January 24, 2024

California Air Resources Board
1001 I St.
Sacramento, CA 95814

RE: "Public Workshop on Potential Updates to the Landfill Methane Regulation" Comments

Dear Chair Randolph,

The undersigned organizations appreciate the opportunity to comment on the material presented during the "Public Workshop on Potential Updates to the Landfill Methane Regulation" held on December 18, 2024. California has a critical opportunity to lead the nation in curbing methane emissions by adopting stronger, more comprehensive landfill methane regulations.

We commend CARB staff for recognizing the importance of updating the Landfill Methane Regulation (LMR) to incorporate advancements in technology and best practices. However, with the urgency of addressing climate change, we strongly urge CARB to accelerate the proposed timeline and adopt the enclosed recommendations to ensure California remains a leader in emissions management and climate action.

ISSUE AREA I: Remote Sensing

Utilization of remote sensing technologies should be mandatory. We endorse staff's proposal to establish a process for approving alternative technologies such as drones and continuous emissions monitoring. However, we strongly recommend integration of mandatory use of remote sensing technologies into surface emissions monitoring (SEM) requirements to improve efficiency, frequency, and coverage of emissions monitoring.

CARB should strengthen the LMR by requiring, not merely allowing, the use of advanced monitoring technologies like drones to detect and pinpoint methane leaks at landfills. The urgent

need to reduce methane emissions demands mandatory utilization of proven technologies that offer safer, less labor-intensive, and more comprehensive monitoring than traditional ground-based methods.

The science is clear; current remote sensing technologies (including drones, rovers, stationary monitors, flyovers, and satellites) are much more effective and comprehensive than the historical reliance on walking SEM. EPA's Aerial Monitoring White Paper, Landfill Methane Emissions Workshops (2021), LMOP Drone Webinar (2023), and 2024 Landfill Technology Workshop demonstrate the effectiveness of drone-based systems for methane monitoring. Notably, Canada's ECCC has proposed drone-based methane detection for surface emissions monitoring, highlighting its ability to cover critical areas like the working face of landfills while expediting SEM reporting. CARB should follow suit by mandating utilization of drone technology to ensure robust and timely methane mitigation.

As originally designed, the LMR required somewhat limited, episodic surface monitoring in recognition of the significant time and expense involved in walking a surface grid with a measuring device. Because drones can be programmed to measure surface emissions semi-autonomously, the cost considerations that limited monitoring have changed drastically, allowing much more frequent and thorough measurements.

Additionally, continuous monitoring technologies are vital for providing real-time, actionable data on surface emissions, enabling landfill operators and regulators to promptly identify and mitigate methane leaks. Continuous monitoring systems can empower nearby communities by delivering timely information on local air quality, helping to address public health concerns and build trust. To enhance transparency, CARB should require continuous monitoring and for emissions data be made publicly accessible. Providing this information ensures accountability, fosters community engagement, and underscores CARB's commitment to reducing emissions and protecting vulnerable populations.

CARB should also require that an initial drone survey of methane emissions be conducted using a drone-based methodology. This survey would provide a baseline assessment of emissions, providing critical insight into site-specific needs and guiding appropriate mitigation measures.

Adoption of drones and other remote sensing technologies offers a significant opportunity to enhance the efficiency and feasibility of many of the staff concepts presented in the workshop that will be discussed in detail throughout this letter.

Super Emitter Response Program (SERP) for Landfills. We endorse staff's proposal to adopt a satellite alert and response program in the LMR similar to what CARB has adopted for the Oil & Gas sector. This innovative approach represents a significant step forward in leveraging advanced technology to rapidly identify and mitigate large methane plumes. CARB's plans to utilize Carbon Mapper data underscores CARB's commitment to efficiently addressing landfill methane emissions and taking full advantage of the tens of millions of dollars that have been invested in the technology.

We strongly support the integration of a Super Emitter Response Program (SERP) into CARB's framework to address high-emission events more quickly and effectively. The SERP should incorporate pre-qualified third-party monitoring efforts, including aerial surveys using helicopters or planes. By enabling qualified third parties to detect and report super emitter events, CARB can expand the reach and effectiveness of its methane mitigation efforts. To maximize the effectiveness of this initiative, we strongly recommend that CARB adopt a multi-tiered approach

to landfill emissions monitoring and mitigation. As the EPA has noted[1], "advanced satellite systems [like Carbon Mapper] offer the potential for more comprehensive and near real-time detection of methane and other greenhouse gases over large areas, providing broader scope of data collection than traditional ground-based methods." Satellite data should serve as the top tier, providing a broad, high-level view to detect large methane plumes and prioritize areas for further investigation or action.

This top-tier program should be complemented by mid-tier technologies, such as drones and other remote sensing tools, for localized detection and quantification of emissions. Finally, traditional walking SEM should remain an essential component (with additional improvements discussed in this letter), serving to authenticate emissions sources, guide targeted mitigation, and confirm reductions. As the EPA states[2], "aerial technologies could be used as a screening tool or *tiered approach* to identify sites that appear to have significant sources of methane emissions that merit a closer examination of on-site emissions using additional tools such as SEM (Method 21) and/or possible [drone] technologies to identify emission hotspots." This comprehensive approach ensures robust oversight and rapid mitigation at all scales of emissions.

These third-party contributions could help identify methane emissions exceeding 100 kg/hr and provide vital data to inform corrective actions. We also recommend that community-based monitoring initiatives be included in a similar capacity to other third-party monitoring initiatives to provide a complete picture of the landfill emissions impacting local communities that go beyond methane. Ensuring a streamlined qualification process for third-party monitors, along with clear guidelines for data validation, will be critical for maintaining the integrity of this program.

To ensure coordinated and effective responses, we recommend that notifications of super emitter events be shared not only with operators and CARB but also with the relevant local Air Quality Management Districts (Air Districts) and Local Enforcement Agencies (LEAs). Including Air Districts and LEAs in the notification process will enhance transparency, improve response times, and facilitate a unified approach to addressing emissions that may have significant regional impacts.

Additionally, the satellite alert and response program should emphasize the role of super emitter events in understanding emissions from the active face, construction, downtime in gas collection systems, and malfunctioning collection wells (as well as improvements to landfill operations and monitoring processes). Research[345] shows these events contribute disproportionately to overall emissions, but are often overlooked. CARB's proactive use of third-party data, such as Carbon Mapper satellite data, for pinpointing and mitigating these large emissions events would set a strong precedent for other states and the EPA, ensuring comprehensive landfill emissions management.

Finally, we encourage CARB to consider the co-benefits of rapid leak detection and repair, particularly in reducing hazardous air pollutants that disproportionately impact disadvantaged communities. By addressing methane leaks promptly, CARB can simultaneously improve public health outcomes while advancing climate goals.

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[1] US EPA Office of Air and Regulations (2024). White Paper - MSW Landfills: Aerial Monitoring for Examining Landfill Methane Emissions. https://www.epa.gov/stationary-sources-air-pollution/non-regulatory-public-docket-municipal-solid-waste-landfills
[2] Id.
[3] Cusworth et al. "Using Remote Sensing to Detect, Validate, and Quantify Methane Emissions from California Solid Waste Operations" https://doi.org/10.1088/1748-9326/ab7b99
[4] Cusworth et al., "Quantifying Methane Emissions from United States Landfills" https://doi.org/10.1126/science.adi7735
[5] Duren et al. "California's Methane Super-Emitters" https://doi.org/10.1038/s41586-019-1720-3

We strongly support CARB's leadership in pursuing innovative solutions to landfill methane emissions and urge the adoption of this multi-tiered monitoring framework, inclusive of a robust SERP incorporating aerial surveys, community-based monitoring, and local AQMD involvement, to achieve meaningful and lasting reductions.

Issue Area I Recommendations:

1. Require the integration of drones and continuous emissions monitoring systems (CEMS) into surface emissions monitoring (SEM) requirements to improve efficiency, frequency, and coverage.
2. Require an initial drone-based survey of methane emissions at all landfills to establish a baseline assessment and guide mitigation measures.
3. Mandate the use of continuous monitoring technologies to provide real-time, actionable data on emissions and make this data publicly accessible for increased transparency and community engagement.
4. Adopt a SERP for landfills, leveraging satellite data (e.g., Carbon Mapper) and aerial surveys to rapidly detect and mitigate large methane plumes.
5. Notify local Air Quality Management Districts (AQMDs) of super emitter events to ensure a unified and transparent response.
6. Implement a multi-tiered monitoring framework that combines satellite data for broad detection, mid-tier technologies (e.g., drones, CEMS, rovers, etc.) for localized monitoring, and traditional walking SEM for verification and targeted mitigation.
7. Include pre-qualified third-party monitors, such as aerial survey operators, in the SERP to enhance methane detection and mitigation. Streamline qualification processes and establish clear data validation guidelines.
8. Incorporate community-based monitoring initiatives to provide a holistic view of emissions and their impacts on local air quality beyond methane.
9. Require monitoring and mitigating emissions from active faces, gas collection system downtime, malfunctioning wells, and construction activities, which contribute significantly to total emissions.

ISSUE AREA II: Improvements to Surface Emissions Monitoring (SEM)

Reducing the concentration threshold. We strongly support staff's proposal to lower the SEM threshold from 500 ppmv to 200 ppmv. This reduction was initially proposed in CARB's original 2010 LMR proposal. While it wasn't included, the regulation did specifically require reporting of all readings above 200 ppmv to identify whether a reduction to 200 ppmv would be feasible. With over a decade of data, no evidence has emerged to suggest that reducing the threshold from 500 ppmv to 200 ppmv is unreasonable. In fact, the workshop presentation highlighted that between 2016 and 2020, many facilities were already maintaining emissions below 200 ppmv. While it is encouraging to see operators consistently operating below the 500 ppmv threshold, lowering the limit to 200 ppmv presents a valuable opportunity to further reduce landfill emissions.

Expanding frequency and coverage. CARB's proposed revisions to SEM requirements present a critical opportunity to address significant inefficiencies and gaps in the current system. While we support CARB's efforts to standardize quarterly monitoring across all areas of landfills, we strongly recommend more frequent SEM—*conducted at least twice a month*—and a comprehensive approach that includes all landfill areas, including those currently exempt from monitoring requirements.

The challenges of current SEM are apparent. The current SEM process is labor intensive, time consuming, and prone to human error. Variations in walking pace and/or improper adherence to Method 21 guidelines can result in missed detections of methane exceedances, as highlighted by the EPA's recent enforcement alert[6]. Additionally, leaving "difficult-to-monitor" areas, such as the active face, steep slopes, and construction areas, leaves substantial portions of landfills unchecked, contributing to underreported methane emissions. These inefficiencies undermine the effectiveness of SEM in identifying and mitigating emissions in a time when slashing emissions has never been more imperative.

Integrating advanced technologies, such as drones equipped with methane sensors, can significantly enhance the feasibility, efficiency, and accuracy of SEM improvements. Unlike manual monitoring, which is labor-intensive and exposes personnel to hazardous conditions like steep slopes, construction zones, and unpredictable weather, drones can survey the entire landfill surface—including currently exempted areas—swiftly and systematically.

Additionally, this reduces human inconsistencies, minimizes hazard risks for workers, and lowers labor costs over time, as highlighted by the EPA's *Unmanned Aircraft System (UAS) Technologies for Landfill Methane Monitoring* whitepaper[7]. While there are initial costs for drone-based systems, the EPA notes that these expenses can be offset through minimized long-term monitoring costs. Additionally, drones enable more frequent monitoring, making it feasible for landfills to meet twice-monthly requirements without adding significant operational burdens. By adopting these advanced methodologies, landfills can achieve safer, more effective, and comprehensive emissions monitoring at reduced cost.

Determining the Full Extent of Surface Leaks. We appreciate CARB staff's acknowledgement of the complexities involved in identifying and addressing the full extent of surface leaks, as well as their efforts to pose critical questions aimed at refining monitoring practices. Determining the full extent of a leak is crucial to effective mitigation, and we support the exploration of methodologies, such as measuring around and exceedance and implementing more comprehensive re-monitoring procedures. These approaches demonstrate a commitment to addressing landfill emissions at their source and ensuring corrective actions are fully informed and effective.

To achieve this goal, we recommend that CARB require increased frequency and coverage of SEM across all landfills, as discussed above. More frequent monitoring, combined with advanced technologies like drones and continuous emissions monitoring systems, would better capture the spatial distribution of leaks and provide a clearer picture of affected areas. Additionally, operators should be required to use tighter spacing intervals and systematic walking patterns (like concentric circles or grid-specific pathways) to ensure no portion of a leak goes undetected and uninspected. For integrated re-monitoring, all eight surrounding grids should be assessed to capture the full extent of the leak.

Monitoring conditions requirements. Higher methane emissions are closely linked to atmospheric conditions, particularly lower barometric pressure. Studies[8][9] show that fluctuations

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[6] US, EPA. "Enforcement Alert: EPA Finds MSW Landfills Are Violating Monitoring and Maintenance Requirements" www.epa.gov/enforcement/enforcement-alert-epa-finds-msw-landfills-are-violating-monitoring-and-maintenance

[7] US EPA Office of Air and Regulations (2024). White Paper - MSW Landfills: Unmanned Aircraft System (UAS) Technologies for Landfill Methane Monitoring https://www.epa.gov/stationary-sources-air-pollution/non-regulatory-public-docket-municipal-solid-waste-landfills

[8] Hanson, James L. et al. "Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills". https://ww2.arb.ca.gov/sites/default/files/2020-06/CalPoly LFG Flux and Collection Efficiencies 3-30-2020.pdf

[9] Aghdam, Ehsan Fathi, et al. "Impact of Meteorological Parameters on Extracted Landfill Gas Composition and Flow." https://doi.org/10.1016/j.wasman.2018.01.045

in barometric pressure significantly affect landfill gas (LFG) recovery efficiency, making these variations more impactful than absolute pressure values.

The effectiveness of gas collection and control systems (GCCS) is influenced by local atmospheric pressure, as wellheads are operated relative to this pressure. Since vacuum pressure is typically adjusted on a monthly basis, short-term fluctuations in atmospheric pressure can affect surface emissions. During periods of rising atmospheric pressure, emissions are reduced, whereas falling pressure leads to increased emissions. As a result, surface emissions monitoring (SEM) conducted during elevated atmospheric pressure may yield unrepresentative measurements.

To address this, the SEM requirements should be revised to ensure that monitoring is conducted when barometric pressure is representative of normal site conditions. Landfill operators should (1) define and submit this pressure range, and (2) record and report barometric pressure during each SEM event to ensure compliance.

Improving recordkeeping and reporting requirements. CARB should require landfill operators to record and report all SEM readings to ensure comprehensive and transparent monitoring. This includes GIS mapping of walking and drone paths, with clear identification of the locations of readings – particularly exceedances– and spatial distributions of identified methane plumes. Incorporating advanced monitoring technologies such as drones and other remote sensing tools will enhance the data accuracy and allow for the identification of emissions trends related to weather and topographic factors. This information can guide better mitigation strategies.

To promote transparency and accountability, SEM reports should be made publicly and readily available. Communities must have access to this critical data to understand local air quality impacts and protect themselves from pollution. These reports should include:

- Locations of all SEM readings and exceedances, marked on a GIS map, including methane concentrations, dates, and any corrective actions taken.
- Trends in methane emissions linked to environmental conditions like wind patterns and atmospheric pressure changes.
- Details of mitigation measures, such as repairs made to gas collection systems or landfill covers.

By prioritizing public accessibility and integrating advanced technologies, CARB can ensure that SEM is effective in identifying leaks, informing mitigation initiatives, and responsive to the needs of communities most impacted by landfill pollution. .

Persistent issues. We support CARB's proposal to hold landfills with persistent emission exceedances accountable through increased monitoring, cover integrity inspections, and remediation. These measures are essential for addressing ongoing issues and ensuring that methane leaks are promptly identified and repaired. However, the current proposal does not fully address all scenarios in which increased monitoring may be necessary.

In addition to CARB's proposed framework, we recommend granting Air Districts discretion to go above and beyond the baseline regulatory requirements. This added flexibility would allow Air Districts to mandate additional mitigation measures tailored to the unique exceedance patterns, site-specific conditions, or community concerns within their jurisdictions. Such authority would enable more proactive and comprehensive response to persistent emissions issues.

Furthermore, while we support increased monitoring for landfills with persistent issues, we strongly advocate for more frequent SEM across all landfills to enhance early detection and

prevention of methane leaks. Expanding monitoring requirements across the board will ensure a proactive approach to emissions mitigation, rather than a reactive one.

By broadening the scope of monitoring and empowering Air Districts to implement measures that exceed the regulatory baseline, CARB can foster a more comprehensive and adaptive strategy for reducing landfill emissions.

Issue Area II Recommendations:

1. Increase SEM frequency across all landfills, not just those with persistent issues, to ensure early detection and prevention of methane leaks.
2. Require SEM at least twice a month over the entire landfill surface (including the working face and steep slopes), with significantly reduced path spacing to less than 25 feet, eliminating exemptions and inconsistent spacing intervals, to ensure comprehensive and accurate methane monitoring.
3. Eliminate the option to increase walking path spacing to 100 feet after four consecutive monitoring periods without exceedances, ensuring consistent monitoring across all landfills.
4. Mandate the use of advanced technologies, such as drones with methane sensors, to modernize SEM processes, enhance efficiency, improve safety, and enable systematic detection of emissions, including full assessment of leak extents with tighter spacing and re-monitoring of surrounding grids.
5. Incorporate barometric pressure considerations into SEM requirements, requiring representative monitoring conditions, submission of pressure ranges, and recording/reporting of barometric pressure during SEM events for accurate emissions data.
6. Require detailed recordkeeping and public reporting of SEM data, including GIS maps of monitoring paths, methane exceedance locations, spatial plume distributions, and trends linked to environmental conditions, to enhance transparency and guide mitigation efforts.
7. Grant Air Districts greater discretion to go above and beyond regulatory requirements, enabling them to develop tailored plans and procedures for landfills in their jurisdictions based on site-specific exceedance patterns and community concerns.
8. Provide resources and guidance for Air Districts to ensure consistent application of SEM enhancements and exceedance response measures across California.
9. Establish clear thresholds, timelines, and procedures for addressing persistent SEM exceedances, requiring increased monitoring, comprehensive cover integrity inspections, and prompt remediation to ensure consistent enforcement and proactive emissions management.

ISSUE AREA III: Gas Collection and Control Systems (GCCS)

Early installation. Capturing landfill methane emissions early is critical to mitigating their significant impact on climate change. Early gas collection ensures that emissions are managed during the initial and most intense decomposition phases, preventing large volumes of methane from escaping into the atmosphere.

Recent evidence from the EPA highlights the need for earlier installation of gas collection and control systems (GCCS) to address methane emissions from landfills. According to the EPA,[10]

[10] US EPA Office of Air and Regulations (2024). White Paper - MSW Landfills: MSW Landfill Gas Collection and Control System (GCCS) Installation Lag Time and Nonmethane Organic Compound (NMOC) Destruction Efficiency https://www.epa.gov/stationary-sources-air-pollution/non-regulatory-public-docket-municipal-solid-waste-landfills

61% of methane generated by landfilled food waste escapes capture, as this waste decomposes quickly, often before GCCS are installed or expanded. In California, decomposing food and other organics account for an estimated 41% of total fugitive methane emissions from MSW landfills[11]. The EPA has shown that early installation of GCCS is both technically feasible and cost-effective, with systems capable of being implemented within a few months of waste placement using technologies like horizontal collectors or caisson wells. Reducing installation lag time, especially for areas undergoing expansion, could significantly decrease methane emissions. Additionally, the EPA[12] argues that earlier installation at the end of Year 1 could reduce methane emissions by approximately 53,000 megagrams per million metric tons of waste disposed annually.

Given these findings, CARB should require GCCS installation within one year of Design Plan approval to align with EPA-supported feasibility and cost-effectiveness data. Accelerating timelines for plan submission and review would further enhance methane capture during critical early stages of waste decomposition. Additionally, the current threshold that requires installation of a gas collection and control system (GCCS) is 3 million Btu/hr heat input and 450,00 tons of waste-in-place. We recommend requiring landfill operators to conduct planning and engineering of GCCS prior to reaching this threshold to facilitate a proactive mitigations approach.

Decommissioned wells and downtime limits. Feedback from landfill inspectors highlighted key gaps in the LMR regarding negative pressure requirements and related exemptions, which they have observed directly contributing to unnecessary emissions at landfills. Based on this expert insight, we strongly recommend that CARB address the following issues to enhance regulatory clarity and prevent misuse:

Decommissioned Wells: While "decommissioned well" is not explicitly defined in the current regulations, the lack of clear guidance has allowed operators to misuse this concept. The intent behind the negative pressure exemption for decommissioned wells in the federal regulations was intended for wells in areas of landfills with verified declining gas generation. Instead of restricting decommissioning to wells that are permanently closed or with declining gas flows, some operators in CA apply the term to wells that are malfunctioning or inadequately maintained, leading to increased point-source emissions. CARB should define "decommissioned well" in the LMR as one that is permanently closed following proper closure procedures and/or experiencing declining flows with proper documentation.

Construction Exemption: Unlike federal regulations, which mandate continuous operations for GCCS (with minimal exemptions), California's LMR includes an exemption for construction activities with no provisions for timeliness. This allows operators to leave collection wells offline for extended periods, significantly increasing fugitive emissions. We recommend that CARB incorporate a timeliness requirement for construction-related downtime, including "reasonable downtime" language, to ensure that wells are returned to operation promptly.

Limiting Gas Collection System Downtime: We support CARB Staff's proposed steps to limit GCCS downtime and recognize this as a critical opportunity to reduce fugitive emissions. Requiring emission mitigation during downtime, limiting the duration and scope of downtime activities, and incorporating best practices already employed by some operators are all promising steps in the right direction. For instance, reconnecting wells to vacuum systems at the end of each workday and implementing mitigation measures can help reduce emissions during component downtime.

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[11] Duren et al. "California's Methane Super-Emitters" https://doi.org/10.1038/s41586-019-1720-3
[12] Id.

In addition to these measures, we strongly recommend that CARB implement robust recordkeeping requirements for downtime activities and make this information publicly available. Operators should document the duration of downtime, the reasons for disconnecting wells, the number of wells affected, and all mitigation efforts undertaken. This data will improve accountability, provide insights to operational practices, and ensure compliance with regulatory requirements. Transparency in downtime reporting would empower nearby communities with the information needed to identify potential connections between well downtime and odor or health impacts.

By defining clear thresholds for downtime durations, specifying best practices for mitigation, emphasizing comprehensive recordkeeping, and ensuring public access to downtime data, CARB can enhance the effectiveness of its landfill methane regulations while fostering trust and accountability between regulators, operators, and nearby communities.

Enhancing operational parameters and advanced monitoring. We support CARB's proposed concepts on improving operational parameters for GCCS, particularly the recommendations to mandate continuous vacuum monitoring, install continuous pressure sensors, and establish and maintain pressure setpoints. These measures will provide valuable data on system status and performance, enabling earlier identification and mitigation of potential issues. Enhanced visibility into the GCCS's operation is critical for optimizing gas collection efficiency and minimizing fugitive emissions.

However, CARB's approach to advanced monitoring for GCCS does not go far enough. Simply encouraging the use of automated wellhead tuning systems and real-time monitoring is insufficient to achieve the level of methane capture necessary to meet California's ambitious climate goals. CARB should mandate the use of automated wellhead tuning systems, which continuously measure parameters such as gas composition, flow, temperature, pressure, and liquid levels, and make automated adjustments to optimize gas collection. These technologies have already demonstrated their ability to increase methane capture, reduce system downtime, and provide actionable data to operators.

Additionally, CARB must require that the data from continuous monitoring systems be made publicly available. This transparency will not only ensure accountability but will also provide nearby communities with valuable insights into local air quality and help build trust between landfill operators and the public. By mandating these advanced systems and increasing transparency, CARB can drive substantial improvements in emissions mitigation and demonstrate its commitment to public health and safety.

Persistent Issues. As discussed above in *Enhancing Operational Parameters and Advanced Monitoring*, we strongly support the use of continuous wellhead monitoring and automated wellhead tuning to optimize methane capture and mitigate fugitive emissions. While we appreciate CARB staff's attention to holding sites with persistent GCCS issues accountable through increased monitoring and tuning, these measures should not be limited to such sites.

Mandating use of advanced technologies and enhancing monitoring requirements across *all* landfills will ensure a proactive approach to emissions mitigation while maximizing gas capture and operational efficiency. Additionally, we reiterate the importance of public transparency for monitoring data, especially at sites with persistent issues.

Issue Area III Recommendations:

1. Mandate installation of gas collection systems within one year of Design Plan approval, aligning with EPA findings on feasibility and cost-effectiveness. Require advanced

planning and engineering of GCCS before reaching the 3 million Btu/hr heat input or 450,000 tons of waste-in-place thresholds to ensure proactive emissions mitigation.
2. Define “decommissioned wells” to prohibit operators from misusing the term for malfunctioning or inadequately maintained wells, reducing point-source emissions.
3. Introduce timeliness requirements for construction-related downtime. Require wells to be returned to operation promptly and enforce mitigation measures, such as reconnecting wells to vacuum systems at the end of each workday.
4. Limit the duration and scope of GCCS downtime. Require recordkeeping and public reporting of downtime activities, including the number of wells affected, reasons for downtime, duration, and mitigation efforts.
5. Require continuous vacuum monitoring, pressure sensors, and automated wellhead tuning systems for all landfills. These technologies optimize gas capture, reduce downtime, and provide actionable data. Mandate public reporting of continuous monitoring data to enhance transparency and build trust.
6. Expand advanced monitoring and tuning requirements to all landfills, not just those with persistent issues. Hold sites with ongoing GCCS challenges accountable through increased monitoring, enhanced tuning, and public transparency.

ISSUE AREA IV: Cover Improvements

Cover integrity plays a critical role in controlling landfill gas emissions, as ineffective or porous covers can allow significant methane leakage. We commend CARB for recognizing this issue and proposing that landfills with persistent emissions exceedances perform cover integrity and collection system analyses. However, CARB must go further to address this critical source of emissions effectively.

In addition to staff concepts, we urge CARB to:

1. Require shorter use of daily covers to minimize methane escape during active landfill operations.
2. Mandate the use of lower-porosity materials, such as soil, instead of high-porosity green waste, which exacerbates emissions.
3. Prohibit intentional landfilling of organic materials as cover should, as it contributes to methane generation rather than mitigating it.
4. Require landfills to implement robust cover design plans, emphasizing the timely placement of protective covers designed to slow methane emissions.

Proactive measures like these will ensure cover integrity is not only monitored but also optimized to significantly reduce emissions at their source.

ISSUE AREA V: Banning Leachate Recirculation

Prohibiting leachate recirculation is a critical best practice that CARB should adopt to align with its goals for improved methane reduction. Leachate recirculation, which involves re-injecting liquid waste into a landfill explicitly to accelerate decomposition and create more space, leads to a rapid increase in methane generation, thereby exacerbating fugitive emissions. This practice not only undermines efforts to minimize leaks, but also raises serious odor, landfill instability, and fire risk concerns. The objectives of leachate recirculation—accelerating decomposition and increasing landfill capacity—are fundamentally at odds with CARB's proposed measures to reduce methane emissions and improve landfill oversight.

ISSUE AREA VI: Flares and Destruction Efficiencies

Landfill gas flares are designed to combust the gases collected from the landfill, routing them from the wellheads to a central flare where they are continuously treated via combustion. Flare efficiency is measured by destruction efficiency, expressed as a percentage. For example, a 99% efficiency indicates that 99% of the gases and chemicals routed to the flare are combusted[13]. However, ensuring this efficiency in practice presents significant challenges.

Currently, landfill flare efficiency is difficult to measure continuously and is only sporadically monitored by landfill operators. This results in suboptimal combustion conditions resulting in dangerous emissions from landfill flaring systems. Research[14] highlights these risks:

> "The combustion performance of the flares varied with landfill gas composition and flare design. The combustion and pollutant removal efficiencies could be lower than 90%, especially for the diffusion flare. Acetaldehyde, benzene, toluene, *p*-cymene, limonene, hydrogen sulfide, and methane could be priority monitoring pollutants for flare emissions in landfills."

These findings make it clear that CARB must take stronger action to ensure the proposed 99% destruction efficiency is achieved consistently in practice. This requires mandating advanced monitoring technologies for landfill flares including the use of Continuous Emissions Monitoring Systems (CEMS) to track and verify flare performance in real time.

CARB has several options to improve flare monitoring and enforcement. A European company specializing in emissions reductions outlines best practices and technologies, including CEMS, to ensure consistent combustion performance in meeting the 99% destruction efficiency requirements[15]. Adopting similar solutions in California would enhance transparency, ensure compliance with efficiency standards, and protect public health by minimizing harmful emissions from landfill gas flaring systems.

ISSUE AREA VII: Clarifications for third-party GCCS operators. We support CARB staff's proposal to clarify that gas system control owners and operators *receiving* landfill gas are subject to the LMR. Ensuring that all entities involved in the treatment and combustion of landfill gas are held accountable is essential for achieving the 99% destruction efficiency target, detecting and repairing leaks, and maintaining consistent and accurate reporting. This clarification will close existing regulatory gaps and provide greater oversight of landfill gas upgrading facilities.

CONCLUSION

California's leadership in tackling climate change depends on swift, bold action to regulate methane emissions effectively. The current timeline for implementing updated regulations – target for 2027– is too slow to address the climate crisis we face today. With widespread

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[13] "ATSDR - Landfill Gas Primer - Chapter 5: Landfill Gas Control Measures." *Cdc.gov*, 2019, www.atsdr.cdc.gov/HAC/landfill/html/ch5.html

[14] Wang, Yujing, et al. "Flare Exhaust: An Underestimated Pollution Source in Municipal Solid Waste Landfills." *Chemosphere*, vol. 325, 1 June 2023, pp. 138327–138327, https://doi.org/10.1016/j.chemosphere.2023.138327

[15] Flare Combustion Efficiency: Best Measurement Techniques - TP-Europe. *TP-Europe*. tpeurope-em.com/flare-combustion-efficiency-best-measurement-techniques/

coalition support for these changes, CARB has a unique opportunity to champion progressive regulations that set a global standard for pollution control.

We urge CARB to prioritize the recommendations outlined in this letter and implement these critical measures without delay. By acting decisively, California can lead the way in reducing landfill emissions, safeguarding public health, and combating the urgent threat of climate change.

Sincerely,

Daniel Chandler, Steering Committee
350 Humboldt

Lisa Arkin, Executive Director
Beyond Toxics

Jane Williams, Executive Director
California Communities Against Toxics

Gracyna Mohabir, Clean Air & Energy Regulatory Advocate
California Environmental Voters

Robina Suwol, Executive Director
California Safe Schools

Erica Parker, Policy Associate
Californians Against Waste

Christian Bisher, Air Quality Specialist
Veronica Aguirre, Community Organizer
Central California Environmental Justice Network

Ricardo Modesta Pulido, Board Chairman
CFASE/Coalition for a Safe Environment/CD/Community Dreams

Janet Cox, CEO
Climate Action California

Andrew Ellis, Legislative Committee Co-Chair
Climate Reality Project – Los Angeles Chapter

Kathy Schaeffer, Legislative Coordinator
Climate Reality Project, San Fernando Valley

Bill Magavern, Policy Director
Coalition for Clean Air

Jen Chandler, Director
Elders Climate Action

Michael Mulligan, MD, Policy and Legislation Volunteer
Elders Climate Action– NorCal

Richard Burke, Chair
Elders Climate Action –SoCal

Bradley Angel, Executive Director
Greenaction for Health and Environmental Justice

Veronica Aguirre & Ruben Rodriguez, Co- Founders
Healthy Environment For All Lives

Katherine Blauvelt, Circular Economy Campaign Director
Industrious Labs

Charles Miller, Chair
Climate Reality Project – Los Angeles

Teresa Bui, Climate Policy Director
Pacific Environment

Stephanie Peck, Founder **Protect Otay Foothills**

Robert M. Gould, MD, President
San Francisco Bay Physicians for Social Responsibility

Pauline Seales, Organizer
Santa Cruz Climate Action Network

Gabriela Facio, Senior Policy Strategist
Sierra Club California

Ellie Cohen, CEO
The Climate Center

Miguel Alatorre Jr, Executive Director
UNIDOS Network Inc

Bianca Lopez, CO-Founder/ Project Director
Valley Improvement Projects

Pete Marsh, CEO
Vector Green Power, LLC