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Subject: Carbon Mapper Testimony on SB 726, Methane Emissions from Landfills and the Role of Remote Sensing in Mitigation Efforts

The Honorable Senator Janeen Sollman
Chair, Oregon Senate Committee on Energy and Environment

The Honorable Senator David Brock Smith
Vice-Chair, Oregon Senate Committee on Energy and Environment

Senate Committee on Energy and Environment
Oregon State Capitol
900 Court St. NE S-421
Salem, OR 9730

Dear Chair Sollman, Vice-Chair Smith, and Members of the Senate Committee on Energy and Environment,

On behalf of Carbon Mapper, thank you for the opportunity to offer testimony on Senate Bill 726, legislation that would mandate owners and operators of municipal solid waste landfills to conduct surface emissions monitoring for methane gas.

Carbon Mapper is a nonprofit organization with a mission to deliver actionable and transparent methane and CO_2 emissions data that can be used to inform and accelerate emissions mitigation. Our work to use remote sensing to detect and quantify localized methane emission sources is grounded in over a decade of methane research conducted through NASA's Jet Propulsion Laboratory as well as published in the science-based literature.

Methane is an especially powerful greenhouse gas with more than 80 times the heat-trapping ability of CO_2 over a 20-year time period – making mitigation not just an urgent issue but an effective way to deliver swift climate benefits. In 2022, U.S. landfills released an estimated 119.8M metric tons of methane into the atmosphere, accounting for 17.1% of the country's total anthropogenic methane emissions[1]. This can be attributed to the breakdown of organic material within landfills which produces methane, and if not captured or destroyed, it escapes into the atmosphere - further accelerating climate change. Landfill gas emissions also pose significant public health risks,

[1] U.S. Environmental Protection Agency. (2024). *Inventory of U.S. greenhouse gas emissions and sinks: 1990–2022*. U.S. Environmental Protection Agency. https://www.epa.gov/system/files/documents/2024-04/us-ghg-inventory-2024-main-text_04-18-2024.pdf

including contributing to regional air pollution and exposing frontline communities to harmful co-emitted gases and odors.

Practices like installation of gas capture systems, early expansion of gas collection, and waste diversion programs are all effective pathways to reduce landfill emissions. Making informed mitigation decisions based on sound science and data collection is essential to ensuring their efficacy and maximizing returns on both public and private climate investments. Conducting emissions monitoring through a combination of satellites, drones, and ground-based measurements can help stakeholders shift from a reactive to a proactive paradigm while better prioritizing efforts surrounding leak detection, repair, and long term mitigation strategies.

The multi-faceted nature of landfill emissions requires a similarly multi-faceted monitoring regime. Landfills are complex, engineered systems with various potential methane sources. Emissions can either be from diffuse sources, where smaller amounts of methane are released from multiple locations spread over a wide-area, or from point sources, where large amounts of methane come from a single concentrated area. Additionally, landfills are dynamic and the operations change over time leading to changes in methane emission sources. Currently, quarterly walking surveys are conducted using handheld methane detectors. However, these conventional surveys only cover part of the landfill and exclude hazardous areas, such as the landfill work face—the location where new waste is added. As a result, significant methane emission sources could be overlooked.

Tools are needed that can comprehensively monitor landfill methane sources at different granularities. Point source imaging instruments deployed on airplanes and satellites are important tools capable of filling monitoring gaps. These instruments are designed to detect and quantify methane point sources, enabling the identification of facilities with large localized emissions, and in some cases attribution of emissions to specific activities and infrastructure at the landfill. The methods underpinning detection and quantification of emissions have been validated through controlled release tests[2] and inter-comparison with other technologies, including at landfills[3]. Over several years of methane surveys across key regions in the U.S., Carbon Mapper has observed about 1/3 of the US's approximately 1,200 open landfills, identifying major methane emission sources at more than 200 of these sites, indicating that there are significant methane mitigation opportunities at US landfills[4].

There is no one-size-fits-all solution for emissions monitoring at landfills, and point

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[2]Examples: Ayasse, A. K., et al. (2023): Performance and sensitivity of column-wise and pixel-wise methane retrievals for imaging spectrometers, Atmos. Meas. Tech., 16, 6065–6074. https://doi.org/10.5194/amt-16-6065-2023; Thorpe, A.K., et al. (2016): Mapping methane concentrations from a controlled release experiment using the next generation airborne visible/infrared imaging spectrometer (AVIRIS-NG), Remote Sens. Environ., 179, 104–15. https://doi.org/10.1016/j.rse.2016.03.032

[3]Cusworth, D.H., et al. (2024): Quantifying methane emissions from United States landfills, Science, 383, 6690. https://doi.org/10.1126/science.adi7735; Duren, R.M., et al. (2019): California's methane super-emitters. Nature, 575(7781), pp.180-184. https://doi.org/10.1038/s41586-019-1720-3

[4] Example study demonstrating point source emissions at US landfills: Cusworth et al., 2024.

source imaging instruments on satellites and airplanes complement other monitoring tools when used to guide follow-up monitoring by operators with drones and ground-based sensors, paving the way for direct mitigation.

Remote sensing technologies are a useful tool to help facility operators develop and implement mitigation solutions. Through airborne surveys done in collaboration with state agencies in California and Pennsylvania, remote sensing data was shared with landfill operators, guiding follow-up investigation and prioritization of mitigation action. For example, in collaboration with the California Air Resources Board (CARB), airborne surveys of potential methane emitting facilities were done in 2020, 2021, and 2023 in California[5]. During the surveys, methane plume detections were shared with CARB and CARB notified facility operators, including just under 100 incidents at landfills. The plume data guided voluntary follow-up by operators, and in about 40% of cases led to direct mitigation of methane emissions across the oil/gas and waste sectors. These efforts show that when provided with timely information, operators can be proactive in taking corrective actions voluntarily – recognizing that comprehensive monitoring means maximizing gas collection efficiency, making more informed decisions on best practices, and offsetting costs.

Additionally, the identification of high-emitting facilities and attribution of emissions to sources can inform decision-making regarding the implementation of effective best practices and regulatory frameworks. For example, the information gathered through the surveys done in collaboration with CARB allowed methane monitoring data to be connected with operational practices at facilities with landfill operators identifying the landfill work face, malfunctioning gas collection systems, cracks in landfill cover, and construction activities as causes of detected emissions. Building on these findings, Carbon Mapper and collaborators used airborne remote sensing data collected in 2023 at over 200 US landfills to attribute airborne detected emissions to specific sources at the landfill, identifying the landfill work face as a major source of methane. In the study, landfills with work face emissions were responsible for 75% of the total methane emissions quantified, highlighting a substantial opportunity for mitigation[6].

By linking operational practices to methane point source detections, data can guide mitigation and verify success. For example, large methane emissions were detected with airborne remote sensing at the Sunshine Canyon Landfill in California, and the data were used by local regulators and site operators to guide follow-up investigation[7]. They identified the causes of emissions on-site and took mitigation action —such as installing additional gas collection pipes and improving cover practices.

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[5]California Air Resources Board. (2023). *Summary report for the 2020-2021 and 2023 airborne methane plume mapping studies*. California Air Resources Board. https://ww2.arb.ca.gov/resources/documents/summary-report-2020-2021-and-2023-airborne-methane-plume-mapping-studies

[6]Scarpelli, T. R., et al. (2024). Investigating major sources of methane emissions at US landfills. *Environmental Science & Technology, 58*(49), 21545-21556. https://doi.org/10.1021/acs.est.4c07572

[7]Cusworth, D.H., et al. (2020): Using remote sensing to detect, validate, and quantify methane emissions from California solid waste operations. Environmental Research Letters, 15(5), p.054012. https://iopscience.iop.org/article/10.1088/1748-9326/ab7b99

Further remote sensing surveys verified that methane emissions were reduced, corresponding to a decrease in odor complaints from the surrounding community.

Conclusion

As the monitoring ecosystem grows, the data will continue to inform effective mitigation strategies and best practices, ensuring decision-making is guided by sound science and data-driven transparency. This approach allows for more cost-effective, proactive emissions management, helping to prevent methane loss while guiding stakeholders, ranging from state regulators to industry, toward the most efficient methods for maximizing mitigation potential. As the committee considers SB 726, there are some key takeaways we encourage you to consider, namely…

1. Existing monitoring is not comprehensive, and our scientific research has shown large, persistent point sources at landfills across the US, including emissions from the landfill work face which is left out of traditional walking surveys.
2. We see opportunities for improving methane collection through best practices including the use of advanced technology, much of which is already being used voluntarily by industry, to fill existing monitoring gaps.
3. It takes a combination of tools to paint a clear picture of landfill emissions. Satellite and airborne remote sensing can provide geographic coverage and identify those largest emitters that can be prioritized for follow-up by complementary near-ground methods like drones.

Thank you for the opportunity to testify and we are available to answer any questions or offer additional testimony at your convenience.

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