



LMOP Webinar

Detecting Landfill Methane Emissions with Drones

September 28, 2023

Welcome and Agenda

AGENDA

US EPA Approved Drone-Based Method for Methane Detection in Terrestrial Applications

David Barron, Chief Technology Officer, Sniffer Robotics

Advanced Gas Emission Detection Solutions

Mitchell Scott, Field Service Technician, ABB


Dane Silva, Senior Technical Service Specialist, ABB

Questions and Answers

Wrap Up

Mention of any company, association, or product in this presentation is for information purposes only and does not constitute a recommendation of any such company, association, or product, either express or implied, by the EPA.

US EPA Approved Drone-Based Method for Methane Detection in Terrestrial Applications

A person wearing a yellow safety vest with the Sniffer Robotics logo and a tan baseball cap is seen from behind, looking at a drone flying in the sky. The drone is a quadcopter with a sensor pod attached, and a thin yellow line connects it to the ground. The background shows a vast, green landscape under a blue sky with scattered clouds.

US EPA Approved Drone-Based Method for Methane Detection in Terrestrial Applications

David Barron
CTO - Sniffer Robotics

The Sniffer Robotics logo, featuring the word "sniffer" in a bold, lowercase, sans-serif font, with five small green circles below it and "00000" in a smaller font to the right.

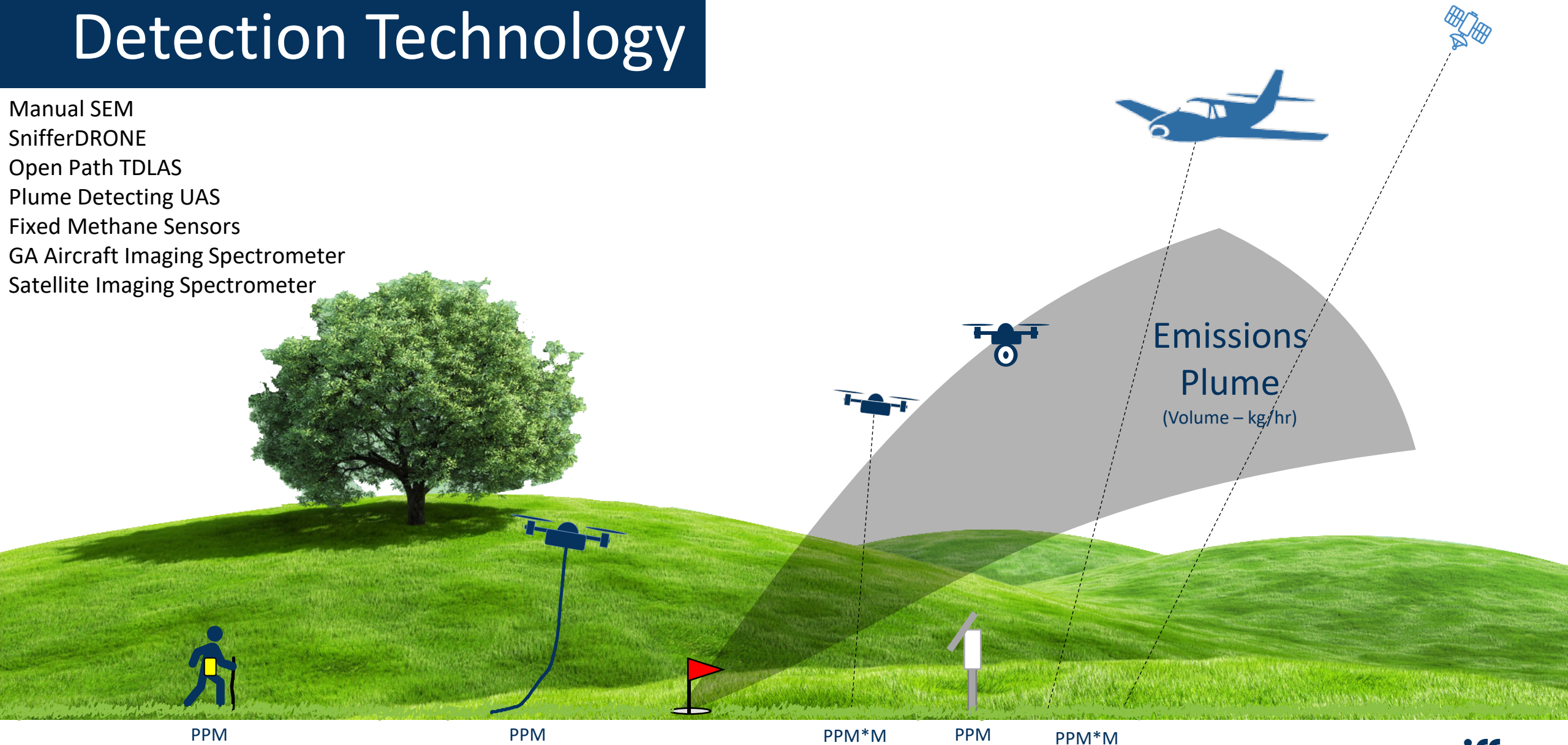
sniffer
00000

The Protolabs Idea Award Winner logo, featuring the Protolabs logo (a blue square with a white 'P' and 'L') and the text "PROTOLABS" above the "IDEA AWARD" text, which is enclosed in a circular graphic, with "WINNER" below it.

PROTOLABS
IDEA
AWARD
WINNER

Deployed Methane Detection Technology

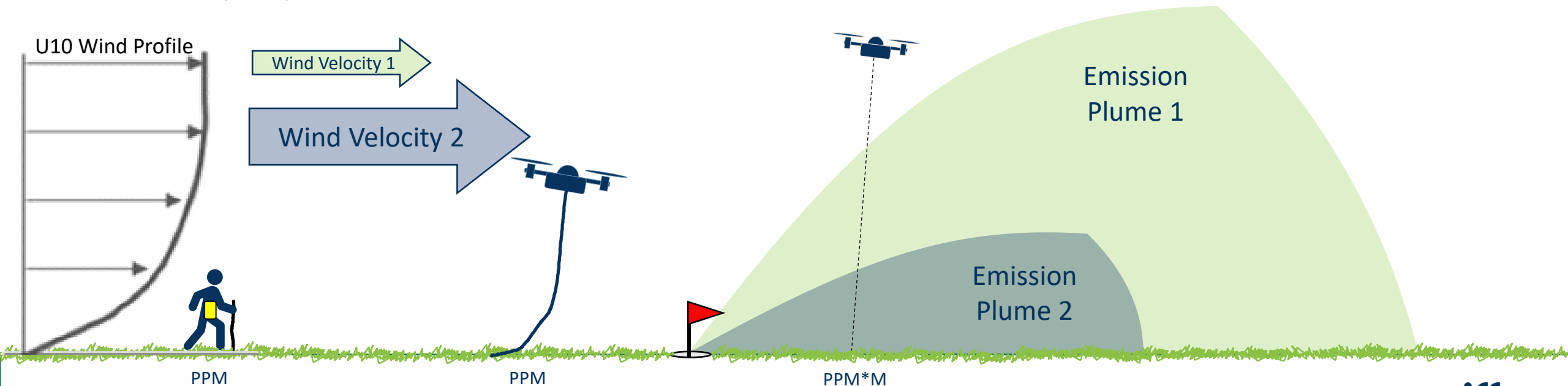
- Manual SEM
- SnifferDRONE
- Open Path TDLAS
- Plume Detecting UAS
- Fixed Methane Sensors
- GA Aircraft Imaging Spectrometer
- Satellite Imaging Spectrometer



LDAR Units

Why we prefer PPM

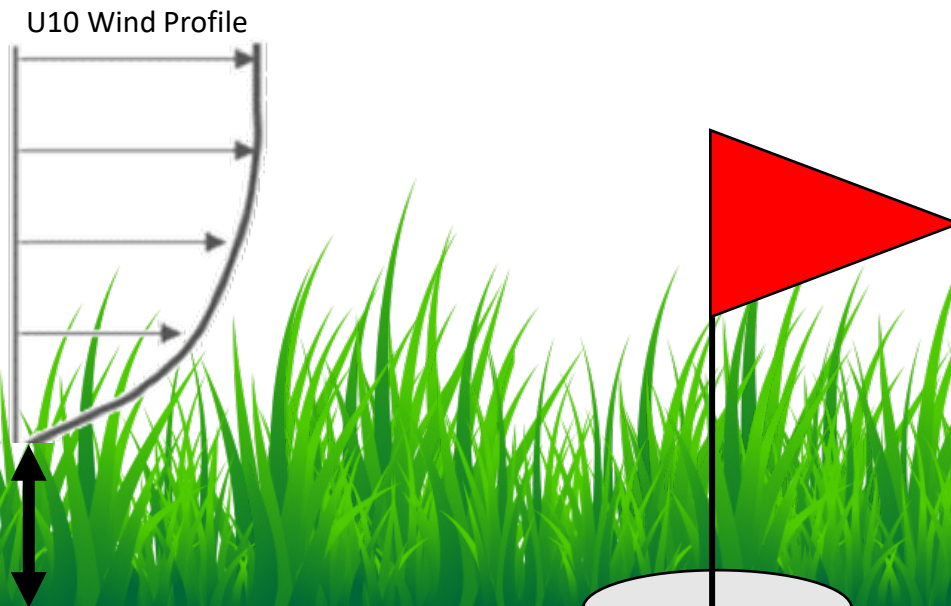
- Units Options:
 - PPM is a direct measurement of concentration at the source location (pipe vent, surface leak, etc.)
 - PPM-M is a path integrated measurement with a higher degree of influence from environmental parameters (wind velocity, pressure, etc.)
- Any given emission, in two different wind environments, will produce different path integrated concentrations (PPM*M)
- Given wind shear drives wind velocity at the emission location to zero – severity of leaks can be approximated using true concentration (PPM)



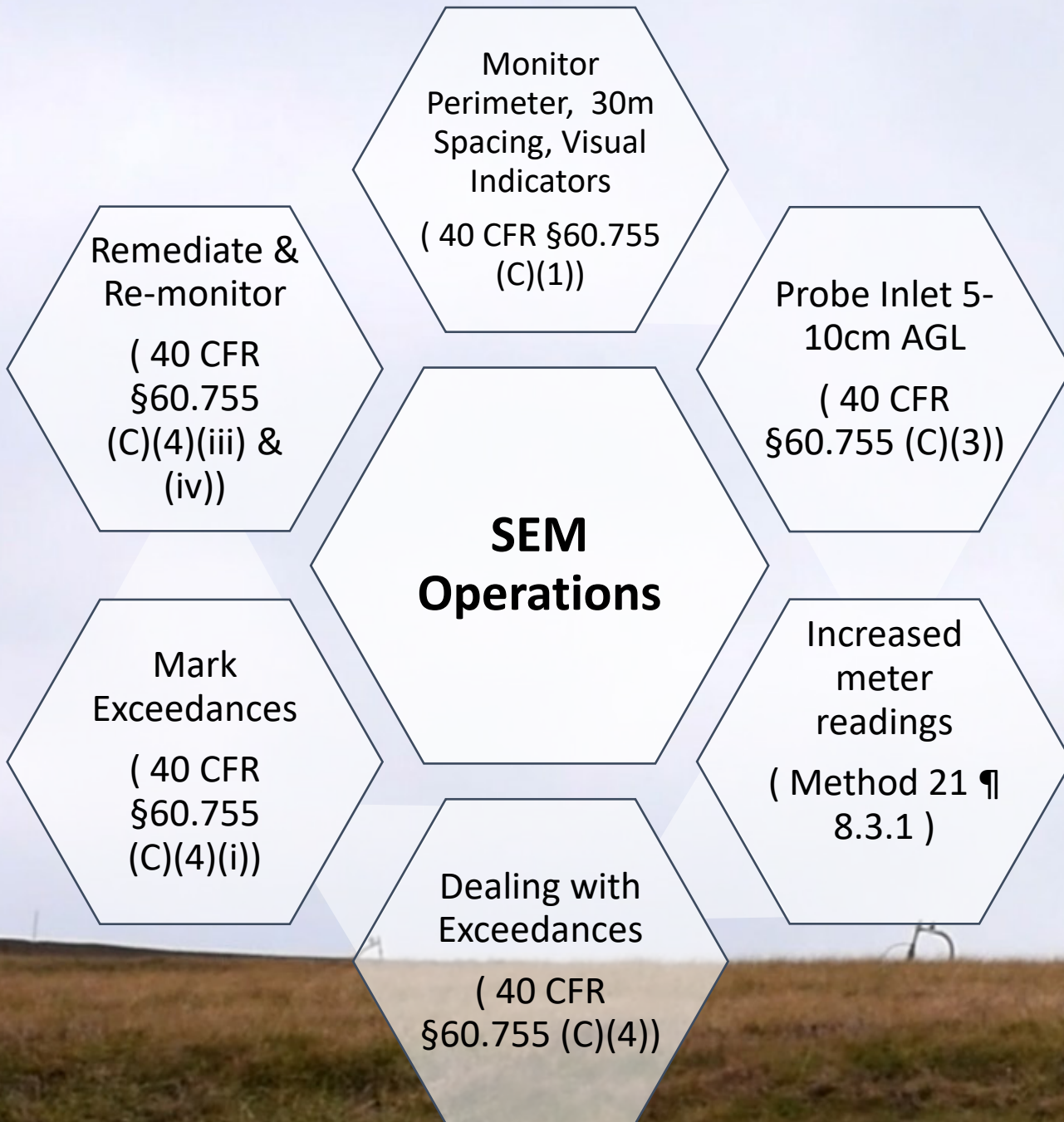
Measurement Location

Why we prefer ground level

- US EPA Method 21 specifies measurements must be taken 5-10cm of surface (pipe, vegetation, etc.)
- For surfaces with features (e.g., vegetation) at non-zero altitudes, the standard wind profile assumptions fall off and are replaced with a nominal low wind environment – such that ground level sampling, in our experience, is more sensitive
- Surfaces with low to ground, man-made features have similar discontinuities in plume geometry

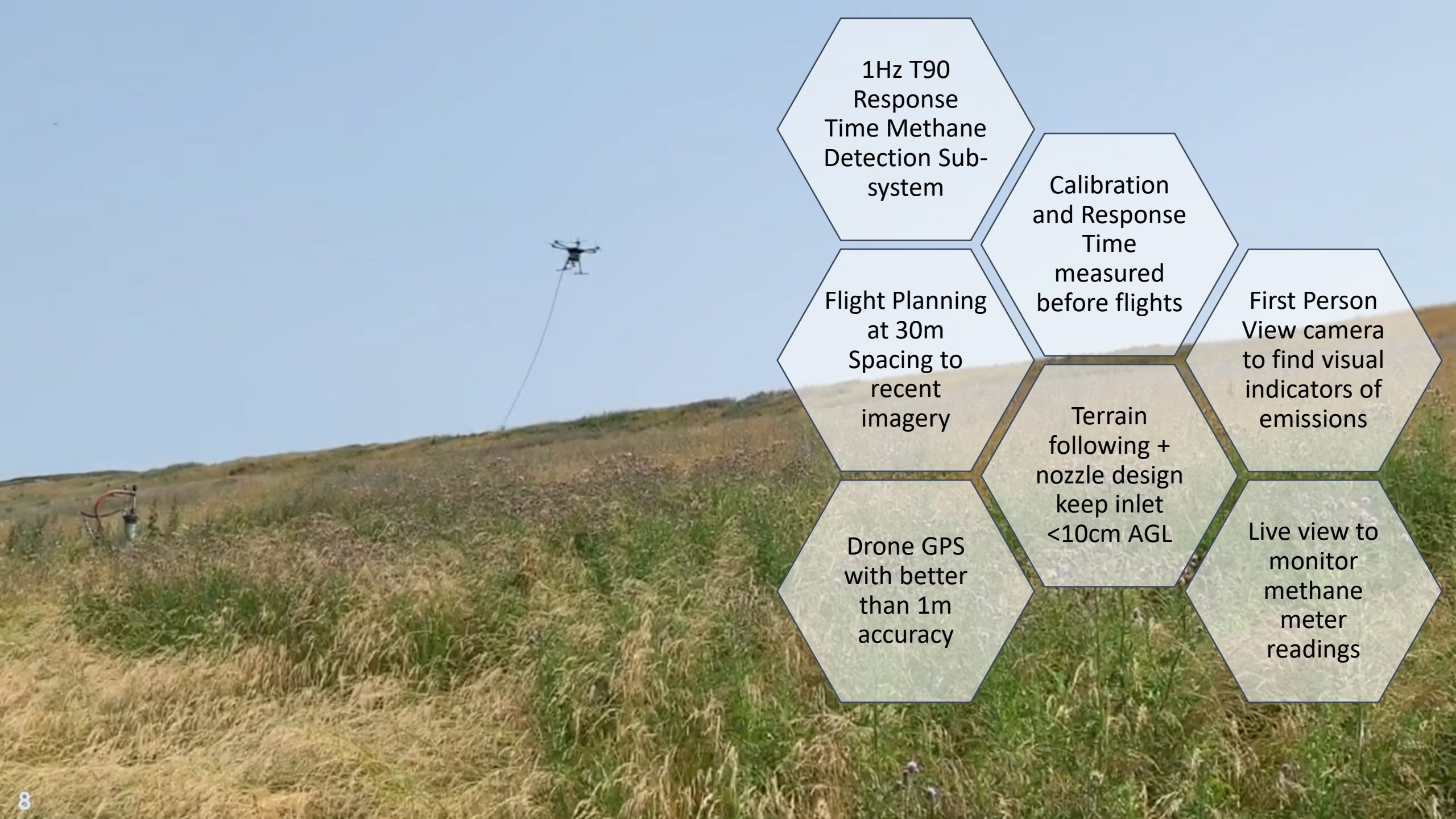


LDAR in MSW Surface Emission Monitoring via Method 21



- Observe readout for increased meter readings
- Find location of maximum meter reading
- Dwell for twice response time





1Hz T90
Response
Time Methane
Detection Sub-
system

Calibration
and Response
Time
measured
before flights

Flight Planning
at 30m
Spacing to
recent
imagery

First Person
View camera
to find visual
indicators of
emissions

Terrain
following +
nozzle design
keep inlet
<10cm AGL

Drone GPS
with better
than 1m
accuracy

Live view to
monitor
methane
meter
readings

Monitor
Perimeter, 30m
Spacing, Visual
Indicators

Remediate &
Re-monitor

(40 CFR
§60.755
(C)(4)(iii) &
(iv))

Probe Inlet
<10cm AGL

**UAS SEM
Operations**

Mark
Exceedances

(40 CFR
§60.755
(C)(4)(i))

Find and
localize
increased
meter
readings

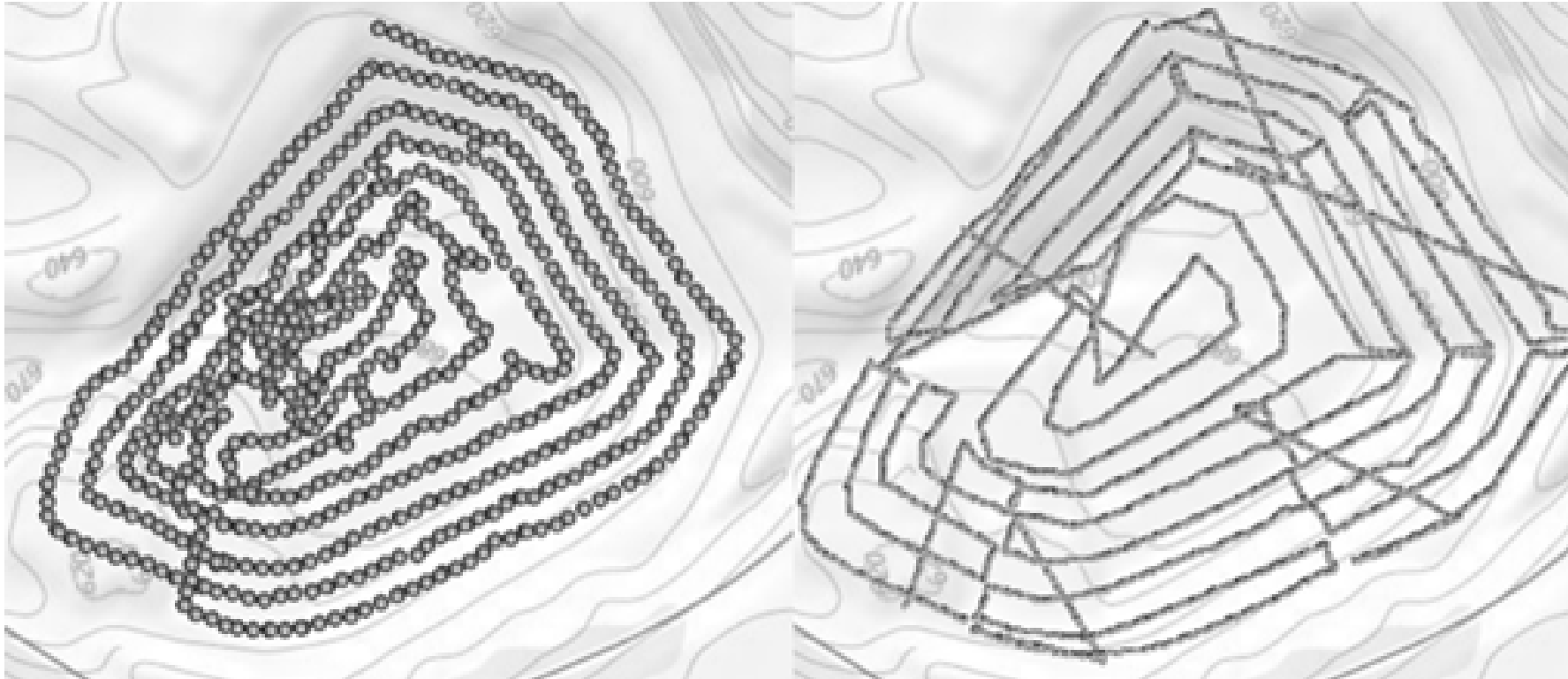
Dealing with
Exceedances

(40 CFR
§60.755 (C)(4))

- a) Record **UAS CH4** readout for increased meter readings
- b) Find location of maximum meter reading **within radius of UAS identified GPS location**
- c) Dwell for twice response time



Precision of Automation – A Case Study



SEM Metrics

Walking Distance:	4.97 miles
Flight Distance:	6.64 miles
Avg Walking Speed:	1.5 mph
AVG Flying Speed:	7.5 mph
Walking Time:	199 minutes
Air Time:	66 minutes

US EPA Approval for UAS Surface Emission Monitoring

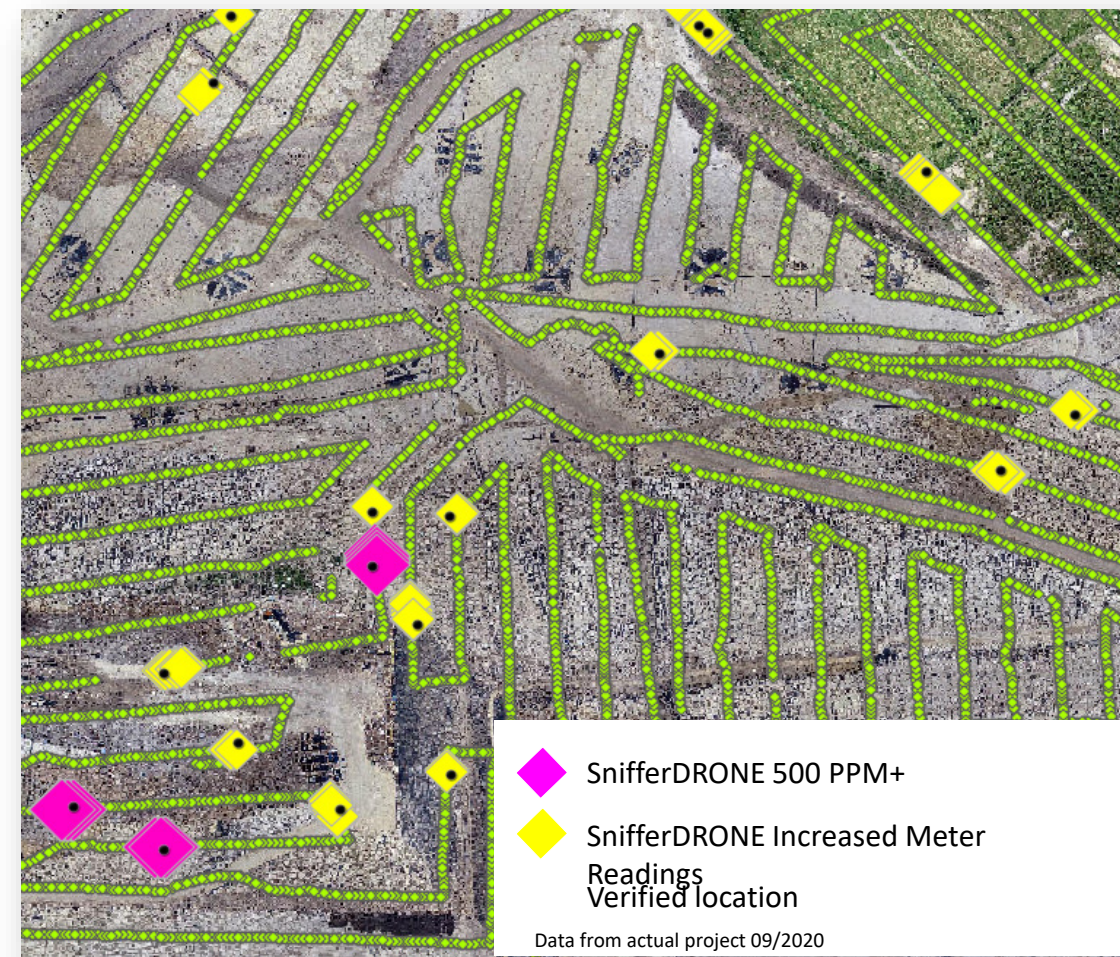
[ALT-150: Approval to Use Unmanned Aerial System Application as an Alternative to Method 21 for Surface Emission Monitoring of Landfills](#)

[OTM-51 UAS Application of Method 21 for Surface Emission Monitoring of Landfills](#)



Sniffer Field Ops™

- Mobile app (iOS/Android)
- Field data collector
- Automated alerts
- Symbology
- Imagery
- History



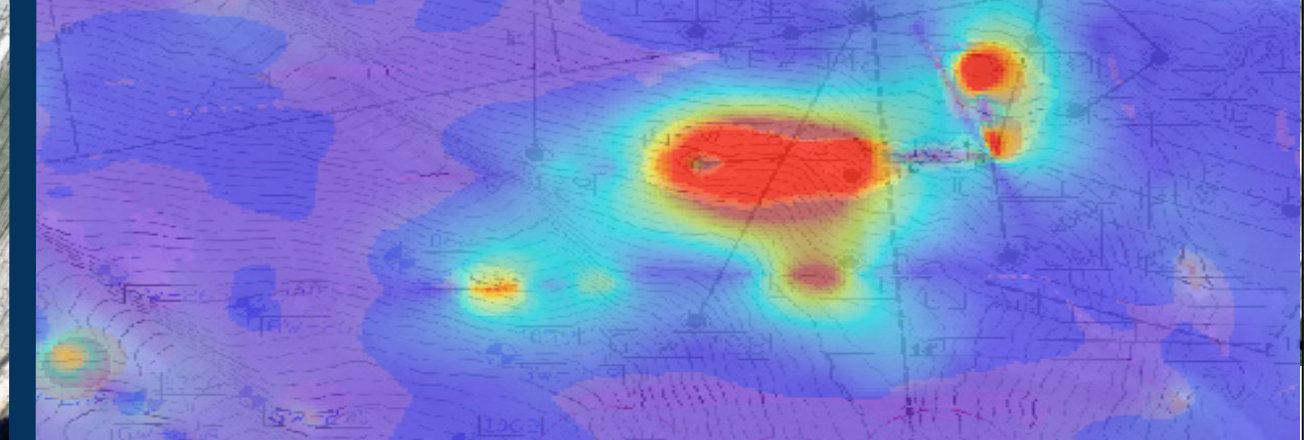
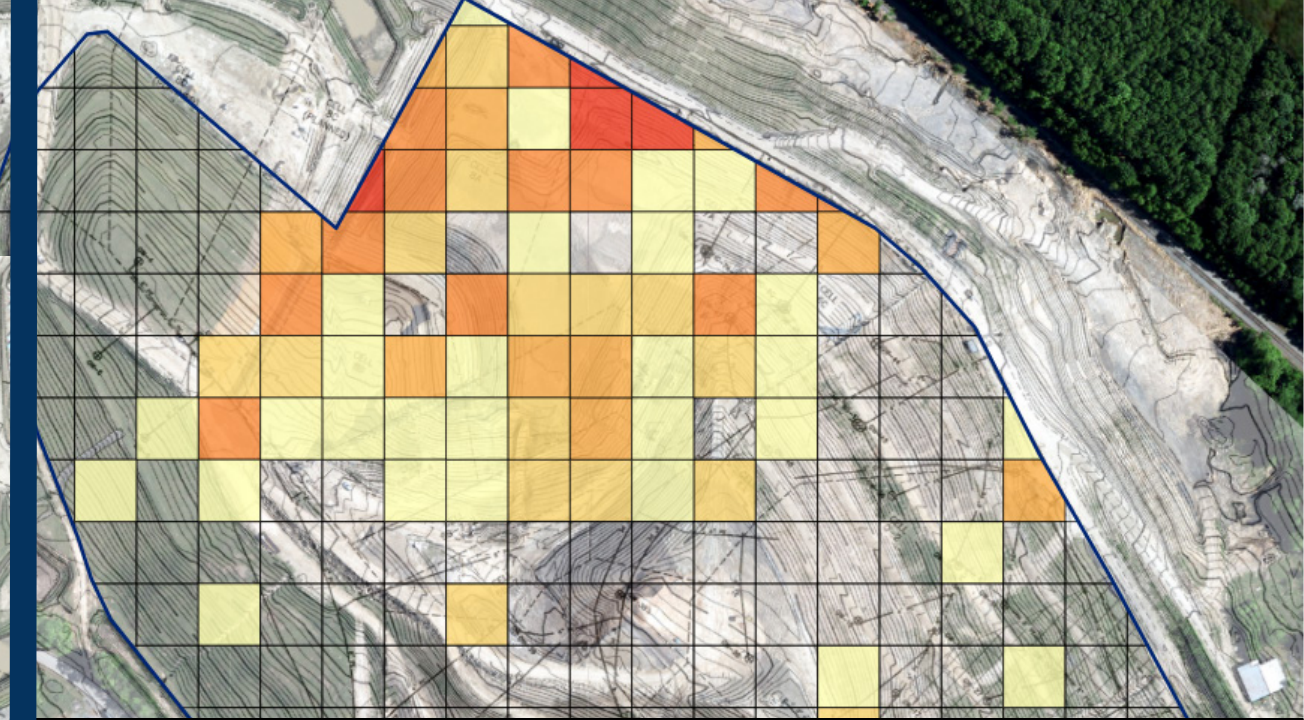
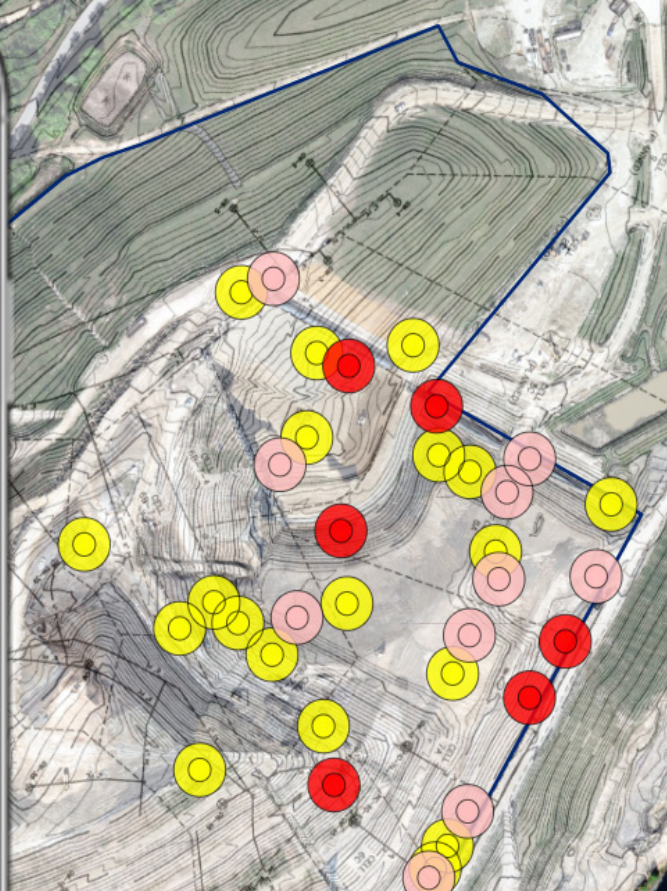
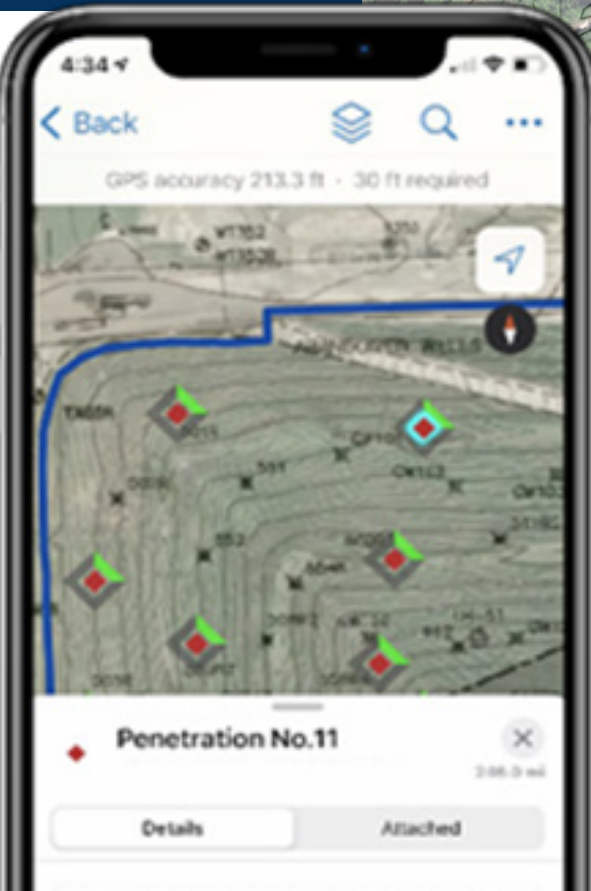
Daily Reports

- By 10:00 am
- Exceedance details
- Maps
- Imagery
- Potential root cause(s)
- Calibration reports

Final Reports

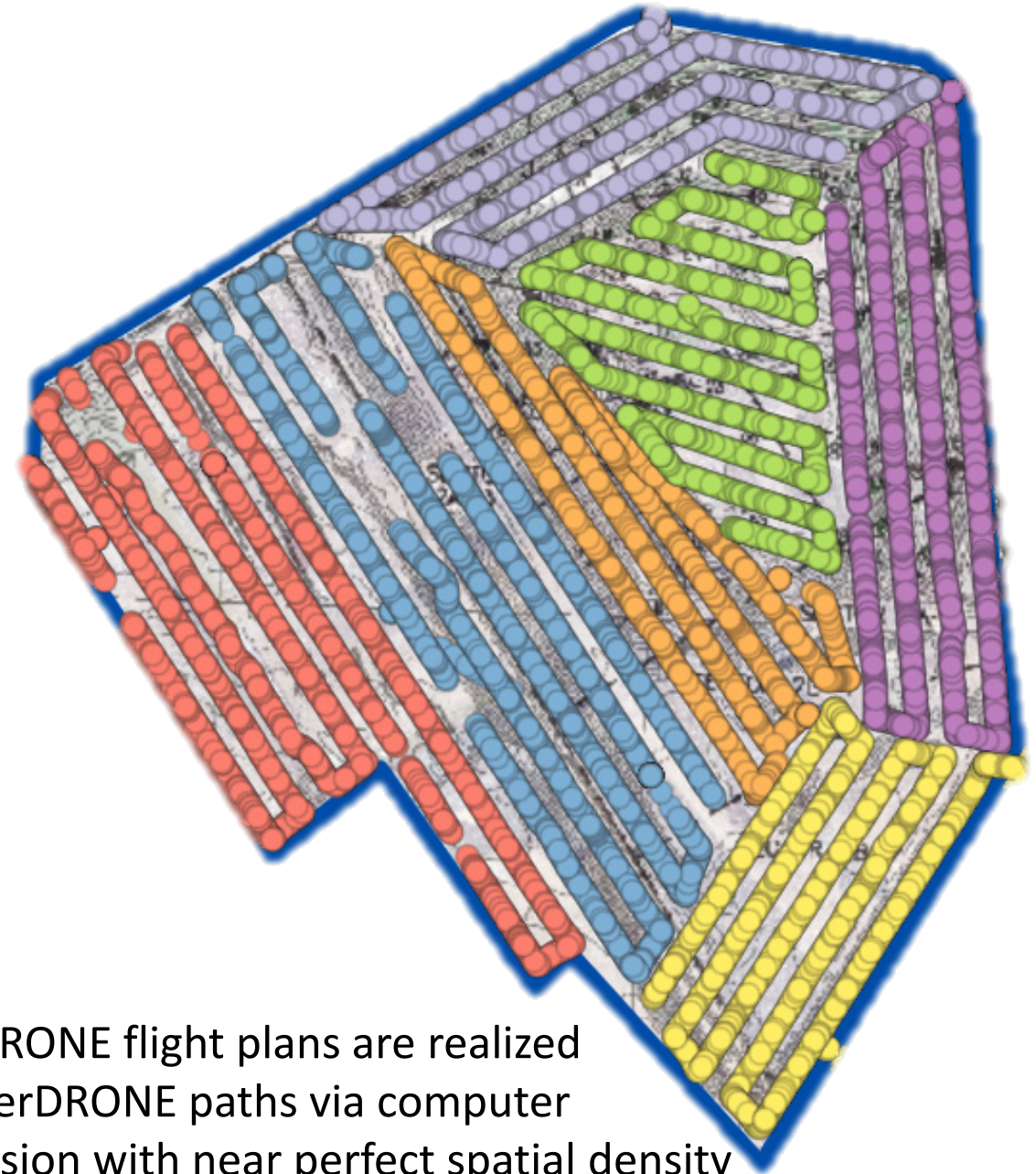
- Internal file report
- Regulatory report

Tools to Precisely Locate VS Tools to Analyze



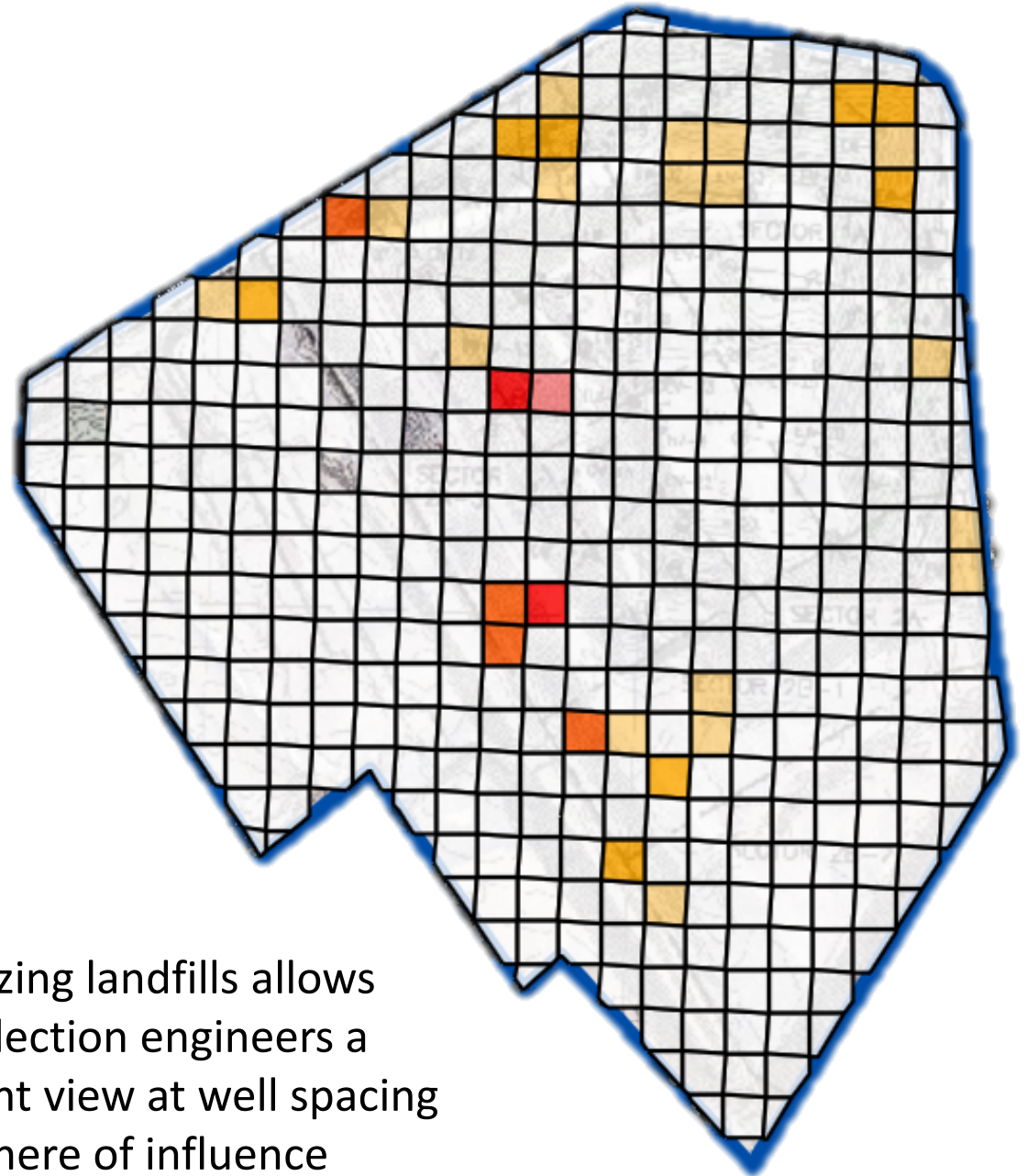
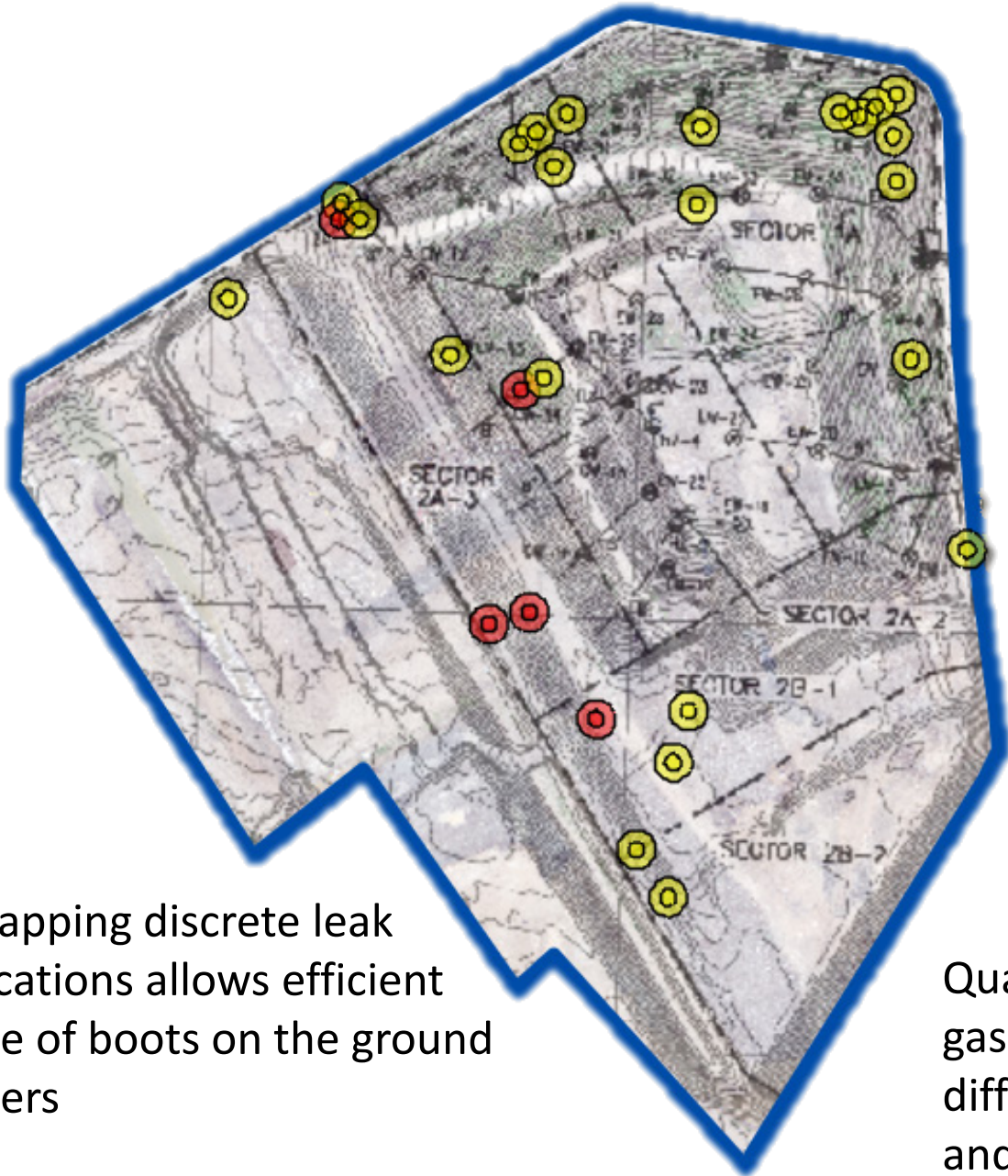
Mobile app and web client guide user directly to increased meter readings for verification
“First to the flag”

Back end analytics allow engineering analysis of the “state of the gas management system”
Quantized emission mapping for well influence mapping, heat mapping, etc.



SnifferDRONE flight plans are realized as SnifferDRONE paths via computer controlled precision with near perfect spatial density

SnifferDRONE Analytics Case Study



Mapping discrete leak locations allows efficient use of boots on the ground users

Quantizing landfills allows gas collection engineers a different view at well spacing and sphere of influence

SnifferDRONE Analytics Case Study



Survey to
Survey
Changes



Heat maps represent snapshots in time and allow today's plans to be formulated

Showing relative change between SnifferDRONE surveys allowing for an understanding of efficacy and impact of remediation

SnifferDRONE Analytics Case Study

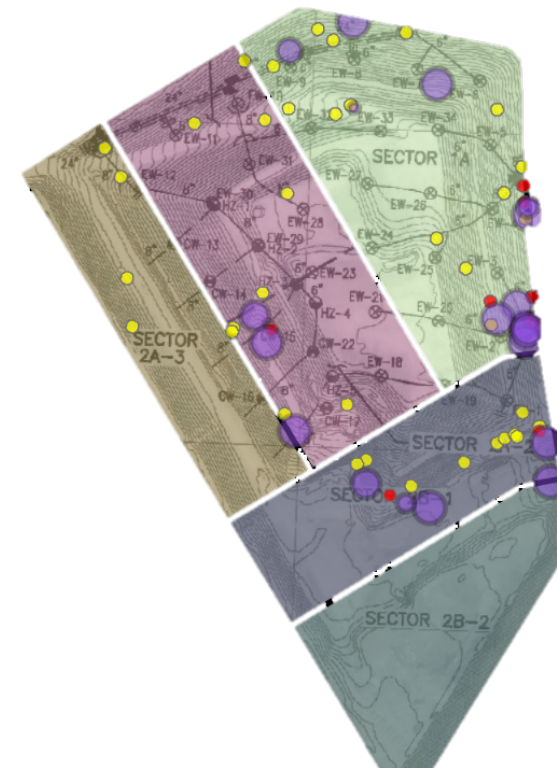


Flux (g/s)



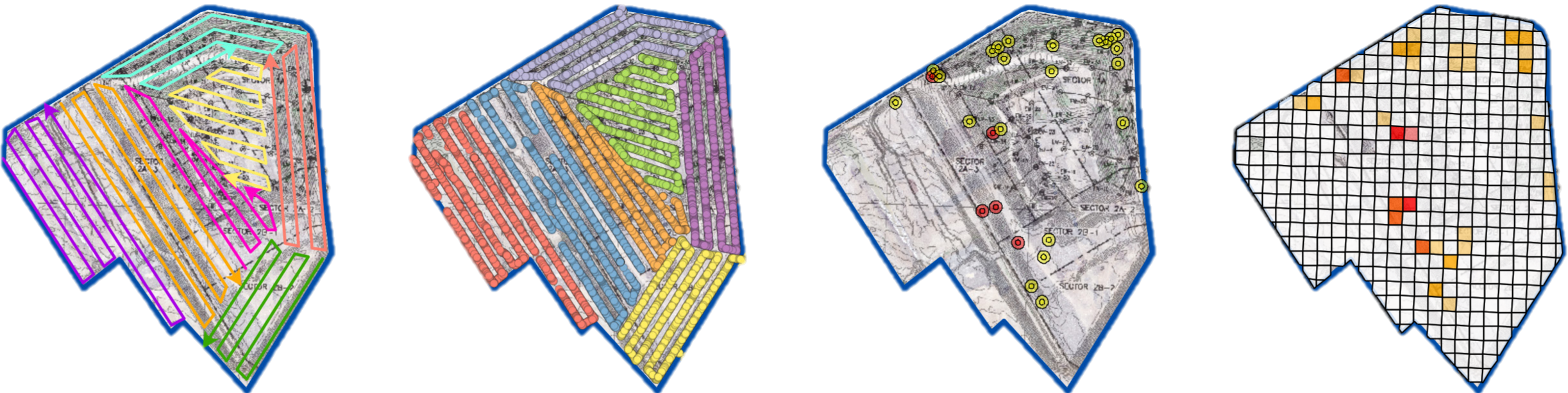
SnifferDRONE Peaks

CH₄



Quantification of full site emissions allows for a macro level understanding of gas collection efficiency

Working towards quantification per user defined regions – e.g., cells





Advanced Gas Emission Detection Solutions



ABB ANALYTICAL MEASUREMENT

Advanced Gas Emission Detection Solutions

Novel platform reduces risk, increases safety, and decreases waste

September 28, 2023



Agenda

- ❖ *Why do we need Advanced Landfill Methane Leak Detection Solutions?*
- ❖ *Why ABB?*
- ❖ *ABB Advanced Leak Detection Solutions*
- ❖ *Success Story with BioResource Development*
- ❖ *Q&A and Closing*



Why Do We Need Advanced Landfill Methane Leak Detection Solutions?

Legacy Leak Survey Methods

- Slow walking/driving
- Poor sensitivity sensors – must close (<3 meters)
- Relies heavily on training & care of surveyors
- Paper-based process is labor intensive



Advanced Mobile Leak Detection

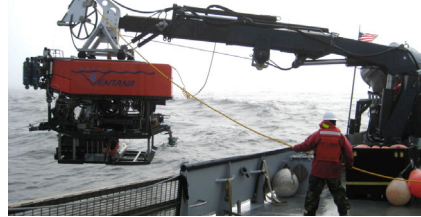
- Enables detection and mapping of methane emissions while flying/driving with unprecedented speed, accuracy, and reliability.
- Can detect, precisely locate, and estimate the size of methane emissions at a rate that covers more area than traditional methods saving considerable time and allows the user to survey locations inaccessible by road or walkway.
- Combining LGR-ICOS laser technology, wind velocity and GNSS sensors, and advanced data analytics, the HoverGuard™ solution detects and quantifies emissions far from hard-to-reach sources in minutes.
- ABB's proprietary software provides real-time visualization, automated analysis/reporting, and emission interpretation.

ABB acquired LGR, a pioneer in mobile leak monitoring

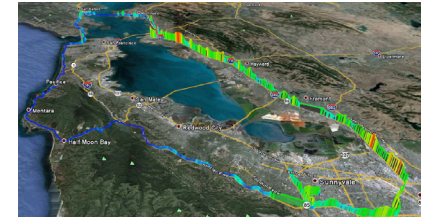
Flying, driving and diving since 2005



NASA – 2005



MBARI – 2010



CARB – 2011



NASA – 2011



Google – 2011



DOE – 2013



NASA – 2014



NFS – 2015



Juelich – 2016

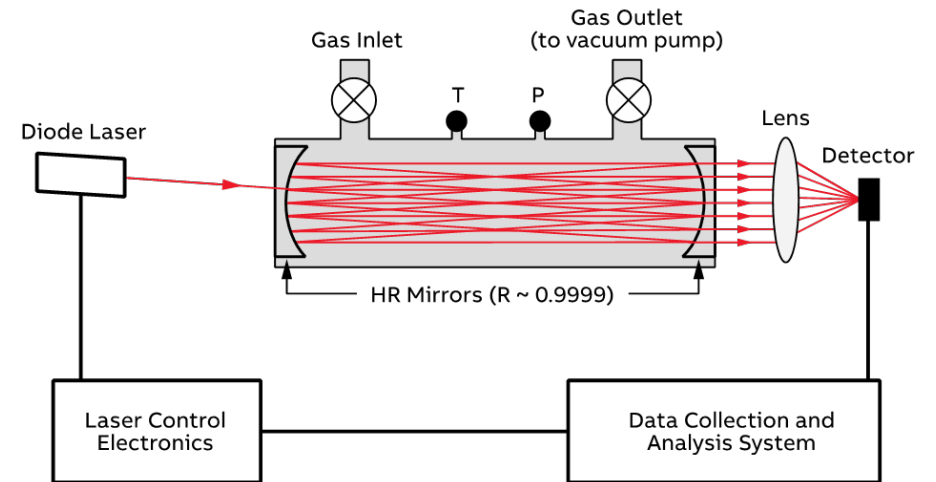
ABB OA-ICOS History

Why ABB?

Los Gatos Research

- Founded in 1994 and acquired by ABB in 2013
 - Based in the Silicon Valley (San Jose, California)
 - >50% Employees are Ph.D. Scientists
 - Currently the R&D center for OA-ICOS
 - Invented Cavity Enhanced Absorption Spectroscopy
 - CRDS, ICOS, Off-axis ICOS
 - 14 Patents with > 100 Scientific Papers Published
- Over 4000 Instruments Sold.... on all 7 continents
- OA-ICOS
 - 4th Generation cavity enhanced technique
 - Provides effective path length of several km
 - Very robust – exact alignment is not critical, enabling mobile monitoring
 - Field Serviceable/Minimal Downtime

Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS)

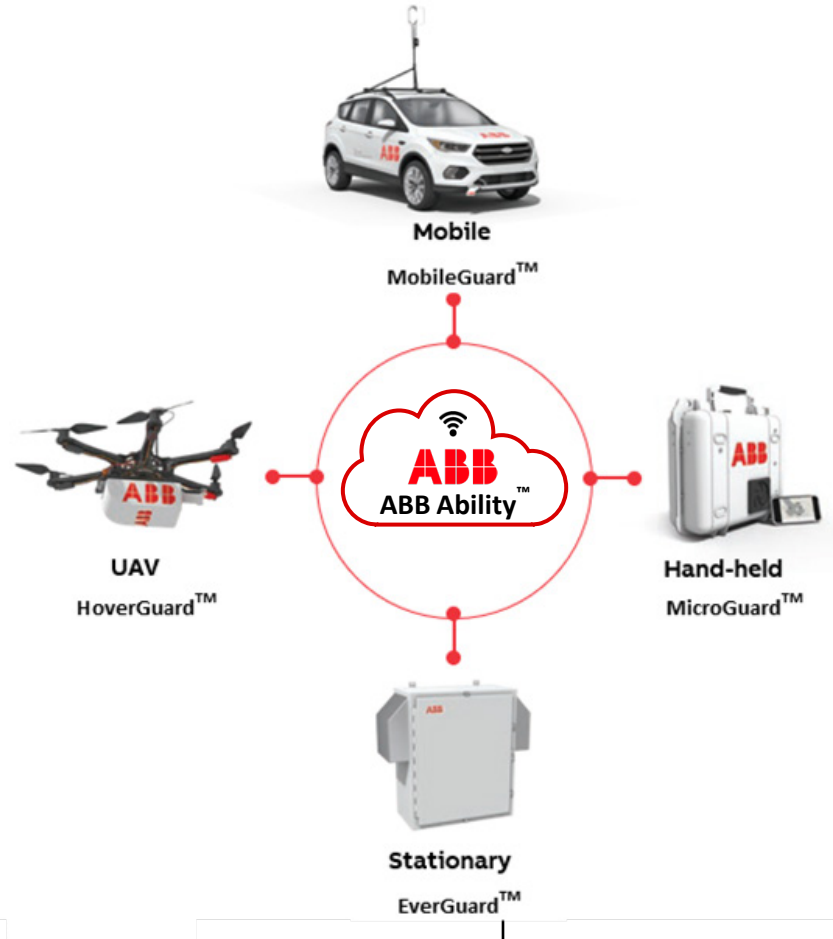


Summary: ABB Ability™ Gas Leak Detection Ecosystem

Why ABB?

Benefits

- Proven performance worldwide
- Cybersecure
- Customer owns and controls all data
- Full featured HW and SW
- Serviceability and reliability
- Comprehensive solutions for all apps
- Cost-effective
- Product offering
- Survey-as-a-Service available (in select areas)



Advantages

- More efficient surveying – fast ROI
- Finds large, small and even hidden leaks
- Source attribution (detects CH₄/C₂H₆)
- Integration of data/maps
- Full data ownership and custody
- No warm-up time
- Service, serviceability, & stability
- Fast ROI

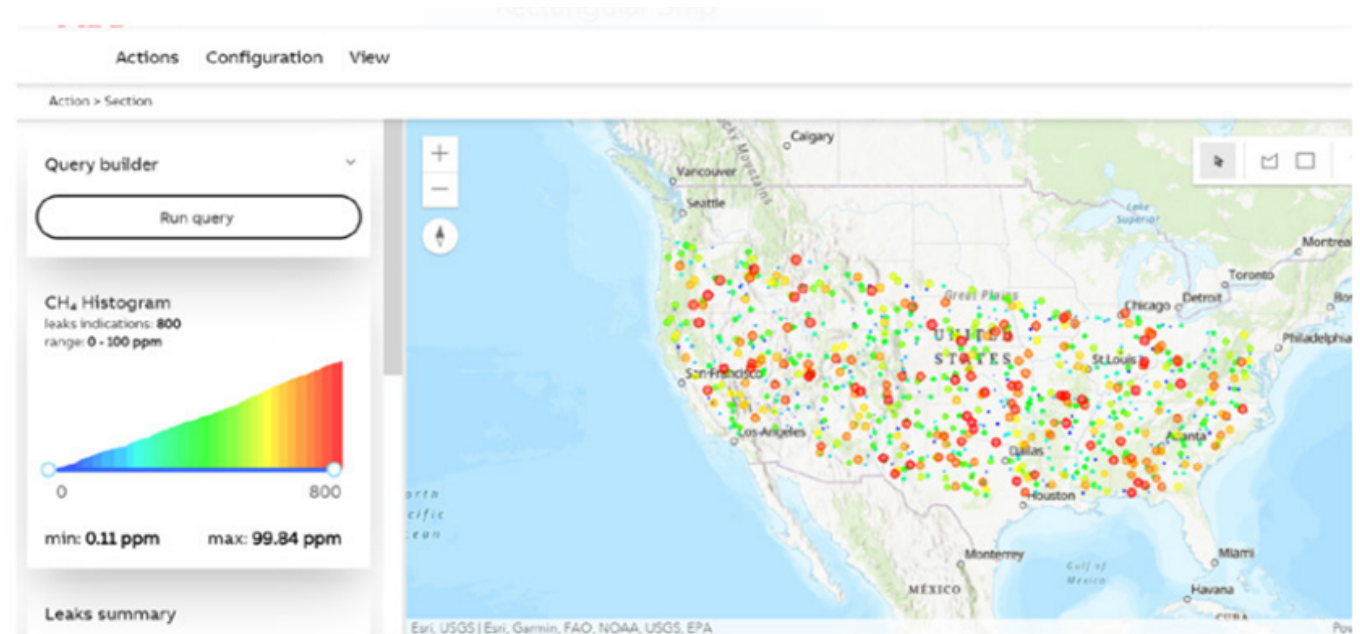
ABB advanced leak detection solutions go beyond detection to find, attribute, and quantify more leaks faster

Cloud storage and Analytics

Cybersecure data sharing and archival

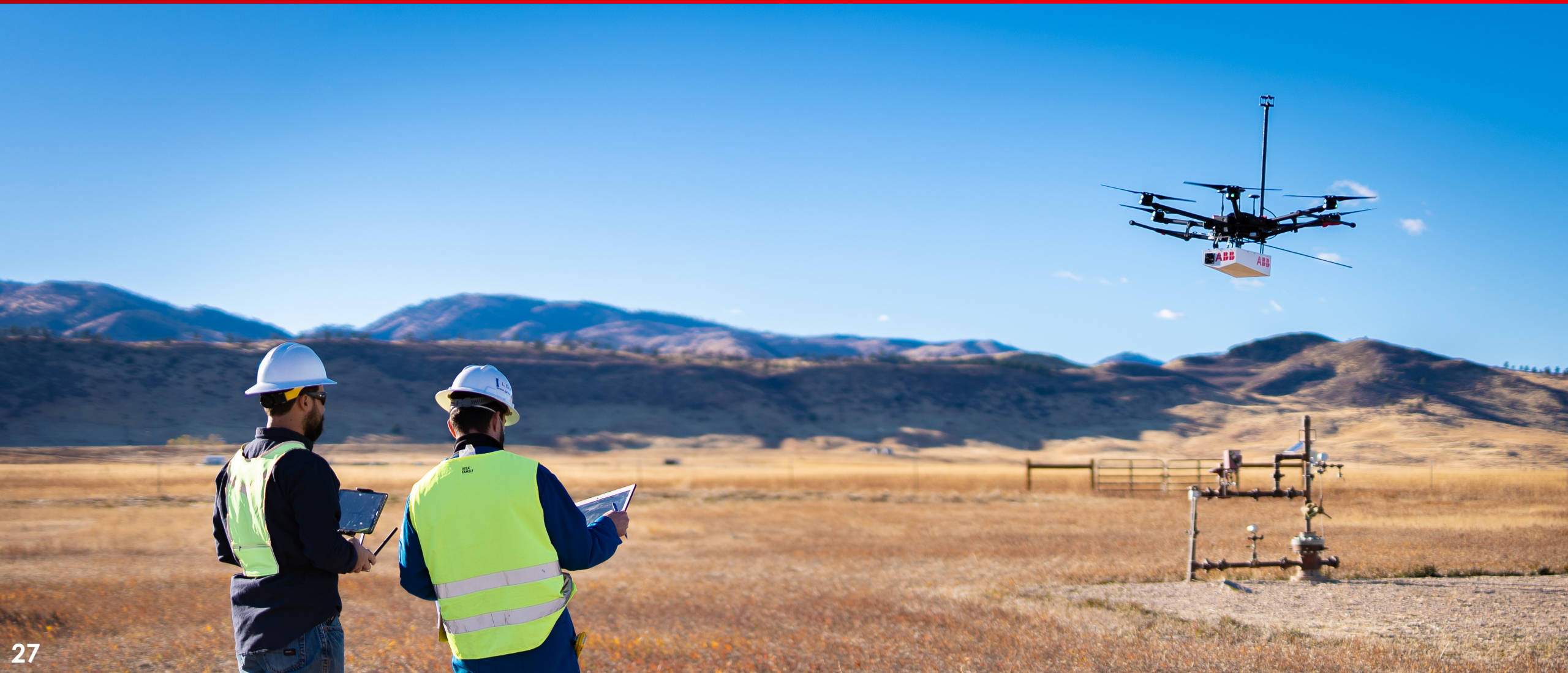
ABB Ability™ Cloud and Google Drive

- Flight, drive, and walking packages uploaded automatically
- All data: customer owned and controlled
- Set sharing access per user
- Unlimited reprocess capability: Command Center
- Cybersecure (HW and SW): ISO27001, SOC 2, rigorous 3rd-party testing
- This powerful feature offers a range of capabilities tailored to big data analytics, centralized user management, and unified access to all Leak Detection Solutions.
- Available dashboard for exploring all your surveys results in a centralized web application supported on ABB Ability™ cloud.



HoverGuard™

UAV-based Gas Leak Detection Technology

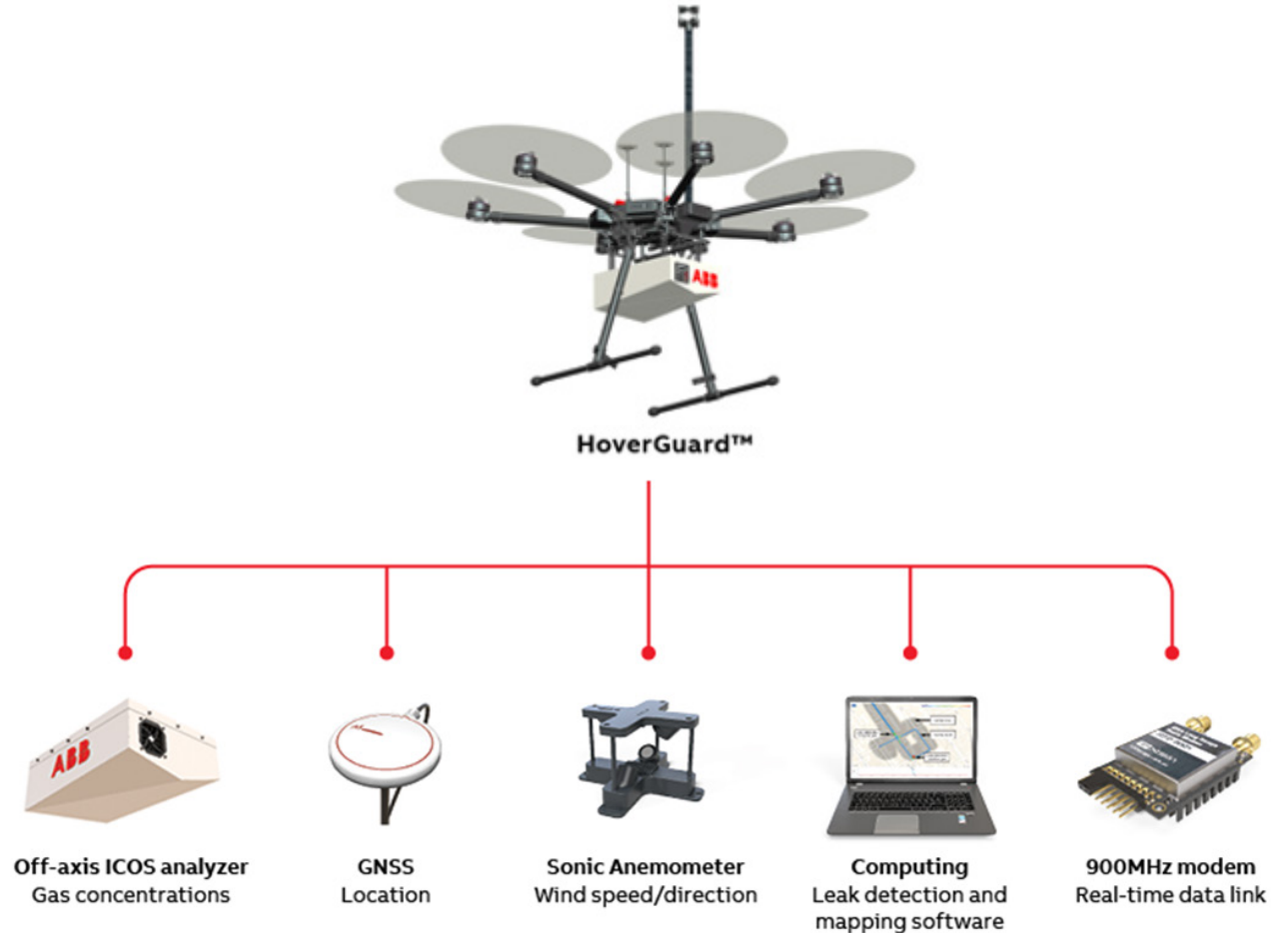


HoverGuard™

Primary components

Main Features

- High sensitivity detects leaks far from source
- Fast response (2.5 Hz) enables measurements while flying at high speed
- Fast data rate (10 Hz) allows high spatial res
- Proprietary software provides estimates of leak origin and size (emissions rate)
- Patented technology provides high accuracy measurements at the precise UAV location
- Advanced analytics and mapping software (FastScanner™) provides real-time results
- FastScanner generates advanced digital reports shareable via cloud connectivity
- Cybersecurity gives customers confidence their data and systems always remain safe



HoverGuard™: UAV-based Detection Solution

Find leaks quickly while flying

- Detection software identifies origin of emissions
- Tested worldwide (in >12 locations)
- Results displayed in Google Earth maps (tablet)
- Highest sensitivity (<1 ppb, typical, in 1 sec)
- Fastest data rate (10 Hz)
- Fastest flow response rate (3 Hz)
- Wireless UI (via smartphone/ tablet)
- 3 kg payload
- Wide (0-50 °C) operating temperature range
- Compact enclosure (13.3" x 8.8" x 4.2")
- Employs patented ICOS (rugged, high performance)
- CO₂ & Methane leak detection optional with 2 laser system



HoverGuard™: Emission Detection Survey



BioResource Development Survey

Survey Goals

- Customer was struggling with poor gas quality in certain landfill cells.
- An initial test survey was completed in 2022 in a limited area that led to a wellhead being dug up revealing a separated gathering pipe.
- A north-west cell has continued to have regular gas quality issues.



BioResource Development Survey

Survey Results

Survey Results

- Follow-up survey found a recurring issue with O-rings missing or being damaged in multiple wellhead sample probes.
- A more impactful issue found was a broad area of ground along the northern edge of the landfill that was no longer holding containment. This is likely the primary cause of the continuous gas quality issues in that area of the gathering field.

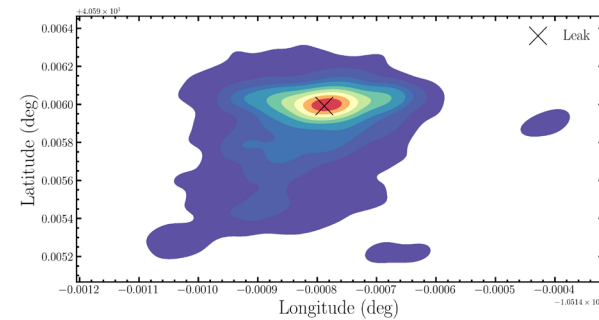
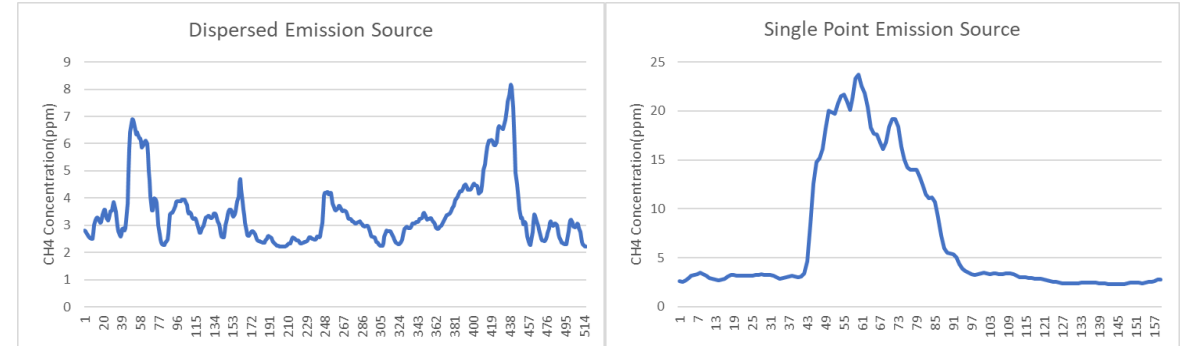
CH4 Heatmap



BioResource Development Survey

Survey Analysis

- High sample rate and high sensitivity allowed rapid coverage of large areas and the ability to operate at varying altitudes.
- Lidar and ppb (part per billion) detection threshold gives capability to use the system close to the ground with an extended inlet for *OTM-51* compliance, or even at 20m+ with no loss of detection
- The ability to measure CO2 simultaneously with CH4
- Real time data during the survey and immediate reporting at the end allows operators to respond quickly and accurately to any issues discovered
- Ability to broadly differentiate between smaller single point emissions and broad, area emissions based on CH4 peak
- Generated reports provide accurate location estimates as well as emission rate quantification



Summary: ABB Ability™ Mobile Gas Leak Detection Solutions

Benefits

- Proven performance and reliability
- Full-featured, common HW/SW platform
- Worldwide service and high serviceability
- Comprehensive solutions for all applications
- Cost-effective (ROI)
- Survey-as-a-Service available
- Cybersecure

Competitive advantages

- More efficient surveying – quick ROI
- Thermogenic identification – no false positives
- Comprehensive xGuard platform: Micro, Mobile, Hover, EverGuard
- Customer enjoys full data ownership – ensures highest integrity
- Shortest warm-up time – highest efficiency
- Unsurpassed service, serviceability, stability, ruggedness, security
- Patented technology and methods

Find more leaks, faster

Q&A and Closing



Contact Info



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ABB

Questions

Q&A

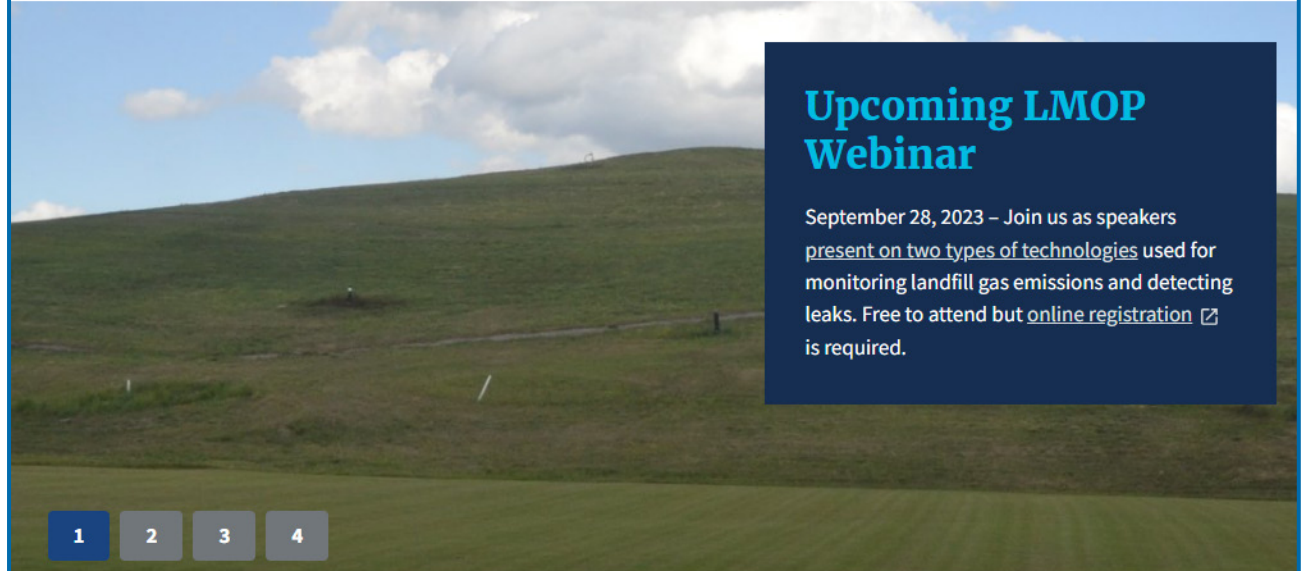
Wrap Up

Contact Information


Wrap Up

- The slides and recording from today's webinar will be posted on the LMOP website
- To learn more about LMOP or LFG energy, visit our website at epa.gov/lmop
- Have a webinar idea? Drop us a note with your email in the Q&A box or email lmop@epa.gov

Landfill Methane Outreach Program (LMOP)



Upcoming LMOP Webinar

September 28, 2023 – Join us as speakers present on two types of technologies used for monitoring landfill gas emissions and detecting leaks. Free to attend but [online registration](#)  is required.

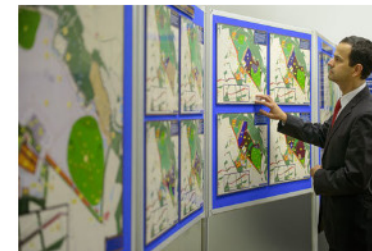


LMOP is a voluntary program that works cooperatively with industry stakeholders and waste officials to reduce or avoid methane emissions from landfills. LMOP encourages the recovery and beneficial use of biogas generated from organic municipal solid waste. [Learn more about LMOP](#) or [join the LMOP listserv](#).

Key Information



Data and Partners



Tools & Resources

