December 13th, 2023

Bill Flagg
Department of Ecology
Air Quality Program
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Mr. Flagg:

Thank you for the opportunity to comment on proposed rulemaking for Chapter 173-408 WAC concerning landfill emissions. The people of Washington spoke clearly and concisely in the December 6th public hearing – they want the best technologies and the best methods deployed at Washington landfills to curb landfill methane emissions, specifically inclusive of drones and automation technologies. To this end, Sniffer Robotics strongly recommends inclusion of US EPA Other Test Method 51 (OTM-51) - *UAS Application of Method 21 for Surface Emission Monitoring of Landfills* as an approved alternative in WAC 173-408-120 (8).

As presented in Table 2 of ALT-150; ***OTM-51 resulted in 76% more increased meter readings than Method 21.***

	Number of Increased Meter Readings (200 – 499 ppm)	Number of Exceedances (≥500 ppm)	Total Readings (≥200 ppm)
Existing SEM a	7	1	8
Existing SEM b	9	0	9
UAS-based Alt 1	8	5	13
UAS-based Alt 2	16	2	18
UAS-based Alt 3	12	3	15
UAS-based Alt 4	13	1	14

As presented in Table 5 of ALT-150; ***OTM-51 resulted in 127% more exceedances than Method 21***.

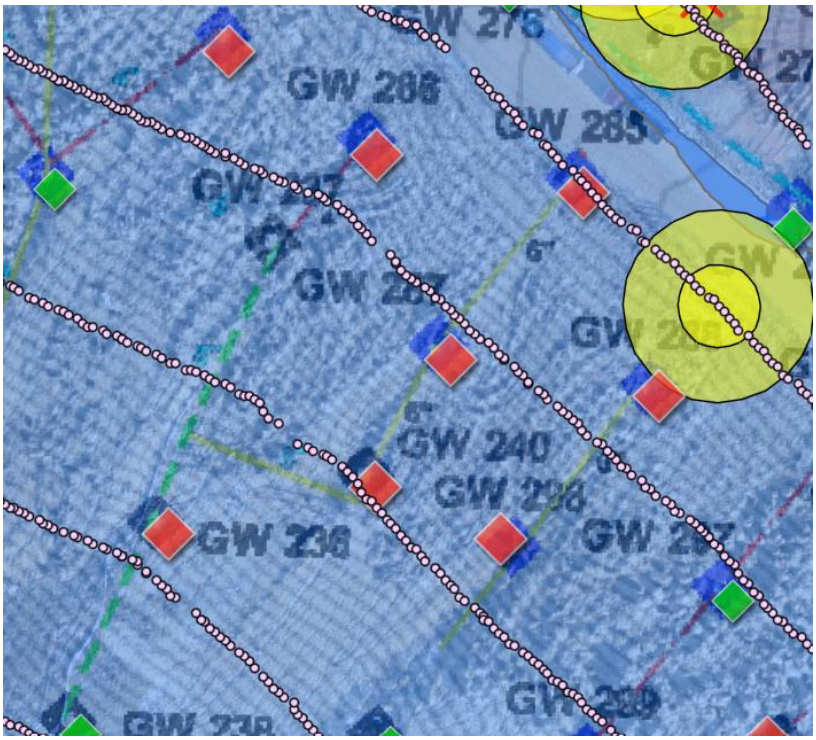
Run	Site ID	Surveys Using UAV-based Alternative Method Date of Test	UAS based method Increased Meter Readings (≥500ppm)	UAS based method Increased Meter Readings (≤500ppm)	UAS based Method Nominal Projected Exceedances	Surveys Using Existing SEM Compliance Method Date of Test	SEM Compliance Method Reported Exceedances	Difference (Projected Exceedances from UAV Method – Reported Exceedances from Existing SEM Method)
1	A	2/19/2020	46	41	58	3/11/2020	3	+55
2	B	3/3/2020	15	41	31	3/10/2020	10	+21
3	B	5/11/2020	1	11	6	6/17/2020	28	-21
4	A	6/13/2020	1	35	17	6/11/2020	2	+145
5	B	8/7/2020	16	44	33	9/15/2020	11	+22
6	A	9/25/2020	3	23	13	9/22/2020	4	+9
7	A	11/23/2020	12	39	28	11/11/2020	4	+35
8	B	4/22/2021	4	83	41	5/5/2021	15	+26
9	C	5/12/2021	15	36	29	6/16/2021	5	+24
10	D	5/10/2021	3	9	7	5/12/2021	0	+7
11	B	7/15/2021	3	16	10	8/24/2021	22	-14
12	B	9/1/2021	9	18	16	8/24/2021	22	-8
		Totals	128	396	287	Totals	126	

OTM-51 was specifically written to modernize surface emission monitoring and has been field proven to do so. Importantly, the increased probability of detection is not due to tighter spacing, narrowly controlling allowable wind speed or delaying SEM operations due to recent rain. The gains from the SnifferDRONE are born out of automation and programmatically enforcing quality control via computer control. It is worth noting then, that tighter spacing or narrow climactic conditions may be secondary effects to simply keeping the nozzle on the

ground a higher proportion of the time, attaining the proper spacing or following Method 21 8.3.1 to actually find the source location of increased meter readings.

Sniffer Robotics' encourages Ecology to consider how more comprehensive data reporting, as is done with the SnifferDRONE, may provide much greater benefits. For example, the SnifferDRONE reports a breadcrumb trail of the data collected as the drone is flown applying a buffer equal to the mandated spacing over each data point – omissions in the coverage are readily apparent. Reporting paths allows them to be audited to ensure increased meter readings were tracked to source locations. Regulations are only as effective as they are implemented in the field.

The figure below illustrates the rich data the SnifferDRONE reports – blue shading is the buffer indicating locations covered adequately, colorized points indicate both methane concentration and the traversed path and other iconography ensures every penetration has been properly inspected. Data overlayed on site as-builts gives context to the field team for crystal clear navigation in their mobile device. All of this is reported in the field via mobile applications pushing data to the cloud for instant oversight.



Other benefits of OTM-51 compared to SEM foot patrols include:

1. *Increased Operator Safety*

The proposed implementation of SEM in the field exposes the SEM operator to safety and health risks. The average landfill requiring quarterly SEM inspections in the United States is approximately 100 acres. The SEM inspection takes two operators approximately three days to complete. Today, this means an operator walks more than 20 miles per 100 acres. This level of exposure to the typical conditions found on a landfill across all seasons presents ample opportunity for:

- Slips, trips, falls and other injuries from walking through varying weather, steep slopes, exposed geomembrane, cracks, ice, snow, mud, active areas and other hazardous conditions;
- Exposure to nuisance insects (ticks, spiders, mosquitos, etc.).
- Exposure to rodents (rats, mice, etc.), snakes, birds of prey, etc.
- Heat exhaustion.
- Hypothermia and frostbite.
- Operator fatigue.
- Exposure to landfill gases (such as Hydrogen Sulfide) not in line with the As Low as Reasonably Possible (ALARA) philosophy.

The above risk factors can be categorized as cost and safety risks resulting in lost time and lost workdays – the practical implication being that operators cannot perform SEM as a full-time position for multiple subsequent days and therefore a greater expense is incurred in the operation. OTM-51 generally removes the operator from the surface of the landfill and allows for the operator to remain in the support vehicle. Sniffer Robotics estimates the time an operator spends on the surface of the landfill is reduced by up to 67% when using OTM-51, resulting in a decrease in the above risk factors.

2. *Expanded Inspection Capability*

The proposed regulations for manual SEM inspection include provisions to omit certain sections of the landfill to account for operator safety, such as areas with steep slopes or other dangerous areas. OTM-51 relies on a UAV agnostic to the landfill's topography and can survey most areas traditional operators would define as steep slopes. The UAV is also unaffected by many dangerous areas, such as locations with elevated Hydrogen Sulfide emissions. The SnifferDRONE doesn't care if the slope is icy or muddy. More experienced UAV operators may also feel confident surveying the active areas of landfills without requiring a work stoppage of heavy equipment – an area deemed dangerous for manual SEM inspection.

3. *Reduction in Operator Bias – Increased Applicability*

There is a high degree of subjectivity in the application of the proposed SEM procedure due to inherent biases and preferences of the SEM operators. For example, an SEM operator that constructs their own patterns for inspecting the landfill may avoid areas that are difficult to survey (e.g. areas that are typically muddy, areas that smell bad, etc.) and in doing so will introduce bias to the results (mud could actually be a leachate seep, odor is typically co-located with methane emissions, etc.). OTM-51 does not preclude the introduction of these biases, but significantly reduces their likelihood as the UAV is responsible for a majority of the inspection activities across the bulk of the landfill, resulting in increased data generated by the SEM inspection and, therefore, applicability of the surface emission monitoring.

4. *Reduction in Variability*

There is a high degree of variability in the application of the proposed SEM procedure and, therefore, the results may not accurately reflect actual conditions. Under the proposed SEM procedure, an operator walking a landfill is required to monitor the output of the methane detector (refreshing, on average, at 1Hz), traversing the landfill (typically on a handheld GPS device) and maintaining a nozzle position 5-10 cm from the ground to identify areas indicating elevated concentrations of landfill gas, all while walking on a sub-optimal surface that presents slip, trip and fall hazards. In practice, SEM operators may fail to follow precise spacing or thoroughly look for indications of increased landfill gas because of site conditions, resulting in gaps in the spacing and variability in results. OTM-51 allows for the UAV to be programmatically flown either manually (with automated control of the AGL for proper geo-location) or programmatically via pre-defined routes through waypoints with a GPS accurate to better than 1 m (with the ability to modify the flight in-situ to inspect areas where visual observations indicate elevated concentrations of landfill gas.) Operating the UAV programmatically means that sampling occurs along nearly perfect patterns.

5. Better Precision – Compliance Verification

OTM-51 is executed using predefined waypoints to precisely sample a landfill and every flight path flown is logged. The path of the UAV (except excursions to sample locations where visual observations indicate elevated concentrations of landfill gas) is known and can therefore be verified to ensure proper compliance with the spacing requirement. The practical implication of the UAV control system is that the UAV flights are precise and can be repeated to verify increased readings have been properly resolved, whereas it is nearly impossible to walk the same SEM route.

6. Ability to Perturb Flight Plans – Increased Applicability and Compliance

The UAV flies to pre-programmed routes with a very high degree of precision. Pre-programmed flights can be repeated for every inspection event, however as an alternative, consider requiring changing the flight paths each quarter to perturb (or shift) the flight plans to survey the interstitial swaths in the 25’ pattern. For example, every quarter the flight plans could be perturbed (programmatically) by 6.25’, such that over the course all 4 quarters of SEM, the entire landfill is inspected to much greater level of fidelity, thus improving probability of detection.

7. *Ability to Survey at Night – Increased Applicability*

Current SEM operations are limited to daytime operations such that SEM technicians can ensure proper footing and maximize operator safety. The UAV flies at a constant AGL measured in real time such that when outfitted with the proper infrared cameras, the UAV can be flown at night with the same level of precision as during the daytime. Flying at night offers a unique perspective on methane emissions when thermally induced winds are at a minimum; nighttime inspections may be the only viable way to meet extremely limiting requirements of WAC 173-408-120 (3)(a)(iii).

For these reasons Sniffer Robotics' strongly urges Washington's Department of Ecology to modify WAC 173-408-120 (8) to include OTM-51.

Proposed Text for WAC 173-408-120 (8):

"Alternative test methods: ***US EPA OTM-51 as approved by US EPA ALT-150 is approved for use under the climactic constraints and pattern spacing detailed in WAC 173-408-120(3)(a)***. Other alternative test methods may be used if they are approved in writing by the department or local authority."

Finally, as in our previous comments dated July 21st 2023, Sniffer Robotics cannot more emphatically stress the importance of striking WAC 173-408-120 (3)(a)(iii). This regulation will cost the industry thousands of dollars in downtime based on poor data – money that could have been spent on actual emission mitigations.

Sincerely

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OTM-51:

https://www.epa.gov/system/files/documents/2022-12/OTM%2051-%20UAS%20Application%20of%20Method%2021%20for%20Surface%20Emission%20Monitoring%20of%20Landfills.pdf

ALT-150:

https://www.epa.gov/system/files/documents/2022-12/Barron%20Sniffer%20Alt%20with%20OTM%2051%20attached_signed.pdf