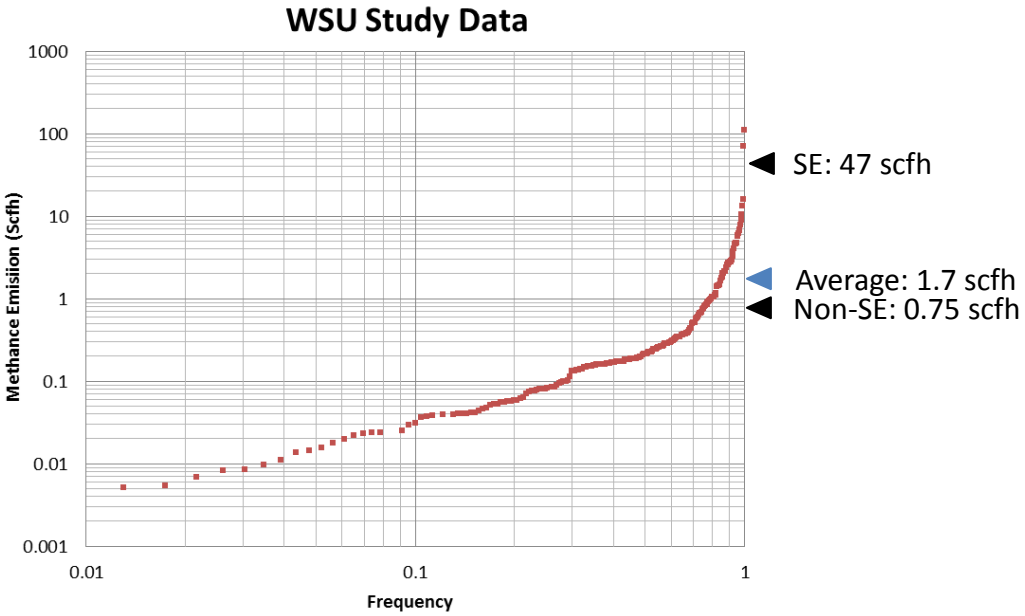
Emission Calculations

Using 2017 data we calculate the average emission factor for all leaks:

$$EF = \frac{2017\ Emissions}{\sum_{Leaks,i} \Delta t(i)}$$

Assuming that the leak size distribution is similar to WSU's distribution:

$$0.02 \cdot EF(A) + 0.98 \cdot EF(\bar{A}) = \mathrm{EF}$$
$$0.02 \cdot EF(A) = 0.56 \cdot EF$$



Emission Calculations

x_B and y_B Super Emitter leaks were detected in 2018 in the surveyed and non – surveyed area respectively:

$P\langle A|B\rangle \cdot x_B$ were actual Super Emitter leaks

$\frac{P\langle A|B\rangle \cdot P\langle \bar{B}|A\rangle \cdot x_B}{P\langle B|A\rangle}$ were missed Super Emitter leaks

Same with y_B

We can therefore calculate the Emission Factor to be assigned to detected Super Emitter leaks and non-Super Emitter leaks:

$$EF(B) = P\langle A|B\rangle \cdot EF(A) + (1 - P\langle A|B\rangle) \cdot EF(\bar{A})$$

$$EF(\bar{B}) = \frac{P\langle A|B\rangle \cdot P\langle \bar{B}|A\rangle}{P\langle B|A\rangle} \cdot \frac{x_B}{x_{\bar{B}}} \cdot EF(A) + \left(1 - \frac{P\langle A|B\rangle \cdot P\langle \bar{B}|A\rangle}{P\langle B|A\rangle} \cdot \frac{x_B}{x_{\bar{B}}} \cdot\right) \cdot EF(\bar{A})$$

Knowing the date of repair of leaks, we can calculate the emissions of 2018:

$$Emissions = \sum_{x_B, y_B} EF(B) \cdot \Delta t_B + \sum_{x_{\bar{B}}, y_{\bar{B}}} EF(\bar{B}) \cdot \Delta t_{\bar{B}}$$

For a WSU distribution:
$EF(B) = 20\ scfh$
$EF(\bar{B}) = 1\ scfh$

Thank you

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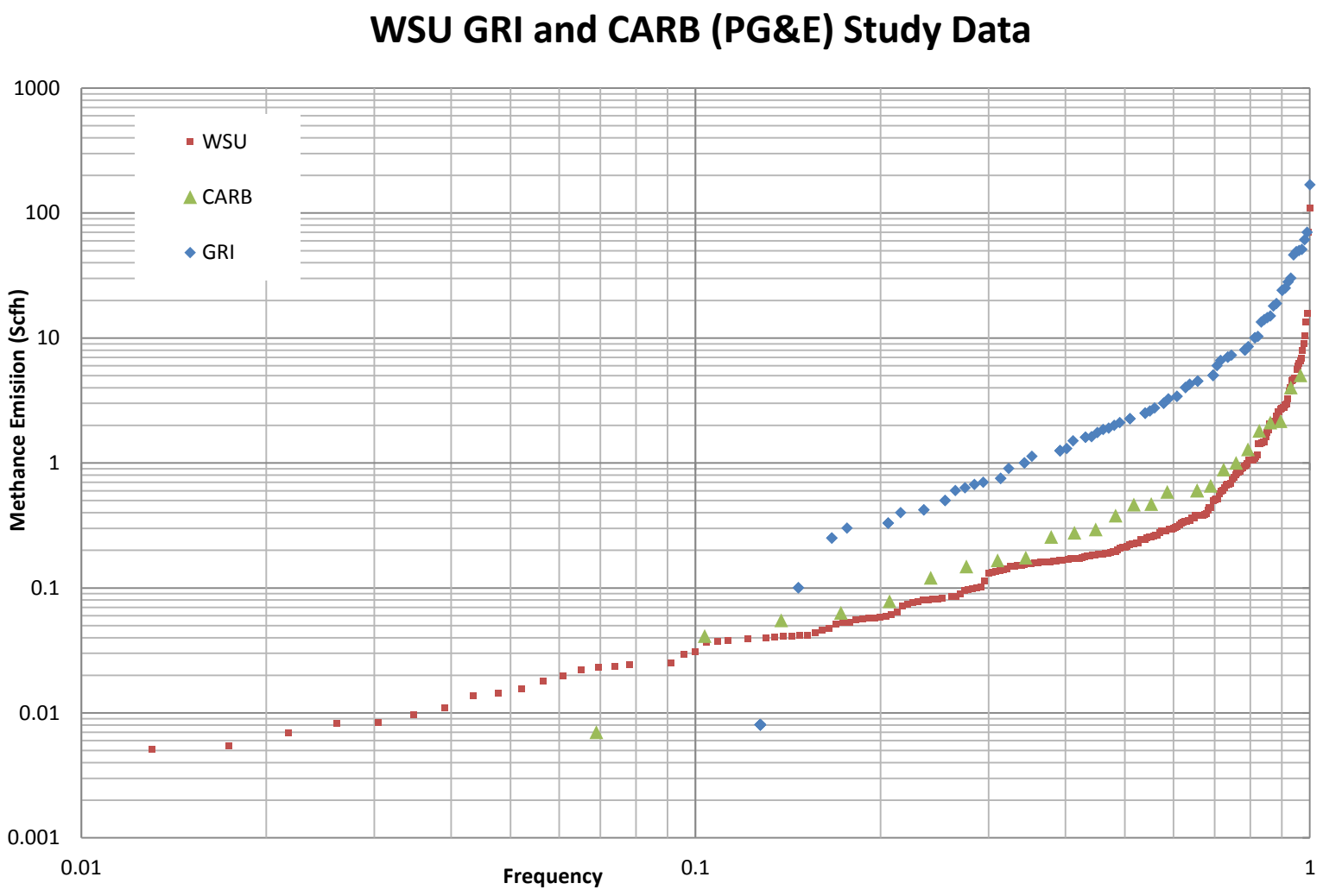
CARB Leak measurements at PG&E

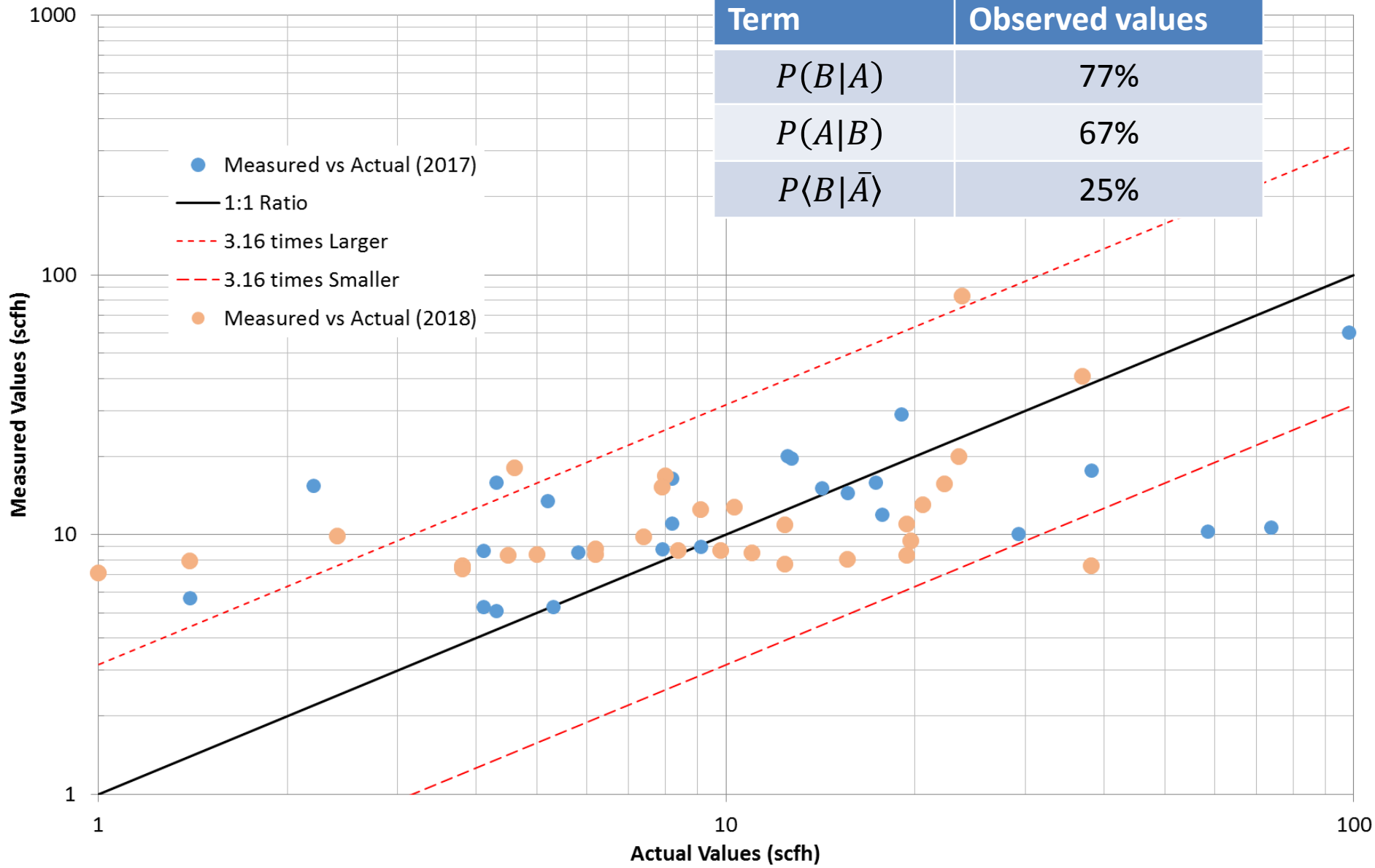


Field validation

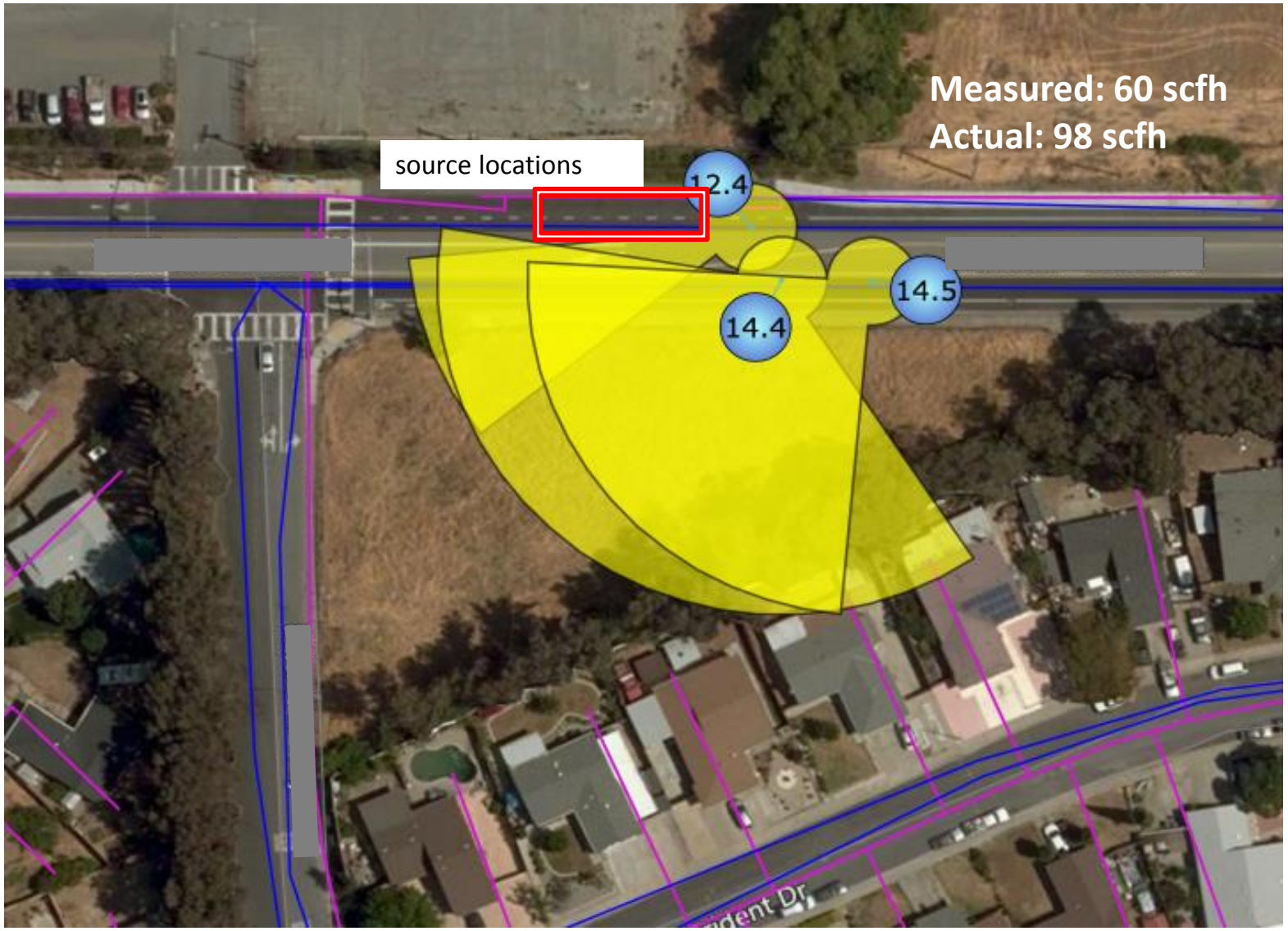
1. Tested the approach in the field by directly measuring flow rate of 58 large leaks related to large detection by Picarro system (>10 scfh)
   - Found about 2 large detections per week
   - Picarro prediction within order of magnitude of actual leak rate

Field tests results

Term	Observed values
$P(B\|A)$	77%
$P(A\|B)$	67%
$P\langle B\|\bar{A}\rangle$	25%



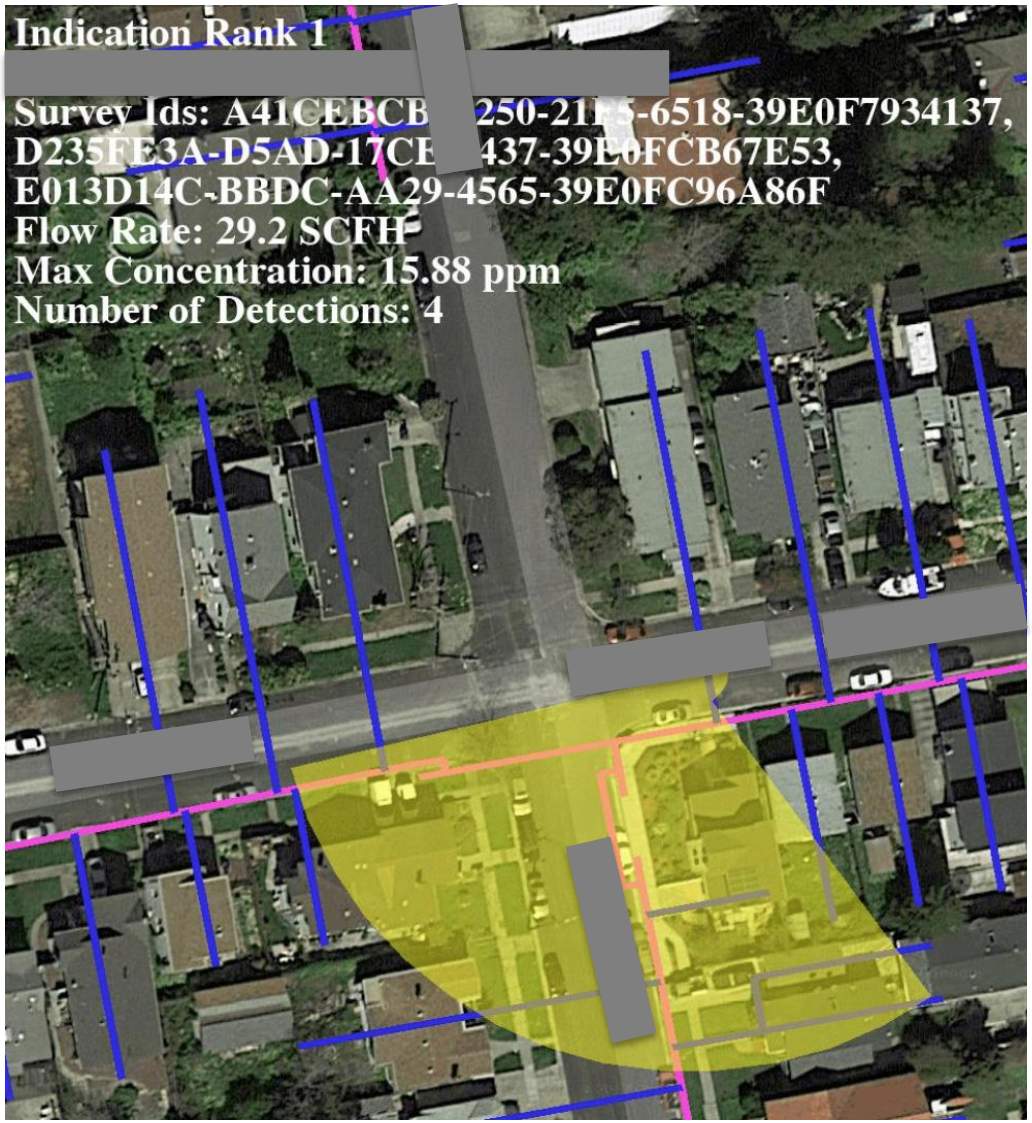
Example 1


Measured: 60 scfh
Actual: 98 scfh
source locations
12.4
14.5
14.4

Example 1

Example 2

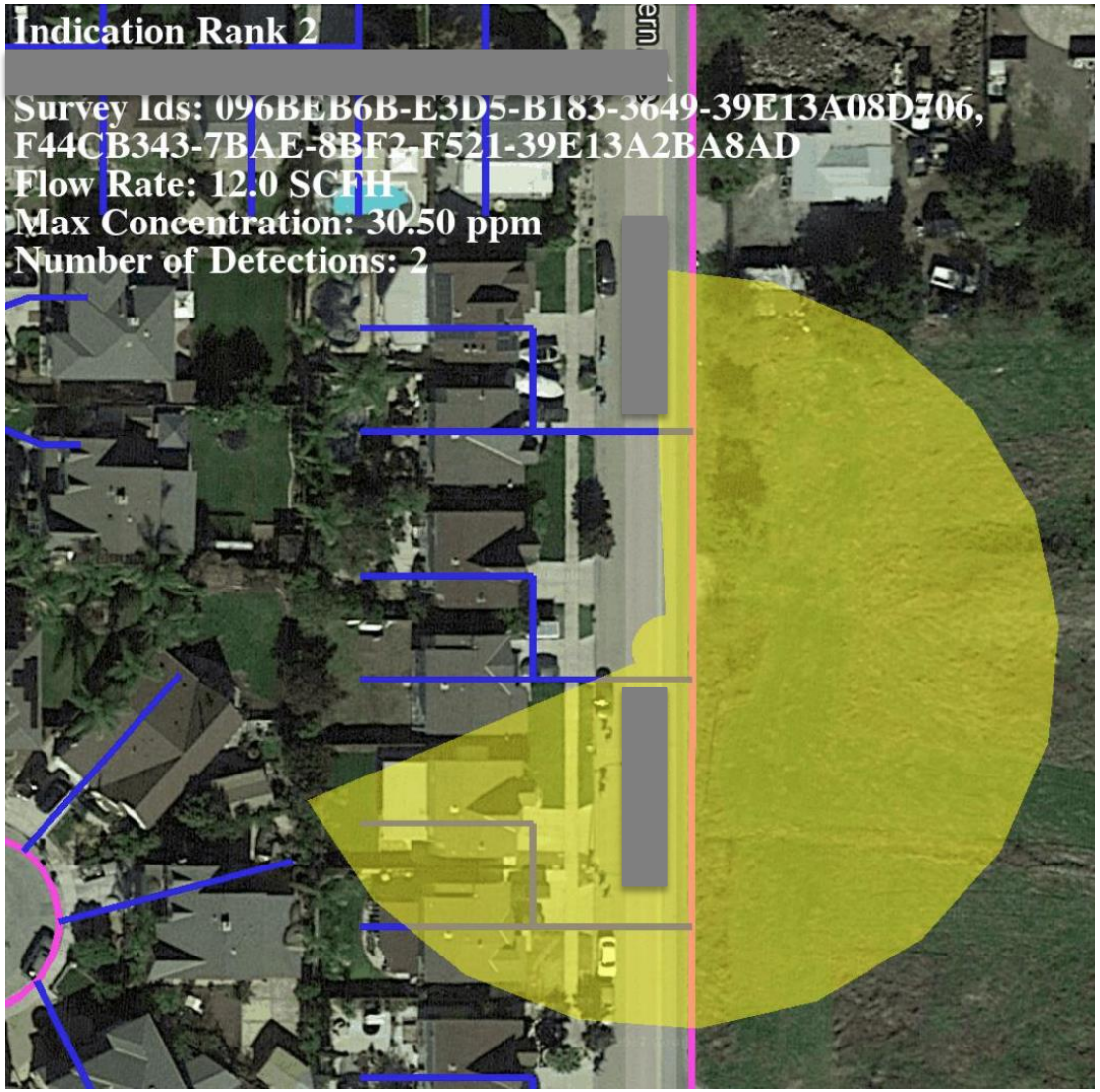
Measured: 29 scfh
Actual: 19 scfh



Example 2

Example 3

Measured: 12 scfh
Actual: 18 scfh



Example 3