SWANA
APPLIED RESEARCH FOUNDATION

Executive Summary
Prepared for:
SWANA Applied Research Foundation
Disposal Group Subscribers

PFAS MANAGEMENT AND TREATMENT OPTIONS FOR LANDFILL LEACHATE

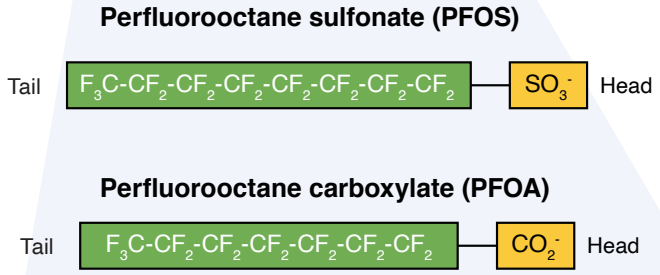
This report provides solid waste landfill managers with up-to-date information and guidance on PFAS management and treatment options for landfill leachate. The research topic was submitted by SCS Engineers and approved for selection by the SWANA Applied Research Foundation's (ARF) FY2020 Disposal Group. The topic was described as follows:

> *"Summarize the current research relative to effective pre-treatment or full-treatment systems to handle PFAS in landfill leachate. Key areas of interest would be a summary of various pre-treatment requirements for different types of municipal wastewater treatment plants. Variations by state would be helpful. Obviously, this may vary depending on the size of the plant and the contribution of flow and contaminant loading from the leachate. The distinction between pre-treatment and full-treatment would be important, especially since most landfill operations do not have experienced wastewater treatment operators, so the simpler the better for municipally-run operations."*

This report was prepared by SWANA ARF staff with input and guidance provided by ARF Disposal Group subscribers. 16 organizations subscribed to the ARF Disposal Group in FY2021, each of which made a funding commitment to support collective applied research on landfill disposal of non-hazardous municipal solid waste.[1]

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that have been used in industrial processes and consumer products throughout the world since the 1950s. Due to their unique capabilities to repel both water and oil, PFAS are used as fluorinated surfactants in numerous applications including fire-fighting foams, paints, household/kitchenware items, product packaging, and fabrics. PFAS do not occur naturally, are widespread in the environment, and are found in humans and wildlife all over the world. Some PFAS do not break down easily in the environment. On average, PFAS can remain in the human body between two and nine years.

Within the group of chemicals commonly referred to as PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) have become chemicals of emerging concern to the public's health. Of the thousands of PFAS compounds, these two types have been the most widely studied.



The Chemical Structure of PFOS and PFOA. SOURCE: ITRC. Naming Conventions and Physical and Chemical Properties of Per- and Polyfluoroalkyl Substances (PFAS). *https://pfas-1.itrcweb.org/fact_sheets_page/PFAS_Fact_Sheet_Naming_Conventions_April2020.pdf.*

[1] *The subscribing members of the ARF's Disposal Group include: New River Resource Authority, VA; Solid Waste Authority of Palm Beach County, FL; Solid Waste Disposal Authority of Huntsville, AL; Chester County Solid Waste Authority, PA; Delaware Solid Waste Authority, DE; Denton, TX; SWANA Iowa Chapter, IA; Mecklenburg County, NC; SWANA New Jersey Chapter; Prince William County, VA; SCS Engineers; Solid Waste Authority of Central Ohio; Solid Waste Disposal Authority of the City of Huntsville, AL; Tetra Tech; Tucson, AZ; and Winston-Salem/ Forsyth County, NC.*

The following findings and conclusions are presented and discussed in the report:

- The mean PFAS concentrations measured in leachate from 18 US landfills in a national study ranged from 9,400–11,200 parts-per-trillion (ppt). In comparison, the health advisory level issued by the US EPA for drinking water is 70 ppt.
- The mass of measured PFAS contributed by US landfill leachate to wastewater treatment plants was estimated to be between 563 and 638 kg for 2013. In comparison, primary manufacturers reported manufacturing (including importing) about 25,600 metric tons (25,600,000 kg) of PFAS at 38 sites in 2015.
- MSW landfills and municipal wastewater treatment plants (WWTPs) often have a symbiotic relationship with landfilling biosolids. Landfill leachate can be treated either on-site at a leachate treatment facility constructed at the landfill, or off-site at a WWTP. The most prevalent off-site management approach is to send leachate to a municipal WWTP where it is mixed with wastewater and treated. In return, landfills are often used to dispose of dewatered biosolids that are generated as a byproduct of wastewater treatment. Unfortunately, WWTPs do not remove PFAS through their treatment process, so any PFAS they receive essentially passes through their system to their effluent streams.
- A recent study conducted in Michigan found leachate in general contributes a relatively minor amount of PFOA and PFOS processed in WWTPs, due to the relatively small leachate volumes treated by the WWTPs.
- The chemical nature of PFAS compounds and their very low concentrations in leachate, coupled with the complex chemical composition of leachate, makes selective treatment for PFAS removal from landfill leachate before its discharge to WWTPs technically infeasible.
- Granular activated carbon (GAC) is a commercially-proven option for leachate PFAS removal, following biological treatment of leachate through a membrane bioreactor (MBR) or similar conventional leachate treatment system. Ion exchange (IX) is likely to work in this capacity as well, but has not yet been demonstrated to do so.
- Reverse osmosis (RO) is a commercially-proven process for PFAS leachate treatment that does not require leachate pretreatment through a membrane bioreactor or similar conventional wastewater treatment process. RO appears to provide a PFAS leachate treatment option that requires less wastewater process knowledge and operator involvement than some other technologies.
- When PFAS residuals from leachate treatment are managed in the landfill, the landfill effectively becomes a terminal sequestration point for PFAS associated with disposal of PFAS-containing waste. This public benefit should be acknowledged by society and reflected both economically, and through the permitting process.

The full report, *PFAS Management and Treatment Options for Landfill Leachate*, is currently only available to SWANA ARF subscribers. SWANA members receive free access to ARF industry reports one year after publication.[2]

[2] *For more information on the SWANA Applied Research Foundation, contact Jeremy K. O'Brien, P.E., Director of Applied Research at SWANA at jobrien@swana.org, or 704-906-7269.*

SWANA APPLIED RESEARCH FOUNDATION

For more information visit SWANA.org