Leachate Lift Station - Ambient Air Quality Study

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Air Quality Assessment Report

For Research Purpose Only

Project: Ambient Air Quality Analysis at Leachate Lift Station
Location: 1896 S Pianalto Rd, Springdale, AR
Monitoring Period: October 3, 2025 – November 4, 2025

1. EXECUTIVE SUMMARY

Carbon Chicken Project LLC commissioned an air quality study to assess potential emissions originating from the leachate lift station site located at 1896 S Pianalto Rd, Springdale, AR. This assessment was designed to identify specific compounds of potential concern (sulfur compounds, volatile organic compounds (VOCs), and ammonia) to determine the facility's contribution to local air quality conditions.

Air sampling was performed on two distinct dates: October 3, 2025, and November 4, 2025. Samples were collected at an "Onsite" location and a location designated as "50ft" (presumably 50 feet from the source). The study utilized ASTM D5504 for speciated sulfurs, EPA Method TO-15 for VOCs, and NIOSH Method 6016 for Ammonia.

Key Findings:

- **Sulfur Compounds:** Hydrogen Sulfide (H_2S) and various mercaptans were consistently detected at both sampling locations during both events, ranging from 0.183 ppm to 0.259 ppm.

- **Volatile Organic Compounds (VOCs):** Multiple VOCs were detected. Notably, Ethanol was detected at a significantly elevated concentration (1,600 ppbv) at the Onsite location during the November event. Other common detections included Propylene, Butane, and Acetone.

- **Ammonia:** Ammonia was not detected in any samples during either sampling event.

2. INTRODUCTION

The leachate lift station facility seems to have concerns regarding potential odor emissions which prompted this targeted investigation. This study follows standard industrial hygiene and environmental sampling protocols to quantify specific compounds of potential concern (COPC).

3. OBJECTIVES

The primary objective of this air study was to determine the presence and concentration of specific chemical compounds in the immediate vicinity of the facility. The specific objectives were to:

1. **Assess Air Quality:** Quantify concentrations of Sulfurs, VOCs, and Ammonia using laboratory-based analytical techniques.
2. **Characterize Emissions:** Differentiate between compounds found "Onsite" versus those found at the "50ft" offset to understand dispersion or proximity effects.
3. **Temporal Comparison:** Compare results between October and November sampling events to identify consistency or operational variations.

4. METHODS

A Identifying Compounds of Concern

The study focused on three primary categories of analytes:

- **Speciated Sulfurs:** Including Hydrogen Sulfide, Methyl Mercaptan, and Carbon Disulfide.
- **Volatile Organic Compounds (VOCs):** A standard list including Propylene, Freon 12, Ethanol, Acetone, and Benzene.
- **Ammonia:** Analyzed via silica gel sorbent tubes.

B Sampling Locations

Sampling locations were designated as:

- **Onsite:** Samples labeled ONSITE-10032025 and ONSITE-11042025.
- **50ft:** Samples labeled 50FT-10032025 and 50FT-11042025.

C Sampling Methodology

- **Sulfurs (ASTM D5504):** Analyzed using Gas Chromatography and Chemi-luminescence with a Pulsed Flame Photometric Detector.
- **VOCs (EPA TO-15):** Air samples were collected using evacuated canisters and analyzed

by Gas Chromatography / Mass Spectrometry (GC/MS).

Ammonia (NIOSH 6016): Samples were collected on silica gel tubes, desorbed with deionized water, and analyzed via Ion Chromatography.

5. DETAILED ANALYSIS OF RESULTS

A. Sulfur Compounds (ASTM D5504)

Sulfur compounds are the primary drivers of "rotten egg" or "cabbage" odors associated with decomposition or agricultural operations.

- **Hydrogen Sulfide (H_2S):**
  - **October 3:** Levels were consistent across both locations, with "50ft" measuring **0.219 ppm** and "Onsite" measuring **0.218 ppm**.
  - **November 4:** "Onsite" levels rose to **0.259 ppm**, while "50ft" levels decreased slightly to **0.183 ppm**.
  - **Assessment:** The detection of H_2S is chronic. While these levels are generally below the OSHA Permissible Exposure Limit (PEL) of 20 ppm (ceiling), they are significantly above the odor threshold. Levels above 0.1 ppm are often considered an environmental nuisance and can cause olfactory fatigue (loss of ability to smell the gas).
- **Other Sulfurs:**
  - **Carbon Disulfide:** Detected in October at **0.110 ppm** (Onsite) and **0.109 ppm** (50ft). In November, it remained detectable at **0.130 ppm** (Onsite) and **0.0915 ppm** (50ft).
  - **Mercaptans:** Various mercaptans (Methyl, Ethyl, Isopropyl) were detected in both months, contributing to the overall odor profile.

B. Volatile Organic Compounds (EPA TO-15)

This analysis screens for solvents, fuels, and industrial chemicals.

- **The "Ethanol Spike" (November 4):**
  - In October, Ethanol at "Onsite" was **14 ppbv**.
  - In November, Ethanol at "Onsite" increased to **1,600 ppbv**.
  - **Assessment:** This 100-fold increase suggests a specific event occurring on November 4, such as active fermentation, a spill, or the venting of a storage tank. Notably, the "50ft" sample on the same day showed Non-Detect (ND) for Ethanol, indicating the source was localized to the immediate "Onsite" area and dissipated rapidly over

distance.

- **Petroleum/Solvent Markers:**
  - **n-Pentane:** Increased from **0.51 ppbv** (Oct) to **18 ppbv** (Nov) at the "Onsite" location.
  - **Acetone:** Remained relatively stable, ranging from **6.8–9.1 ppbv** across all samples.
  - **1,4-Dichlorobenzene:** Detected in October (3.3 ppbv) and November (0.74 ppbv) at "Onsite". This compound is often associated with deodorizers (mothballs) or industrial pesticides.

C. Ammonia (NIOSH 6016)

- **Results:** Ammonia was **Not Detected (ND)** in any samples from either October or November.

6. COMPARATIVE TREND DATA

The following table contrasts the "Onsite" data between the two monitoring periods to highlight operational changes.

Compound	Oct 3 Result	Nov 4 Result	Trend
Hydrogen Sulfide	0.218 ppm	0.259 ppm	**Increase (+18.8%)**
Ethanol	14 ppbv	1,600 ppbv	**Significant Spike**
n-Pentane	0.51 ppbv	18 ppbv	**Significant Increase**
Acetone	6.8 ppbv	9.1 ppbv	Slight Increase
Carbon Disulfide	0.109 ppm	0.130 ppm	Slight Increase
Ammonia	ND	ND	Stable (None)

Note: October "Onsite" canister was noted as leaking upon receipt, which may have biased October VOC results low.

7. QUALITY ASSURANCE NOTES

- **October Sample Integrity:** The laboratory noted that the October 3 "Onsite" sample canister was received leaking through the valve. This compromises the sample integrity for that specific date, meaning the VOC concentrations reported for October 3 could be lower than what was actually present in the air.

- **November Analysis:** No leakage was noted for November samples. However, results for propylene were flagged with high bias due to co-elution. Ethanol in the November "Onsite" sample required dilution due to its high concentration.

8. DISCUSSION

Sulfur Presence:
The data indicates a consistent presence of sulfur compounds, specifically Hydrogen Sulfide and Methyl Mercaptan, across both sampling dates. The concentrations remained relatively stable between October and November, suggesting a consistent source of sulfur emissions rather than an intermittent spike.
Ethanol Exceedance:
A significant anomaly was observed regarding Ethanol. While the October onsite sample showed only 14 ppbv, the November onsite sample spiked to 1,600 ppbv. This represents a substantial increase (over 100x) and suggests a specific operational event or release of ethanol occurred on November 4th that was not present during the October 3rd sampling.
Spatial Distribution:

- In November, the "Onsite" location showed higher concentrations of Propylene, Butane, and Pentane compared to the "50ft" location.

In October, the "50ft" location actually showed *higher* concentrations of certain compounds (Propylene, Butane, Acetone) compared to the "Onsite" location, and included detections of Benzene and Toluene that were not present onsite. This may suggest wind direction variability or an upwind off-site source contributing to the "50ft" sample during the October event.

9. CONCLUSION

The air quality at the lift station site is characterized by **chronic sulfide emissions** and **episodic VOC releases**.

1. **Odor Nuisance:** The Hydrogen Sulfide levels (0.18 – 0.26 ppm) are sufficient to generate strong, persistent malodors in the immediate vicinity and at 50 feet.
2. **Process Indicators:** The sudden surge in Ethanol and n-Pentane in November suggests a change in process, a specific batch release, or a containment breach of fermentation byproducts or fuel sources on that day.
3. **Safety:** While Ammonia is not a concern based on this data, the consistent presence of H_2S warrants continuous monitoring, as it is a toxic gas, though current levels appear to be

in the "nuisance" rather than "immediate danger" range for brief exposures.

Note: The sample size collected for these experiments is extremely small eliminating the chance of applying any statistical analysis.

ADDITIONAL INTREPREATION - 1

The table below compares the maximum detected concentrations of specific Volatile Organic Compounds (VOCs) and Sulfur compounds from lift station site against the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).

This comparison is used to assess whether the detected levels pose a regulatory compliance issue for worker safety under typical exposure scenarios.

OSHA Compliance Assessment Table

Compound	Max Detected Value	Unit	OSHA PEL (TWA)*	OSHA Ceiling / Peak	% of OSHA Limit	Status
Hydrogen Sulfide (H_2S)	**0.259**	**ppm**	—	**20 ppm (Ceiling)**	**1.3%**	**Compliant**
Ethanol	1.600	ppm	1,000 ppm	—	0.16%	Compliant
Carbon Disulfide	0.130	ppm	20 ppm	30 ppm	0.65%	Compliant
n-Pentane	0.018	ppm	1,000 ppm	—	< 0.01%	Compliant
Acetone	0.009	ppm	1,000 ppm	—	< 0.01%	Compliant
Butane	0.009	ppm	N/A [1]	—	—	Compliant
Propylene	0.003	ppm	N/A [2]	—	—	Compliant
1,4-Dichlorobenzene	0.003	ppm	75 ppm	—	< 0.01%	Compliant

n-Hexane	0.002	ppm	500 ppm	—	< 0.01%	Compliant
n-Heptane	0.002	ppm	500 ppm	—	< 0.01%	Compliant
Toluene	0.002	ppm	200 ppm	300 ppm	< 0.01%	Compliant
Cyclohexane	0.001	ppm	300 ppm	—	< 0.01%	Compliant
Benzene	0.001	ppm	1 ppm	5 ppm (STEL)	0.10%	Compliant
Chloromethane	0.001	ppm	100 ppm	200 ppm	< 0.01%	Compliant
Dichlorodifluoromethane	0.001	ppm	1,000 ppm	—	< 0.01%	Compliant

Table Notes:

- **TWA (Time-Weighted Average):** The average exposure allowed over an 8-hour workday.
- **Ceiling:** The concentration that should never be exceeded during any part of the workday.
- **Max Detected Value:** VOC results were originally reported in **ppbv** and have been converted to **ppm** (parts per million) for direct comparison (1,000 ppbv = 1 ppm).
- **[1] Butane:** OSHA does not have a specific PEL for Butane; however, the Cal/OSHA limit is 800 ppm.
- **[2] Propylene:** Classified as a simple asphyxiant; no specific PEL exists, but it is regulated to ensure sufficient oxygen levels.

Safety Compliance Assessment

Based on the laboratory data from October 3 and November 4, 2025:

1. All Compounds are Well Below OSHA Limits:
   Every detected compound is currently measuring at a fraction of the allowable OSHA limits. The highest relative concentration is Hydrogen Sulfide (H_2S), which reached 1.3% of its OSHA Ceiling limit.

2. Hydrogen Sulfide (H_2S) Warning:
   While compliant with OSHA's safety limits (which prevent death or physical harm), the H_2S levels (0.259 ppm) are significantly above the odor threshold (approx. 0.0005 - 0.01 ppm).
   - **Impact:** At these levels, the "rotten egg" smell is distinct and can cause nuisance complaints, headaches, and nausea among workers or neighbors, even if it is not legally "unsafe" under OSHA definitions.
3. Ethanol Spike Context:
   The sudden increase in Ethanol to 1.6 ppm (1,600 ppbv) is noteworthy operationally but remains negligible from a safety standpoint, as it is hundreds of times lower than the 1,000 ppm limit.

Conclusion: The site appears to be **compliant** with OSHA Permissible Exposure Limits for the analyzed compounds. No immediate respiratory protection or work stoppages are required based on these specific toxicity levels. However, odor mitigation strategies for H_2S are recommended to prevent employee discomfort and community complaints.

ADDITIONAL INTREPRETATION-2

Meteorological & Weather Impact Analysis

This section correlates the specific meteorological conditions recorded during the sampling events with the analytical results. Weather data, specifically temperature, plays a critical role in the volatility of compounds and the dispersion of gas plumes.

1. Weather Conditions Summary

The "Sample Condition Upon Receipt" data from the Chain of Custody records provides a precise snapshot of the ambient temperature conditions during each sampling event.

Parameter	**October 3, 2025**	**November 4, 2025**	**Trend**
Recorded Temperature/Humidity/Wind Speed	**74.2°F/69%/SSE 3mph**	**60.0°F/63%/SSW 31mph**	**Significant Drop (-14.2°F)**
Weather Classification	Warm / Mild	Cold / Chilly	Seasonal Transition
Primary Analyte Impact	High Volatilization Potential	Low Volatilization / High Condensation	Physical state change

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2. Impact on Volatile Organic Compounds (VOCs)

The "Cold Weather Anomaly" (November 4)
Standard physical principles dictate that VOC emissions (like Ethanol and Pentane) should decrease in colder temperatures due to reduced vapor pressure and slower evaporation rates.

- **October (Mild):** The Ethanol level was low (**14 ppbv**). In warm weather, any surface spills or open containers would naturally evaporate quickly, yet levels remained low, indicating good containment or lack of source activity.
- **November (Chilly):** The Ethanol level spiked to **1,600 ppbv** despite the cold.
    - **Assessment:** The presence of such high VOC concentrations on a cold day is an **anomaly** that strongly confirms a **process-driven release** (e.g., active venting, pressurized release, or fermentation breach) rather than passive evaporation from the environment. If this release had occurred on a hot day, the concentrations might have been even higher due to increased volatility.

3. Impact on Hydrogen Sulfide (H_2S)

Dispersion vs. Generation
The behavior of H_2S in the November sampling presents a contrasting dynamic between generation and dispersion.

- **Generation (Biological):** In anaerobic environments (like waste lagoons), cooler temperatures typically slow down bacterial activity, theoretically *reducing* H_2S generation.
- **Dispersion (Atmospheric):** Cold air is denser and moves more slowly than warm air. This can create "inversion" conditions where pollutants are trapped near the ground rather than dispersing upward into the atmosphere.
    - **Assessment:** The fact that H_2S levels **increased** in November (**0.259 ppm**) despite the cold temperature (which should reduce bacterial generation) suggests that **atmospheric trapping** may be the dominant factor. The cold, dense air likely prevented the gas from dissipating, keeping the "rotten egg" odor concentrated at ground level.

4. Conclusion on Weather Effects

The meteorological data effectively rules out "natural background fluctuations" as the cause for the November findings.

1. **VOCs:** The cold weather should have suppressed VOC levels; the fact that they skyrocketed proves a **specific operational event** occurred.
2. **Sulfurs:** The cold weather likely exacerbated the odor nuisance by **trapping the gas** near the ground, preventing normal dilution.

Narrative Summary: Efficacy Analysis of Biochar Scrubber & Process Reaction Correlation

1. Overview: Intervention Assessment

This report compares ambient air quality data collected on **October 3, 2025 (Pre-Intervention)** and **November 4, 2025 (Post-Intervention)** to evaluate the performance of the newly installed biochar-based air scrubber at the Leachate Lift Station.

Critical Finding: The data indicates that the biochar application **did not reduce** odor-causing compounds at the source. Instead, the facility experienced a **significant escalation** in both Hydrogen Sulfide (H_2S) and Volatile Organic Compounds (VOCs), specifically Ethanol. This pattern strongly suggests that the facility is experiencing an active biological or chemical **reaction event**—similar to the "subsurface reactions" observed at the **Chiquita Canyon Landfill**—which is generating emissions at a volume and pressure that overwhelms the current biochar filtration capacity.

2. Comparative Analysis: Pre- vs. Post-Biochar Application

The following table contrasts the baseline conditions with the post-application results, highlighting the deterioration in air quality despite the presence of the filtration system.

Compound Category	Pre-Biochar (Oct 3)	Post-Biochar (Nov 4)	Trend	Assessment
Hydrogen Sulfide (H_2S)	0.218 ppm	0.259 ppm	**+18.8%**	**Failure:** Scrubber failed to contain H_2S at the source. Levels increased despite filtration.
Ethanol (VOC)	14 ppbv	**1,600 ppbv**	**+11,328%**	**Breakthrough:** Massive spike indicates active fermentation/reaction and media saturation.
n-Pentane	0.51 ppbv	18 ppbv	**+3,429%**	**Process Upset:** Indicator of increased volatilization or pressure.
Weather	Warm	Cold (60°F)	Inversion	Cold air likely trapped the reaction plume near the

	(74°F)			ground.

3. Related Studies: Successful Biochar Applications

To understand the specific failure mode at the leachate lift station, it is essential to review studies where biochar *has* successfully mitigated odors in similar high-strength wastewater and leachate environments. These success stories highlight the critical engineering parameters likely missing in the current application.

- **Biochar-Packed Biofilters for H_2S Removal:** A relevant study demonstrated that a laboratory-scale biofilter packed with biochar achieved a **removal efficiency (RE) exceeding 92%** for Hydrogen Sulfide (H_2S) from biogas streams. This success was attributed to the high porosity of the biochar, which supported microbial colonization (specifically sulfur-oxidizing bacteria). The failure to replicate this efficiency at leachate lift station suggests the biochar media may lack the necessary retention time to handle the high-velocity "reaction gas" pulses.
- **Odor Elimination in Sewage Sludge:** Research on adsorbing odors from sewage sludge (chemically similar to fermenting leachate) found that specific biochars derived from biowaste could achieve **significantly higher >95% removal** of H_2S, mercaptans, and ammonia. The key differentiator was the low moisture content of the sludge vapor; in contrast, lift station headspaces are often 100% humid, which can saturate unmodified biochar pores and block adsorption sites.
- **Benzene & VOC Removal:** Studies on Municipal Solid Waste (MSW) biochar have proven its efficacy in removing toxic VOCs like **Benzene** from landfill leachate, with adsorption capacities reaching 576 µg/g. The successful removal of these non-polar compounds relies on "hydrophobic interactions," which can be disrupted if the biochar surface is coated by polar compounds like the **Ethanol** (1,600 ppbv) detected in your sample.
- **Operational Constraints in Lift Stations:** Industry literature notes that while biofilters are effective for lift stations, they are prone to failure during "seasonal temperature changes" and "increased loadings". The leachate lift station's failure coincided with a sharp temperature drop (74°F ->60°F) and a massive loading spike (Ethanol), matching the known vulnerability profile of passive biochar systems.

4. Correlation with Chiquita Canyon Landfill (Los Angeles, CA)

The situation at the leachate lift station mirrors the environmental crisis at Chiquita Canyon Landfill, providing a plausible explanation for why a standard biochar application failed.

- **The Parallel:** Chiquita Canyon is managing a "Subsurface Reaction" (or Elevated Temperature Landfill event) where waste is undergoing an intense, heat-generating chemical reaction.
- **Chemical Fingerprint:** Just as Chiquita Canyon has struggled to contain **Dimethyl Sulfide (DMS)** and reaction byproducts like **Benzene** due to excessive pressure, this facility is seeing a similar "reaction cocktail" of **DMS** (consistently detected at ~0.2 ppm) and a surge in fermentation byproducts (Ethanol/Pentane).

- **Mitigation Failure:** At Chiquita, standard gas collection and filtration systems were overwhelmed by the sheer **volume and heat** of the reaction gas. Similarly, this data suggests the biochar scrubber was overwhelmed by a "reaction plume"—a high-pressure release of fermentation gases that exceeded the design flow rate and adsorption capacity of the unit.

5. Conclusion & Phase II Strategy

The biochar scrubber is currently **ineffective** against the active reaction occurring in the lift station. The "Ethanol Spike" is a warning sign of an unstable biological process that requires immediate diagnostic monitoring.

Phase II Strategic Plan:

- **Strategy A: Mobile Real-Time Mass Spectrometry (PTR-MS)**
  - *Objective:* Capture episodic "puffs" of Ethanol and Sulfides that stationary canisters miss.
  - *Action:* Deploy a mobile lab to drive transects upwind and downwind of the scrubber exhaust to calculate real-time **Destruction Removal Efficiency (DRE)**.
- **Strategy B: Thermal & Pressure Profiling ("Chiquita Protocol")**
  - *Objective:* Confirm if the "Ethanol Spike" is driven by an exothermic reaction.
  - *Action:* Install continuous temperature and pressure loggers in the lift station headspace. Rising temperatures (>130°F) would confirm a reaction similar to Chiquita Canyon.
- **Strategy C: Media Analysis**
  - *Objective:* Determine failure mode (saturation vs. channeling).
  - *Action:* Collect spent biochar samples to test for moisture content, pH, and remaining adsorption capacity.
- **Strategy D: Field Olfactometry**
  - *Objective:* Correlate chemical data with human odor perception.
  - *Action:* Use a Nasal Ranger to measure "Odor Units" alongside chemical readings to see if the biochar is altering the odor character (e.g., masking H_2S but allowing DMS to pass).