ATTACHMENT B

SWAPE Technical Consultation, Data Analysis and Litigation Support for the Environment

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February 14, 2024

Ellison Folk
Shute Mihaly & Weinberger LLP
396 Hayes Street
San Francisco, CA 94102

Subject: Comments on the Proposed Amendments to the Low Carbon Fuel Standard

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Dear Ms. Folk,

SWAPE was retained by Shute Mihaly & Weinberger LLP to provide written comments on the Proposed Amendments to the Low Carbon Fuel Standard ("LCFS") released by the California Air Resources Board ("CARB"), specifically the *Staff Report: Initial Statement of Reasons* ("ISOR") and the *Appendix D: Draft Environmental Impact Analysis for the Proposed Low Carbon Fuel Standard Regulation* ("EIA").[1, 2] Upon review, I have found that the ISOR and EIA inadequately addressed the following:

- Anaerobic digestate increases the potential for nitrate contamination of groundwater; and
- Anaerobic digestate increases N_2O and NOx emissions into the atmosphere; and
- Anaerobic digestate increases ammonia emissions, which is an odorous compound. Odor associated with anaerobic digestate soil application can result in odor complaints to nearby communities which are often of lower socioeconomic status resulting in environmental justice issues.

In "Table 1.1: Summary of Potential Environmental Impacts" in the ISOR, CARB listed the following impacts as "Potentially Significant and Unavoidable":[3]

- "Short-term Construction-Related and Long-Term Operational-Related Impacts on Air Quality"

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[1] ISOR.pdf.
[2] EIA.pdf.
[3] ISOR. PDF Pg. 64-65.

- "Short-Term Construction-Related and Long-Term Operational-Related Impacts to Geology and Soils"
- "Short-Term Construction-Related and Long-Term Operational-Related Impacts to Hydrology and Water Quality"

Upon review, I find the ISOR and EIA are insufficient in addressing my concerns regarding anaerobic digesters' air quality and groundwater impacts. The following are my comments regarding these documents.

Anaerobic Digestion

Anaerobic Digester Digestate Impact on Air

In the ISOR, CARB listed the impacts of "Short-term Construction-Related and Long-Term Operational-Related Impacts on Air Quality" as "Potentially Significant and Unavoidable".[4] The following section highlights a clear indication that CARB's analysis fell short in adequately assessing the significance of these impacts on air quality.

Anaerobic digestion efficiently decomposes waste into smaller molecules, enhancing their propensity to volatilize into the atmosphere. During the anaerobic digestion process, quantities of ammonia are produced as a byproduct. This odorous compound possesses the potential to cause irritation and discomfort to the throat, lungs, and eyes, and prolonged exposure to elevated ammonia levels can lead to lung damage.[5] Furthermore, ammonia emits a strong odor that is easily detectable at low concentrations and contributes to irritation such as immediate burning of the nose and respiratory tract.[6] From a study by Rosenfeld et. al. in 2000, anaerobic digestion can emit enough ammonia to contribute to odor emissions. The study mentions:

> *"Odor emissions from land application of biosolids have become a concern for biosolids managers. Chemical odorant emissions from biosolids were identified using gas chromatography-mass spectrometry and included dimethyl disulfide (DMDS), dimethyl sulfide (DMS), carbon disulfide (CS2), ammonia (NH3), trimethyl amine (TMA), and acetone."*[7]

This confirms that ammonia emissions from biosolids (digestate) are broken down during the anaerobic digestion process, potentially leading to increased ammonia concentration and, consequently, odor and health irritation.

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[4] ISOR. PDF Pg. 64-65.

[5] Centers for Disease Control and Prevention. *Ammonia: Exposure, Decontamination, Treatment*. Last Reviewed: February 6, 2023.

[6] New York State Department of Health. The Facts About Ammonia. Updated: July 28, 2004.

[7] Rosenfeld, P.E., and Henry C. L., (2000). Wood ash control of odor emissions from biosolids application. Journal of Environmental Quality. Vol 29, 1662-1668.

Another study, conducted by Holly et al. in 2017, evaluated the effects of anaerobic digestion on greenhouse gas and ammonia emissions during manure storage. According to Holly et al., anaerobic digestion can increase ammonia emissions. The study stated that the anaerobic digestion process "resulted in a gas emission tradeoff as it increased NH_3 [ammonia] emissions by 81% during storage, which could be mitigated by subsequent SLS [solid-liquid separation], manure storage covers, or other beneficial management practices."[8] The study further explains:

> *"During the AD process, methanogens and other microorganisms break down proteins, amino acids, and urea forming NH4 (Bernet et al., 2000). In addition, mineralization of organic N and volatile fatty acids during AD increases manure pH and available N (Petersen and Sommer, 2011), factors which increase NH3 emissions."*[9]

Holly et al. also found that nitrous oxide emissions were increased from anaerobically digested solids during storage:

> *"Overall, the methane emissions from storage were reduced by manure processing by 25%, 46%, and 68% for AD, SLS, and AD+SLS, respectively. However, these reductions from storage were somewhat negated when examing [sic] total GHG's to 44% and 27% for SLS and AD+SLS due to N2O losses from solid storage."*[10]

They concluded that greenhouse gas emissions were not further reduced when solid-liquid separation was employed in addition to anaerobic digestion as opposed to anaerobic digestion alone, as "anaerobically stacking digested solids increased emissions of N2O negating abatement of total GHG."[11] The findings of this study show the importance of considering nitrous oxide emissions from digestate solids in cumulative GHG emissions, which CARB failed to adequately address in the EIA. Furthermore, the ISOR and EIA claim methane reductions are achieved by digesters without any discussion of digestate-related N_2O, which Holly (2017) found negated methane reductions by more than 40 percent.

As anaerobic digestion breaks down organic material, biogas is produced. Preble et. al. (2020) explained that during biogas combustion in the anaerobic digestion process, ammonia is oxidized to nitrous oxides, which, in turn, increases nitrous oxide emissions.[12] The study "quantifies emission rates of GHGs, criteria air pollutants, and toxic/odorous compounds from the AD composting process."[13] The study further states:

> *"In situ measurements of key sources at two large-scale industrial facilities in California were conducted to quantify pollutant emission rates across the AD composting*

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[8] Holly et al., (2017). Greenhouse gas and ammonia emissions from digested and separated dairy manure during storage and after land application.
[9] Ibid.
[10] Id. PDF Pg. 7.
[11] Id. PDF Pg. 9.
[12] Preble et. al. (2020). *Air Pollutant Emission Rates for Dry Anaerobic Digestion and Composting of Organic Municipal Solid Waste*. PDF Pg 2.
[13] Ibid.

> *process. These measurements established a strong relationship between flared biogas ammonia (NH3) content and emitted nitrogen oxides (NOx), indicating that fuel NOx formation is significant and dominates over the thermal or prompt NOx pathways when biogas NH3 concentration exceeds ~200 ppm."*[14]

The above study highlights a crucial aspect, noting that "biogas may contain significant amounts of ammonia (NH_3) that is produced during the degradation of amino acids during acidogenesis - one of the four primary stages in AD."[15] Additionally, it emphasizes the potential consequences, explaining that "the oxidation of NH_3 present in the biogas to nitrogen oxides (NOx = NO + NO_2) can cause elevated flare emissions that contribute to air quality problems and exceed permitted levels."[16]

Anaerobic digesters produce significant amounts of greenhouse gases, such as methane and carbon dioxide.[17] Notably, the combustion of biogas in an internal combustion engine yields high levels of air pollution, including carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), and various hazardous air pollutants.[18] Biogas combustion also results in formaldehyde emissions. According to the EPA, formaldehyde is a "probable" carcinogen.[19] Based on an article by the Vermont Department of Environmental Conservation, anaerobic digesters can result in increased formaldehyde emissions from combustion of biogas. The article states:

> *"The use of internal combustion engines to burn biogas also generates substantially more formaldehyde emissions than would occur with other fuels or other combustion devices. According to the U.S. Environmental Protection Agency (US EPA), formaldehyde is ubiquitous and naturally occurring in the environment at low levels, contributing to asthma and eye and respiratory irritation. At higher concentration, it can cause severe irritation and is considered a probable human carcinogen by the US EPA."*[20]

The impact of emissions from anaerobic digestion on nearby communities, especially those in close proximity to dairy farms, is a critical aspect of environmental justice and public health. The emissions from anaerobic digestion can disproportionately affect nearby communities, particularly those adjacent to dairy farms, often comprising lower-income residents. Lower-income residents are often more vulnerable to the adverse effects of these emissions due to various factors, such as lack of resources, inadequate infrastructure, and the concentration of anaerobic digester facilities near these populations.

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[14] Id. PDF Pg 1.
[15] Ibid.
[16] Id. PDF pg 2.
[17] Anaerobic Digesters. Vermont Department of Environmental Conservation. Accessed January 26, 2024.
[18] Ibid.
[19] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Formaldehyde. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
[20] Anaerobic Digesters. Vermont Department of Environmental Conservation. Accessed January 26, 2024.

The above section clearly highlights CARB's lack of extensive analysis in assessing the potential impacts of anaerobic digestion on air quality.

Anaerobic Digester Digestate Impact on Groundwater

In the ISOR, CARB listed the impacts of "Short-Term Construction-Related and Long-Term Operational-Related Impacts to Geology and Soils" and "Short-Term Construction-Related and Long-Term Operational-Related Impacts to Hydrology and Water Quality" as "Potentially Significant and Unavoidable".[21] This section serves as a response to CARB's analysis of these impacts.

Anaerobic digestion breaks down waste into a digestate of smaller molecules that are more susceptible to leaching into the groundwater. Several studies have found that anaerobic digestion leads to higher concentrations of ammonia in digestate, which can subsequently convert to nitrate. The leaching of nitrates into drinking water and food can lead to the onset of blue baby syndrome, also known as methemoglobinemia.[22] The consumption of nitrate reduces the ability of red blood cells to transport oxygen, leading to illness in infants younger than 12 months and presenting as a distinctive blue or brown tint to their skin.[23]

Figure 1. Baby with methemoglobinemia [24]

[21] ISOR. PDF Pg. 64-65.
[22] Nitrates, Blue Baby Syndrome, and Drinking Water: A Fact Sheet for Families. PEHSU. March 2016. PDF Pg. 1.
[23] Nitrates, Blue Baby Syndrome, and Drinking Water: A Fact Sheet for Families. PEHSU. March 2016. PDF Pg. 1.
[24] St. Bartholomew's Hospital, London/Photo Researchers (n.d.). American Scientist.

Lamolinara et al. (2022) found that digestate, the nutrient-rich product from anaerobic digestion of organic waste, can "contribute to nutrient pollution without comprehensive management strategies."[25] This type of pollution can lead to harmful algal blooms, hypoxia, and eutrophication.[26] Improper application of digestate has the potential to adversely affect both plant growth and soil health.[27] The chemical composition of digestate can present challenges for sustainable disposal.[28] Early application of digestate may lead to nutrient loss, translocation to deeper soil layers, or discharges of $NO3^-$ into groundwater.[29]

Anaerobic digestion breaks down waste, rendering it more susceptible to seepage into groundwater than undigested manure. Treatment lagoons are used to facilitate the waste treatment process and are lined, inhibiting nitrate from entering the groundwater. Anaerobic digestate is more extensively broken down compared to sludge from treatment lagoons. One study by Agga et al. (2022) indicated that treatment lagoons can reduce nitrogen compared to aerobic digestion:

> *"Unlike anaerobic digesters, uncovered lagoons are open to the air, photosynthesizing bacteria may develop that act to reduce nitrogen and sulfur-containing compounds and help eliminate odor in the effluent storage layer."*[30]

Nitrate pollution leading to groundwater contamination is much more likely to occur with anaerobically digested digestate, as the ammonia is more readily available for conversion into nitrate, which can then leach into groundwater. A 2010 study titled "Biogas Digestates as Organic Fertilizer in Different Crop Rotations" assessed bioenergy cropping systems for yield performance, ecological impacts, and economic feasibility. The research revealed that treatments with high digestate application rates could elevate the risk of $NO3^-$ discharges into groundwater.[31] Another study, by Fermoso et al. in 2019, highlighted that the prolonged use of digestate from anaerobic digesters could result in rapid nitrification of ammonium (NH4+-N) in the soil, making it readily accessible to crops and prone to leaching, potentially causing groundwater pollution.[32] A study by Amon et al. (2006) found that anaerobic digester digestate increases nitrate loss potential.[33] The study states:

> *"Anaerobic digestion reduces manure carbon and dry matter content by about 50%. NH4-N content and pH in digested slurry are higher than in untreated slurry (Messner, 1988). Thus, potentials for NH3 emissions during slurry storage are enhanced. Due to*

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[25] Lamolinara et al. (2022). Anaerobic digestate management, environmental impacts, and techno-economic challenges. PDF Pg. 1.
[26] Ibid.
[27] Id. PDF Pg. 2.
[28] Ibid.
[29] Ibid.
[30] Agga et al. (2022). Lagoon, Anaerobic Digestion, and Composting of Animal Manure Treatments Impact on Tetracycline Resistance Genes. PDF Pg. 7.
[31] Formowitz and Fritz (2010). Biogas Digestates as Organic Fertilizer in Different Crop Rotations. PDF Pg. 4.
[32] Fermoso et al. (2019). Trace Elements in Anaerobic Biotechnologies. IWA. June 2019. PDF Pg. 187.
[33] Amon et al. (2006). Methane, nitrous oxide and ammonia emissions during storage and after application of dairy cattle slurry and influence of slurry treatment.

the reduced dry matter content, biogas slurry can infiltrate more rapidly into the soil, which reduces NH3 emissions after slurry application. However, the increased NH4-N content and pH give rise to higher NH3 loss potentials."[34]

There is a potential for nitrate contamination of groundwater, excessive accumulation of soil phosphorus, and eutrophication of surface waters from anaerobic digesters.[35] The above section clearly highlights CARB's lack of extensive analysis in assessing the potential impacts of anaerobic digestion on groundwater quality.

Conclusion: Anaerobic Digester Impacts Inadequately Evaluated

CARB failed to adequately address air quality, soil and geology, and groundwater quality issues in the ISOR and EIA. Further analysis is required to quantify the impact of increased anaerobic digesters and the impacts on groundwater and air quality, especially in locations where digestate is applied to soil. Further assessment is essential to properly evaluate the impact of emissions to air and discharges to groundwater from anaerobic digestion on nearby communities, specifically lower-income neighborhoods.

Disclaimer

SWAPE has received limited discovery regarding this project. Additional information may become available in the future; thus, we retain the right to revise or amend this report when additional information becomes available. Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable environmental consultants practicing in this or similar localities at the time of service. No other warranty, expressed or implied, is made as to the scope of work, work methodologies and protocols, site conditions, analytical testing results, and findings presented. This report reflects efforts which were limited to information that was reasonably accessible at the time of the work, and may contain informational gaps, inconsistencies, or otherwise be incomplete due to the unavailability or uncertainty of information obtained or provided by third parties.

Sincerely,

Paul E. Rosenfeld, Ph.D.

Attachment A: Paul E. Rosenfeld CV

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[34] Ibid.

[35] Mahony et al. (2002) Feasibility Study for Centralised Anaerobic Digestion for Treatment of Various Waste and Wastewaters in Sensitive Catchment Areas. PDF Pg. 5.

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Chemical Fate and Transport & Air Dispersion Modeling

Principal Environmental Chemist

Risk Assessment & Remediation Specialist

Education

Ph.D. Soil Chemistry, University of Washington, 1999. Dissertation on volatile organic compound filtration.

M.S. Environmental Science, U.C. Berkeley, 1995. Thesis on organic waste economics.

B.A. Environmental Studies, U.C. Santa Barbara, 1991. Focus on wastewater treatment.

Professional Experience

Dr. Rosenfeld has over 25 years of experience conducting environmental investigations and risk assessments for evaluating impacts to human health, property, and ecological receptors. His expertise focuses on the fate and transport of environmental contaminants, human health risk, exposure assessment, and ecological restoration. Dr. Rosenfeld has evaluated and modeled emissions from oil spills, landfills, boilers and incinerators, process stacks, storage tanks, confined animal feeding operations, industrial, military and agricultural sources, unconventional oil drilling operations, and locomotive and construction engines. His project experience ranges from monitoring and modeling of pollution sources to evaluating impacts of pollution on workers at industrial facilities and residents in surrounding communities. Dr. Rosenfeld has also successfully modeled exposure to contaminants distributed by water systems and via vapor intrusion.

Dr. Rosenfeld has investigated and designed remediation programs and risk assessments for contaminated sites containing lead, heavy metals, mold, bacteria, particulate matter, petroleum hydrocarbons, chlorinated solvents, pesticides, radioactive waste, dioxins and furans, semi- and volatile organic compounds, PCBs, PAHs, creosote, perchlorate, asbestos, per- and poly-fluoroalkyl substances (PFOA/PFOS), unusual polymers, fuel oxygenates (MTBE), among other pollutants. Dr. Rosenfeld also has experience evaluating greenhouse gas emissions from various projects and is an expert on the assessment of odors from industrial and agricultural sites, as well as the evaluation of odor nuisance impacts and technologies for abatement of odorous emissions. As a principal scientist at SWAPE, Dr. Rosenfeld directs air dispersion modeling and exposure assessments. He has served as an expert witness and testified about pollution sources causing nuisance and/or personal injury at sites and has testified as an expert witness on numerous cases involving exposure to soil, water and air contaminants from industrial, railroad, agricultural, and military sources.

Professional History:

Soil Water Air Protection Enterprise (SWAPE); 2003 to present; Principal and Founding Partner
UCLA School of Public Health; 2007 to 2011; Lecturer (Assistant Researcher)
UCLA School of Public Health; 2003 to 2006; Adjunct Professor
UCLA Environmental Science and Engineering Program; 2002-2004; Doctoral Intern Coordinator
UCLA Institute of the Environment, 2001-2002; Research Associate
Komex H_2O Science, 2001 to 2003; Senior Remediation Scientist
National Groundwater Association, 2002-2004; Lecturer
San Diego State University, 1999-2001; Adjunct Professor
Anteon Corp., San Diego, 2000-2001; Remediation Project Manager
Ogden (now Amec), San Diego, 2000-2000; Remediation Project Manager
Bechtel, San Diego, California, 1999 – 2000; Risk Assessor
King County, Seattle, 1996 – 1999; Scientist
James River Corp., Washington, 1995-96; Scientist
Big Creek Lumber, Davenport, California, 1995; Scientist
Plumas Corp., California and USFS, Tahoe 1993-1995; Scientist
Peace Corps and World Wildlife Fund, St. Kitts, West Indies, 1991-1993; Scientist

Publications:

Rosenfeld P.E. and Spaeth K.R., (2023) Authors' Response to Letter to the Editor from Bullock and Ramacciotti, Volume 234, https://doi.org/10.1007/s11270-023-06165-3

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Hensley A.R., Scott, A., **Rosenfeld P.E.,** Clark, J.J.J. (August 21 – 25, 2006). Dioxin Containing Attic Dust And Human Blood Samples Collected Near A Former Wood Treatment Facility. *The 26th International Symposium on Halogenated Persistent Organic Pollutants – DIOXIN2006*. Lecture conducted from Radisson SAS Scandinavia Hotel in Oslo Norway.

Hensley A.R., Scott, A., **Rosenfeld P.E.,** Clark, J.J.J. (November 4-8, 2006). Dioxin Containing Attic Dust And Human Blood Samples Collected Near A Former Wood Treatment Facility. *APHA 134 Annual Meeting & Exposition.* Lecture conducted from Boston Massachusetts.

Paul Rosenfeld Ph.D. (October 24-25, 2005). Fate, Transport and Persistence of PFOA and Related Chemicals. Mealey's C8/PFOA. *Science, Risk & Litigation Conference.* Lecture conducted from The Rittenhouse Hotel, Philadelphia, PA.

Paul Rosenfeld Ph.D. (September 19, 2005). Brominated Flame Retardants in Groundwater: Pathways to Human Ingestion, *Toxicology and Remediation PEMA Emerging Contaminant Conference*. Lecture conducted from Hilton Hotel, Irvine California.

Paul Rosenfeld Ph.D. (September 19, 2005). Fate, Transport, Toxicity, And Persistence of 1,2,3-TCP. *PEMA Emerging Contaminant Conference.* Lecture conducted from Hilton Hotel in Irvine, California.

Paul Rosenfeld Ph.D. (September 26-27, 2005). Fate, Transport and Persistence of PDBEs. *Mealey's Groundwater Conference.* Lecture conducted from Ritz Carlton Hotel, Marina Del Ray, California.

Paul Rosenfeld Ph.D. (June 7-8, 2005). Fate, Transport and Persistence of PFOA and Related Chemicals. *International Society of Environmental Forensics: Focus on Emerging Contaminants*. Lecture conducted from Sheraton Oceanfront Hotel, Virginia Beach, Virginia.

Paul Rosenfeld Ph.D. (July 21-22, 2005). Fate Transport, Persistence and Toxicology of PFOA and Related Perfluorochemicals. *2005 National Groundwater Association Ground Water and Environmental Law Conference*. Lecture conducted from Wyndham Baltimore Inner Harbor, Baltimore Maryland.

Paul Rosenfeld Ph.D. (July 21-22, 2005). Brominated Flame Retardants in Groundwater: Pathways to Human Ingestion, Toxicology and Remediation. *2005 National Groundwater Association Ground Water and Environmental Law Conference.* Lecture conducted from Wyndham Baltimore Inner Harbor, Baltimore Maryland.

Paul Rosenfeld, Ph.D. and James Clark Ph.D. and Rob Hesse R.G. (May 5-6, 2004). Tert-butyl Alcohol Liability and Toxicology, A National Problem and Unquantified Liability. *National Groundwater Association. Environmental Law Conference*. Lecture conducted from Congress Plaza Hotel, Chicago Illinois.

Paul Rosenfeld, Ph.D. (March 2004). Perchlorate Toxicology. *Meeting of the American Groundwater Trust*. Lecture conducted from Phoenix Arizona.

Hagemann, M.F., **Paul Rosenfeld, Ph.D.** and Rob Hesse (2004). Perchlorate Contamination of the Colorado River. *Meeting of tribal representatives*. Lecture conducted from Parker, AZ.

Paul Rosenfeld, Ph.D. (April 7, 2004). A National Damage Assessment Model For PCE and Dry Cleaners. *Drycleaner Symposium. California Ground Water Association*. Lecture conducted from Radison Hotel, Sacramento, California.

Rosenfeld, P. E., Grey, M., (June 2003) Two stage biofilter for biosolids composting odor control. *Seventh International In Situ And On Site Bioremediation Symposium Battelle Conference* Orlando, FL.

Paul Rosenfeld, Ph.D. and James Clark Ph.D. (February 20-21, 2003) Understanding Historical Use, Chemical Properties, Toxicity and Regulatory Guidance of 1,4 Dioxane. *National Groundwater Association. Southwest Focus Conference. Water Supply and Emerging Contaminants*.. Lecture conducted from Hyatt Regency Phoenix Arizona.

Paul Rosenfeld, Ph.D. (February 6-7, 2003). Underground Storage Tank Litigation and Remediation. *California CUPA Forum*. Lecture conducted from Marriott Hotel, Anaheim California.

Paul Rosenfeld, Ph.D. (October 23, 2002) Underground Storage Tank Litigation and Remediation. *EPA Underground Storage Tank Roundtable*. Lecture conducted from Sacramento California.

Rosenfeld, P.E. and Suffet, M. (October 7- 10, 2002). Understanding Odor from Compost, *Wastewater and Industrial Processes. Sixth Annual Symposium On Off Flavors in the Aquatic Environment. International Water Association*. Lecture conducted from Barcelona Spain.

Rosenfeld, P.E. and Suffet, M. (October 7- 10, 2002). Using High Carbon Wood Ash to Control Compost Odor. *Sixth Annual Symposium On Off Flavors in the Aquatic Environment. International Water Association*. Lecture conducted from Barcelona Spain.

Rosenfeld, P.E. and Grey, M. A. (September 22-24, 2002). Biocycle Composting For Coastal Sage Restoration. *Northwest Biosolids Management Association*. Lecture conducted from Vancouver Washington..

Rosenfeld, P.E. and Grey, M. A. (November 11-14, 2002). Using High-Carbon Wood Ash to Control Odor at a Green Materials Composting Facility. *Soil Science Society Annual Conferenc*e. Lecture conducted from Indianapolis, Maryland.

Rosenfeld. P.E. (September 16, 2000). Two stage biofilter for biosolids composting odor control. *Water Environment Federation.* Lecture conducted from Anaheim California.

Rosenfeld. P.E. (October 16, 2000). Wood ash and biofilter control of compost odor. *Biofest.* Lecture conducted from Ocean Shores, California.

Rosenfeld, P.E. (2000). Bioremediation Using Organic Soil Amendments. *California Resource Recovery Association*. Lecture conducted from Sacramento California.

Rosenfeld, P.E., C.L. Henry, R. Harrison. (1998). Oat and Grass Seed Germination and Nitrogen and Sulfur Emissions Following Biosolids Incorporation with High-Carbon Wood-Ash. *Water Environment Federation 12th Annual Residuals and Biosolids Management Conference Proceedings*. Lecture conducted from Bellevue Washington.

Rosenfeld, P.E., and C.L. Henry. (1999). An evaluation of ash incorporation with biosolids for odor reduction. *Soil Science Society of America*. Lecture conducted from Salt Lake City Utah.

Rosenfeld, P.E., C.L. Henry, R. Harrison. (1998). Comparison of Microbial Activity and Odor Emissions from Three Different Biosolids Applied to Forest Soil. *Brown and Caldwell.* Lecture conducted from Seattle Washington.

Rosenfeld, P.E., C.L. Henry. (1998). Characterization, Quantification, and Control of Odor Emissions from Biosolids Application To Forest Soil. *Biofest.* Lecture conducted from Lake Chelan, Washington.

Rosenfeld, P.E, C.L. Henry, R. Harrison. (1998). Oat and Grass Seed Germination and Nitrogen and Sulfur Emissions Following Biosolids Incorporation with High-Carbon Wood-Ash. Water Environment Federation 12th Annual Residuals and Biosolids Management Conference Proceedings. Lecture conducted from Bellevue Washington.

Rosenfeld, P.E., C.L. Henry, R. B. Harrison, and R. Dills. (1997). Comparison of Odor Emissions from Three Different Biosolids Applied to Forest Soil. *Soil Science Society of America*. Lecture conducted from Anaheim California.

Teaching Experience:

UCLA Department of Environmental Health (Summer 2003 through 20010) Taught Environmental Health Science 100 to students, including undergrad, medical doctors, public health professionals and nurses. Course focused on the health effects of environmental contaminants.

National Ground Water Association, Successful Remediation Technologies. Custom Course in Sante Fe, New Mexico. May 21, 2002. Focused on fate and transport of fuel contaminants associated with underground storage tanks.

National Ground Water Association; Successful Remediation Technologies Course in Chicago Illinois. April 1, 2002. Focused on fate and transport of contaminants associated with Superfund and RCRA sites.

California Integrated Waste Management Board, April and May, 2001. Alternative Landfill Caps Seminar in San Diego, Ventura, and San Francisco. Focused on both prescriptive and innovative landfill cover design.

UCLA Department of Environmental Engineering, February 5, 2002. Seminar on Successful Remediation Technologies focusing on Groundwater Remediation.

University Of Washington, Soil Science Program, Teaching Assistant for several courses including: Soil Chemistry, Organic Soil Amendments, and Soil Stability.

U.C. Berkeley, Environmental Science Program Teaching Assistant for Environmental Science 10.

Academic Grants Awarded:

California Integrated Waste Management Board. $41,000 grant awarded to UCLA Institute of the Environment. Goal: To investigate the effect of high carbon wood ash on volatile organic emissions from compost. 2001.

Synagro Technologies, Corona California: $10,000 grant awarded to San Diego State University.
Goal: investigate the effect of biosolids for restoration and remediation of degraded coastal sage soils. 2000.

King County, Department of Research and Technology, Washington State. $100,000 grant awarded to University of Washington: Goal: To investigate odor emissions from biosolids application and the effect of polymers and ash on VOC emissions. 1998.

Northwest Biosolids Management Association, Washington State. $20,000 grant awarded to investigate effect of polymers and ash on VOC emissions from biosolids. 1997.

James River Corporation, Oregon: $10,000 grant was awarded to investigate the success of genetically engineered Poplar trees with resistance to round-up. 1996.

United State Forest Service, Tahoe National Forest: $15,000 grant was awarded to investigating fire ecology of the Tahoe National Forest. 1995.

Kellogg Foundation, Washington D.C. $500 grant was awarded to construct a large anaerobic digester on St. Kitts in West Indies. 1993

Deposition and/or Trial Testimony:

In the United States District Court for the Western District of Louisiana
Ricky Bush v. Clean Harbors Colfax LLC
Case No. 1:22-cv-02026-DDD-JPM
Rosenfeld Deposition 12-18-2023

In United States District Court of Hawaii
Patrick Feindt, Jr. et al. vs. The United States of America
Case No. 1:22-cv-LEK-KJM
Rosenfeld Deposition 11-29-2023

In the Circuit Court for the Twentieth Judicial Circuit St. Clair County, Illinois
Timothy Gray vs. Rural King et al.
Case No 2022-LA-355
Rosenfeld Deposition 9-26-2023

In United States District Court Eastern District of Wisconsin
Gary L. Siepe vs. Soo Line Railroad Company
Case No. 2:21-cv-00919
Rosenfeld Deposition 9-15-2023

In the Circuit Court of Cook County Illinois
Donald Fox vs. BNSF
Case No. 2021 L12
Rosenfeld Deposition 9-12-2023

In the Court of Common Please Cuyahoga County, Ohio
Thomas Schleich vs. Penn Central Corporation
Lead Case No. CV-20-939184
Rosenfeld Deposition 8-27-2023

In the Circuit Court of Jackson County Missouri at Kansas City
Timothy Dalsing vs. BNSF
Case No. No. 2216-cv06539
Rosenfeld Deposition 7-28-2023

In the United States District Court for the Southern District of Texas Houston Division
International Terminals Company LLC Deer Park Fire Litigation
Lead Case No. 4:19-cv-01460
Rosenfeld Deposition 7-25-2023

In the Circuit Court of Livingston County Missouri
Shirley Ralls vs. Canadian Pacific Railway and Soo Lind Railroad
Case No. 28LV-CV0020
Rosenfeld Daubert Hearing 7-18-2023 Trial Testimony 7-19-2023

In the Circuit Court of Cook County Illinois
Brenda Wright vs. Penn Central and Conrail
Case No. No. 2032L003966
Rosenfeld Deposition 6-13-2023

In the Circuit Court Common Please Philadelphia of Jefferson County Alabama
Frank Belle vs. Birmingham Southern Railroad Company et al.
Case No. 01-cv-2021-900901.00
Rosenfeld Deposition 4-6-2023

In the Circuit Court of Jefferson County Alabama
Linda De Gregorio vs. Penn Central
Case No. 002278
Rosenfeld Deposition 3-27-20203

In the United States District Court Eastern District of New York
Rosalie Romano et al. vs. Northrup Grumman Corporation
Case No. 16-cv-5760
Rosenfeld Deposition 3-16-2023

In the Superior Court of Washington, Spokane County
Judy Cundy vs. BNSF
Case No. 21-2-03718-32
Rosenfeld Deposition 3-9-2023

In The Court of Common Pleas of Philadelphia County, PA Civil Trial Division
Feaster v Conrail
Case No. 001075
Rosenfeld Deposition 2-1-2023

In United States District Court for the Central District of Illinois
Sherman vs. BNSF
Case No. 3:17-cv-01192
Rosenfeld Deposition 1-18-2023

In United States District Court District of Colorado
Gonzales vs. BNSF
Case No. 1:21-cv-01690
Rosenfeld Deposition 1-17-2023

In United States District Court District of Colorado
Abeyta vs. BNSF
Case No. 1:21-cv-01689-KMT
Rosenfeld Deposition 1-3-2023

In United States District Court For The Easter District of Louisiana
Nathaniel Smith vs. Illinois Central Railroad
Case No. 2:21-cv-01235
Rosenfeld Deposition 11-30-2022

In the Superior Court of the State of California, County of San Bernardino
Billy Wildrick, Plaintiff vs. BNSF Railway Company
Case No. CIVDS1711810
Rosenfeld Deposition 10-17-2022

In the State Court of Bibb County, State of Georgia
Richard Hutcherson, Plaintiff vs Norfolk Southern Railway Company
Case No. 10-SCCV-092007
Rosenfeld Deposition 10-6-2022

In the Civil District Court of the Parish of Orleans, State of Louisiana
Millard Clark, Plaintiff vs. Dixie Carriers, Inc. et al.
Case No. 2020-03891
Rosenfeld Deposition 9-15-2022

In The Circuit Court of Livingston County, State of Missouri, Circuit Civil Division
Shirley Ralls, Plaintiff vs. Canadian Pacific Railway and Soo Line Railroad
Case No. 18-LV-CC0020
Rosenfeld Deposition 9-7-2022

In The Circuit Court of the 13th Judicial Circuit Court, Hillsborough County, Florida Civil Division
Jonny C. Daniels, Plaintiff vs. CSX Transportation Inc.
Case No. 20-CA-5502

Rosenfeld Deposition 9-1-2022

In The Circuit Court of St. Louis County, State of Missouri
Kieth Luke et. al. Plaintiff vs. Monsanto Company et. al.
Case No. 19SL-CC03191
Rosenfeld Deposition 8-25-2022

In The Circuit Court of the 13th Judicial Circuit Court, Hillsborough County, Florida Civil Division
Jeffery S. Lamotte, Plaintiff vs. CSX Transportation Inc.
Case No. NO. 20-CA-0049
Rosenfeld Deposition 8-22-2022

In State of Minnesota District Court, County of St. Louis Sixth Judicial District
Greg Bean, Plaintiff vs. Soo Line Railroad Company
Case No. 69-DU-CV-21-760
Rosenfeld Deposition 8-17-2022

In United States District Court Western District of Washington at Tacoma, Washington
John D. Fitzgerald Plaintiff vs. BNSF
Case No. 3:21-cv-05288-RJB
Rosenfeld Deposition 8-11-2022

In Circuit Court of the Sixth Judicial Circuit, Macon Illinois
Rocky Bennyhoff Plaintiff vs. Norfolk Southern
Case No. 20-L-56
Rosenfeld Deposition 8-3-2022, Trial 1-10-2023

In Court of Common Pleas, Hamilton County Ohio
Joe Briggins Plaintiff vs. CSX
Case No. A2004464
Rosenfeld Deposition 6-17-2022

In the Superior Court of the State of California, County of Kern
George LaFazia vs. BNSF Railway Company.
Case No. BCV-19-103087
Rosenfeld Deposition 5-17-2022

In the Circuit Court of Cook County Illinois
Bobby Earles vs. Penn Central et. al.
Case No. 2020-L-000550
Rosenfeld Deposition 4-16-2022

In United States District Court Easter District of Florida
Albert Hartman Plaintiff vs. Illinois Central
Case No. 2:20-cv-1633
Rosenfeld Deposition 4-4-2022

In the Circuit Court of the 4th Judicial Circuit, in and For Duval County, Florida
Barbara Steele vs. CSX Transportation
Case No.16-219-Ca-008796
Rosenfeld Deposition 3-15-2022

In United States District Court Easter District of New York
Romano et al. vs. Northrup Grumman Corporation
Case No. 16-cv-5760
Rosenfeld Deposition 3-10-2022

In the Circuit Court of Cook County Illinois
Linda Benjamin vs. Illinois Central
Case No. No. 2019 L 007599
Rosenfeld Deposition 1-26-2022

In the Circuit Court of Cook County Illinois
Donald Smith vs. Illinois Central
Case No. No. 2019 L 003426
Rosenfeld Deposition 1-24-2022

In the Circuit Court of Cook County Illinois
Jan Holeman vs. BNSF
Case No. 2019 L 000675
Rosenfeld Deposition 1-18-2022

In the State Court of Bibb County State of Georgia
Dwayne B. Garrett vs. Norfolk Southern
Case No. 20-SCCV-091232
Rosenfeld Deposition 11-10-2021

In the Circuit Court of Cook County Illinois
Joseph Ruepke vs. BNSF
Case No. 2019 L 007730
Rosenfeld Deposition 11-5-2021

In the United States District Court For the District of Nebraska
Steven Gillett vs. BNSF
Case No. 4:20-cv-03120
Rosenfeld Deposition 10-28-2021

In the Montana Thirteenth District Court of Yellowstone County
James Eadus vs. Soo Line Railroad and BNSF
Case No. DV 19-1056
Rosenfeld Deposition 10-21-2021

In the Circuit Court Of The Twentieth Judicial Circuit, St Clair County, Illinois
Martha Custer et al. vs Cerro Flow Products, Inc.
Case No. 0i9-L-2295
Rosenfeld Deposition 5-14-2021
Trial October 8-4-2021

In the Circuit Court of Cook County Illinois
Joseph Rafferty vs. Consolidated Rail Corporation and National Railroad Passenger Corporation d/b/a AMTRAK,
Case No. 18-L-6845
Rosenfeld Deposition 6-28-2021

In the United States District Court For the Northern District of Illinois
Theresa Romcoe vs. Northeast Illinois Regional Commuter Railroad Corporation d/b/a METRA Rail
Case No. 17-cv-8517
Rosenfeld Deposition 5-25-2021

In the Superior Court of the State of Arizona In and For the Cunty of Maricopa
Mary Tryon et al. vs. The City of Pheonix v. Cox Cactus Farm, L.L.C., Utah Shelter Systems, Inc.
Case No. CV20127-094749

Rosenfeld Deposition 5-7-2021

In the United States District Court for the Eastern District of Texas Beaumont Division
Robinson, Jeremy et al vs. CNA Insurance Company et al.
Case No. 1:17-cv-000508
Rosenfeld Deposition 3-25-2021

In the Superior Court of the State of California, County of San Bernardino
Gary Garner, Personal Representative for the Estate of Melvin Garner vs. BNSF Railway Company.
Case No. 1720288
Rosenfeld Deposition 2-23-2021

In the Superior Court of the State of California, County of Los Angeles, Spring Street Courthouse
Benny M Rodriguez vs. Union Pacific Railroad, A Corporation, et al.
Case No. 18STCV01162
Rosenfeld Deposition 12-23-2020

In the Circuit Court of Jackson County, Missouri
Karen Cornwell, Plaintiff, vs. Marathon Petroleum, LP, Defendant.
Case No. 1716-CV10006
Rosenfeld Deposition 8-30-2019

In the United States District Court For The District of New Jersey
Duarte et al, Plaintiffs, vs. United States Metals Refining Company et. al. Defendant.
Case No. 2:17-cv-01624-ES-SCM
Rosenfeld Deposition 6-7-2019

In the United States District Court of Southern District of Texas Galveston Division
M/T Carla Maersk vs. Conti 168., Schiffahrts-GMBH & Co. Bulker KG MS "Conti Perdido" Defendant.
Case No. 3:15-CV-00106 consolidated with 3:15-CV-00237
Rosenfeld Deposition 5-9-2019

In The Superior Court of the State of California In And For The County Of Los Angeles – Santa Monica
Carole-Taddeo-Bates et al., vs. Ifran Khan et al., Defendants
Case No. BC615636
Rosenfeld Deposition 1-26-2019

In The Superior Court of the State of California In And For The County Of Los Angeles – Santa Monica
The San Gabriel Valley Council of Governments et al. vs El Adobe Apts. Inc. et al., Defendants
Case No. BC646857
Rosenfeld Deposition 10-6-2018; Trial 3-7-19

In United States District Court For The District of Colorado
Bells et al. Plaintiffs vs. The 3M Company et al., Defendants
Case No. 1:16-cv-02531-RBJ
Rosenfeld Deposition 3-15-2018 and 4-3-2018

In The District Court Of Regan County, Texas, 112th Judicial District
Phillip Bales et al., Plaintiff vs. Dow Agrosciences, LLC, et al., Defendants
Cause No. 1923
Rosenfeld Deposition 11-17-2017

In The Superior Court of the State of California In And For The County Of Contra Costa
Simons et al., Plaintifs vs. Chevron Corporation, et al., Defendants
Cause No. C12-01481
Rosenfeld Deposition 11-20-2017

In The Circuit Court Of The Twentieth Judicial Circuit, St Clair County, Illinois
Martha Custer et al., Plaintiff vs. Cerro Flow Products, Inc., Defendants
Case No.: No. 0i9-L-2295
Rosenfeld Deposition 8-23-2017

In United States District Court For The Southern District of Mississippi
Guy Manuel vs. The BP Exploration et al., Defendants
Case No. 1:19-cv-00315-RHW
Rosenfeld Deposition 4-22-2020

In The Superior Court of the State of California, For The County of Los Angeles
Warrn Gilbert and Penny Gilber, Plaintiff vs. BMW of North America LLC
Case No. LC102019 (c/w BC582154)
Rosenfeld Deposition 8-16-2017, Trail 8-28-2018

In the Northern District Court of Mississippi, Greenville Division
Brenda J. Cooper, et al., Plaintiffs, vs. Meritor Inc., et al., Defendants
Case No. 4:16-cv-52-DMB-JVM
Rosenfeld Deposition July 2017

In The Superior Court of the State of Washington, County of Snohomish
Michael Davis and Julie Davis et al., Plaintiff vs. Cedar Grove Composting Inc., Defendants
Case No. 13-2-03987-5
Rosenfeld Deposition, February 2017
Trial March 2017

In The Superior Court of the State of California, County of Alameda
Charles Spain., Plaintiff vs. Thermo Fisher Scientific, et al., Defendants
Case No. RG14711115
Rosenfeld Deposition September 2015

In The Iowa District Court In And For Poweshiek County
Russell D. Winburn, et al., Plaintiffs vs. Doug Hoksbergen, et al., Defendants
Case No. LALA002187
Rosenfeld Deposition August 2015

In The Circuit Court of Ohio County, West Virginia
Robert Andrews, et al. v. Antero, et al.
Civil Action No. 14-C-30000
Rosenfeld Deposition June 2015

In The Iowa District Court for Muscatine County
Laurie Freeman et. al. Plaintiffs vs. Grain Processing Corporation, Defendant
Case No. 4980
Rosenfeld Deposition May 2015

In the Circuit Court of the 17th Judicial Circuit, in and For Broward County, Florida
Walter Hinton, et. al. Plaintiff, vs. City of Fort Lauderdale, Florida, a Municipality, Defendant.
Case No. CACE07030358 (26)
Rosenfeld Deposition December 2014

In the County Court of Dallas County Texas
Lisa Parr et al, Plaintiff, vs. Aruba et al, Defendant.
Case No. cc-11-01650-E
Rosenfeld Deposition: March and September 2013

Rosenfeld Trial April 2014

In the Court of Common Pleas of Tuscarawas County Ohio
John Michael Abicht, et al., Plaintiffs, vs. Republic Services, Inc., et al., Defendants
Case No. 2008 CT 10 0741 (Cons. w/ 2009 CV 10 0987)
Rosenfeld Deposition October 2012

In the United States District Court for the Middle District of Alabama, Northern Division
James K. Benefield, et al., Plaintiffs, vs. International Paper Company, Defendant.
Civil Action No. 2:09-cv-232-WHA-TFM
Rosenfeld Deposition July 2010, June 2011

In the Circuit Court of Jefferson County Alabama
Jaeanette Moss Anthony, et al., Plaintiffs, vs. Drummond Company Inc., et al., Defendants
Civil Action No. CV 2008-2076
Rosenfeld Deposition September 2010

In the United States District Court, Western District Lafayette Division
Ackle et al., Plaintiffs, vs. Citgo Petroleum Corporation, et al., Defendants.
Case No. 2:07CV1052
Rosenfeld Deposition July 2009