

**CHAPTER 15 TECHNICAL NOTE #7:  
FOAMS AS ALTERNATIVE DAILY COVERS  
FOR UNLINED CLASS III LANDFILLS**

July 22, 1993

Due to increasing demands for landfill space, landfill owners and operators are searching for new methodologies to conserve landfill space. In California as well as nationally and internationally, several manufacturers are actively promoting their patented foam formulations as alternatives to soil as daily cover materials on landfills. The advantage of foams is that they collapse, thus conserving available landfill volume. This Technical Note is intended to provide information on potential water quality impacts from three of these foams.

**BACKGROUND:** The California Integrated Waste Management Board (**CIWMB**) issues permits to landfill owner/operators to conduct demonstration projects to establish the suitability of proposed alternative daily covers (**ADC's**). The demonstration is permitted on a site-specific basis and typically lasts for one year. Other ADC demonstration projects have included shredded greenwaste, geotextiles, and treated sewage. Regional Water Quality Control Board approval is required before demonstration projects can proceed, as is the approval of other relevant agencies. Several foam manufacturers have approached landfill owner/operators regarding demonstration projects on unlined, Class III landfills. In April, 1991, staff of the San Diego Regional Water Quality Control Board requested assistance from State Water Resources Control Board staff to evaluate potential water quality impacts from the proposed use of two foams, Sanifoam™ and Terrafoam™, in three unlined San Diego County landfills.

**GENERAL CONSIDERATIONS:** Several factors should be considered when evaluating proposed ADC demonstration projects. First, any material that is proposed as an ADC for a particular Waste Management Unit (**WMU**)

must be acceptable as waste to that particular WMU, because it will be incorporated into the landfill, just as the waste is. The decision to permit the demonstration project is essentially, therefore, one of waste evaluation.

Second, it is important to exercise caution before issuing approval for proposed demonstration projects, because of the difficulty of monitoring for water quality impacts. The difficulty arises from two factors: (1) the problem of correctly attributing leachate constituents to a particular source (i.e., to waste or to ADC material), and (2) the inadequate time frame (one year is too short a period for water quality impacts to become apparent).

Additionally, in the case of unlined landfills, their lack of a leachate collection and removal system (**LCRS**) means that the first line of defense against water quality impacts is lacking, and there is no protection of beneficial uses of the waters of the state from any potential releases from the ADC.

Finally, it is important to recognize the considerable impact that Regional Water Quality Control Board decisions have, even those that are site-specific, and of a limited duration.

Manufacturers are quick to claim "California approval" and to publicize this in their promotional literature. Furthermore, this "approval" carries considerable weight, nationally and internationally.

**SANIFOAM™X**  
**DISCUSSION AND**  
**CONCLUSIONS:**

**Sanifoam™** is manufactured by **3M Industrial Chemical Products Division** of St. Paul Minnesota. It is a polymerized foam material, consisting largely of urea-formaldehyde resin. This foam was

widely used in the United States and the rest of the world as building insulation (Urea-formaldehyde foam insulation or "**UFFI**"). In 1982, the U.S. Consumer Product Safety Commission (**CPSC**) banned the use of UFFI in residences and schools...[because] UFFI represented an unreasonable risk of injury to consumers from irritation, sensitization, and cancer because of formaldehyde gas emissions" (California Air Resources Board, 1989, p. C-6). These adverse effects on health became known as the "sick building syndrome". This ban was overturned in court in 1983 on procedural grounds. "However, manufacturers generally ceased production of UFFI, so CPSC took no further regulatory action" (*Ibid.*). The California Energy Commission also banned UFFI's (*Ibid.*).

The manufacturer is now promoting urea-formaldehyde foam (**UFF**) for use on landfills as an ADC. **Sanifoam**<sup>TM</sup> is shipped to the site in two separate phases: the urea-formaldehyde resin and the foaming agent. When the two are mixed, the material polymerizes to form the foam. The foam is sprayed on the working face by machine, and immediately becomes rigid. One and one-half to two inches of **Sanifoam**<sup>TM</sup> are used in order to meet daily cover performance criteria.

State Water Board staff's primary concern regarding **Sanifoam**<sup>TM</sup> is the potential for degradation of water quality from the presence of formaldehyde in the leachate. Formaldehyde is an organic chemical with both a high solubility in water and a low boiling point. It is toxic [Oral LD<sub>50</sub>(women)=36 mg/kg] (Sax, 1979, p. 694) and is a USEPA suspected carcinogen (Category B-1 inhalation) and a Prop 65 listed carcinogen (Marshack, 1991).

There are three fundamental problems

associated with obtaining accurate measurements of formaldehyde in leachate. First, formaldehyde "has a high affinity for water...{and} is difficult to extract and concentrate using methods traditionally applied to more hydrophobic chemical species" (Havlicek et al, 1984, p. 26). Many of the published analytical methods which are well-suited for the analysis of formaldehyde in air are not suitable for the analysis of water, because of interferences, especially from phenol, lignocellulostic components, and certain degradation products of urea (Havlicek, et al, 1984, p. 26). Accurate results can be obtained when the solution is derivatized using 2,4 dinitrophenylhydrazones (**DNPH**) and analyzed using a High Performance Liquid Chromatograph (**HPLC**) (Bicking and Cooke, 1987, p. 10). Second, because formaldehyde is highly volatile, great care must be taken in sampling, storage, and analysis to prevent outgassing. Zero headspace samplers and analysis vessels are required, and samples should be refrigerated at 4° C. Third, any microbes present in the leachate may cause formaldehyde concentrations to decrease rapidly (Bicking and Cooke, 1987, p. 11), and emulsion formation in the stored samples (due to self-polymerization) is also a problem (Bicking and Cooke, 1987). Because of these three problems, it is more likely for concentrations of formaldehyde to be underestimated than are concentrations of other analytes.

In our analysis of **Sanifoam™**, State Water Board staff considered all available information, notably research results from laboratory testing of UFF at the Georgia Institute of Technology (Graven and Pohland, 1987). The research was funded by Sanifoam, Inc., the foam installation company. The data showed that leachate which passed

through **Sanifoam**<sup>™</sup> and simulated municipal solid waste (**MSW**) contained formaldehyde in excess of 28,000 ppb (see Figure 1). As stated above, the State Action Level for formaldehyde is 30 ppb. Furthermore, a supplementary study showed that the UFF accounted for an increase of 700% in formaldehyde yielded to leachate (96 mg, vs. 12 mg in the cell without UFF: the 12 mg was presumably yielded by the MSW in the cell) (Graven and Pohland, 1987, p. 51) (see Figure 2). A Toxic Leaching Characteristics Procedure (**TCLP**) performed on **Sanifoam**<sup>™</sup> at the request of State Water Board staff confirmed the research findings, as 21,000 ppb of formaldehyde were measured in the leachate.

The manufacturer's and the installation company's contentions that the formaldehyde is biodegradable are largely irrelevant, as California landfills are constructed and operated to be relatively dry. Presumably, only isolated pockets of active biological processes exist within the landfills, and thus biodegradation is not a reliable method of reducing formaldehyde concentrations.

Because **Sanifoam**<sup>™</sup> yields excessively high concentrations of formaldehyde to leachate, State Water Board staff recommended against using **Sanifoam**<sup>™</sup> in unlined landfills in a November 18, 1991 memorandum from Elizabeth Babcock to Robert Morris. The San Diego Regional Water Board staff concurred in a December 30, 1991 letter from Arthur L. Coe to Mr. William A Worrell of the County of San Diego. The foam installation company has made direct and indirect informal appeals (see attached March 10, April 24, and July 20, 1992 letters), however, CAL-EPA has backed the State Water Board staff position (see attached June 25, 1992 letter from

James Strock). Furthermore, the Chairman of the State Water Board has advised the foam installation company to make any future appeals according to established procedures (see attached August 20, 1992 letter from W. Don Maughan).

State Water Board staff has not analyzed potential water quality impacts from the use of **Sanifoam**<sup>TM</sup> on lined landfills with LCRS's. **Sanifoam**<sup>TM</sup> has been used for eight years in the lined portion of the Bradley Avenue landfill in Los Angeles County, following a two-month demonstration project in 1984. Analysis of a sample of the landfill's leachate in 1992 did not reveal the presence of formaldehyde; this is a somewhat surprising finding, because some formaldehyde would be expected to be present in leachate from municipal solid waste landfills. However, as discussed above, sampling and analytical errors could have resulted in false negatives. Additionally, at Bradley Ave. landfill, the leachate is collected in vaults with adequate headspace to allow formaldehyde to outgas, so that formaldehyde could have outgassed even before the sample was taken.

Leachate samples from lined landfills with LCRS's in other states which are using **Sanifoam**<sup>TM</sup> as daily cover material do contain large amounts of formaldehyde. In Cape May, N.J., leachate formaldehyde concentrations ranged from 150 to 530 ppb a few months after **Sanifoam**<sup>TM</sup> use began (Environmental and Energy Consultants, Inc., December, 1990). Samples were observed to be outgassing and were allowed to degas before the container was sealed; this likely resulted in underestimation of formaldehyde concentrations. In Outagamie County, Wisconsin after several years of **Sanifoam**<sup>TM</sup> use, formaldehyde concentrations in leachate

ranged from 6100 to 16,500 ppb. These concentrations far exceed the California State Action Level of 30 ppb.

Unless stringent QA/QC plans are vigilantly enforced, concentrations of formaldehyde are easily underestimated.

These concentrations likely exceed the State Action Level. The leachate may then escape appropriate treatment to remove the formaldehyde. Accordingly, Regional Water Board staff are urged to be conservative in considering any proposals to use **Sanifoam**<sup>TM</sup> as daily cover material, even in lined facilities. It may be relevant to recall that any material that is proposed as an ADC must be acceptable to that WMU. A recent telephone inquiry to State Water Board staff indicates that the manufacturer is actively promoting the use of **Sanifoam**<sup>TM</sup> in California on at least one lined landfill.

In addition, any ADC demonstration projects require approval from the local Air Quality Management District, and formaldehyde outgassing may be an issue in areas with compromised air quality. Formaldehyde was declared a Toxic Air Contaminant in March 1992 by the California Air Resources Board (**ARB**). Furthermore, formaldehyde is a significant component that reacts to form ozone; ozone is a major component of smog. New "reactivity regulations" are forthcoming from the ARB that may further limit formaldehyde emissions.

**TERRAFOAM<sup>TM</sup>X**  
**DISCUSSION AND**  
**CONCLUSIONS:**

**Terrafoam**<sup>TM</sup> is manufactured by **Chubb Environmental Security, Inc.**, of Exton, Pennsylvania. It is an aqueous foam made predominantly of protein hydrolysate. **Terrafoam**<sup>TM</sup> is shipped as a concentrate to the site, where it is diluted with 97 parts of water to 3 parts of **Terrafoam**<sup>TM</sup> concentrate. Then compressed air is added, and the foam is

applied by machine to the working face. It is soft in consistency, and six inches are normally used in order to meet daily cover performance criteria.

State Water Board staff have two primary concerns relative to **Terrafoam**<sup>TM</sup>: (1) the high water content of the foam, and (2) the presence of ammonium thiocyanate and thiourea in the foam.

The high water content of **Terrafoam**<sup>TM</sup> concerns State Water Board staff, because of the potential for generating additional leachate. According to Chapter 15 §2520(d)(3), waste containing less than 50 percent solids may not be discharged to Class III landfills unless "...the discharger can demonstrate that such discharge will not exceed the moisture-holding capacity of the landfill...". Because **Terrafoam**<sup>TM</sup> is over 97% water (by weight) when emplaced, it clearly falls under the jurisdiction of §2520(d)(3). Accordingly, Regional Water Boards are encouraged to require the discharger to demonstrate that using six inches of **Terrafoam**<sup>TM</sup> daily will not cause the moisture-holding capacity of the landfill to be exceeded. New USEPA SubTitle D regulations (40 CFR Part 258), which will be implemented in October, 1993, require that MSW landfills exclude bulk or non-containerized liquid wastes, as determined by Method 9095, the "Paint Filter Liquids Test."

The second concern regarding the two chemical constituents remains unresolved. Manufacturer contentions that the constituents are biodegradable are largely irrelevant to California landfills, which are relatively dry, with a minimum of biodegradation occurring. The ammonium thiocyanate (NH<sub>4</sub>SCN) is present in the concentrate at approximately 20,000 ppm, so that the



foam when applied contains 700 to 800 ppm (700,000 to 800,000 ppb) of this constituent. State Water Board staff are concerned about ammonium thiocyanate because of its potential to degrade into cyanide in the complex chemical environment of landfills, and then degrade water quality.

The thiourea  $[(\text{NH}_2)_2\text{CS}]$  is present because it is an isomer of and an impurity in ammonium thiocyanate. The thiourea is of concern because it is an Occupational Health and Safety Administration (OSHA) and a Prop 65 listed carcinogen. No data are currently available on the fate and transport of these constituents in landfill environments. State Water Board staff will request testing, including the TCLP, of **Terrafoam™** to address fate and transport concerns.

**OTHER FOAMSX  
DISCUSSION AND  
CONCLUSIONS:**

State Water Board staff has briefly analyzed **Rusmar AC-645™** foam, at the request of the San Diego Regional Water Board. **Rusmar ACB645™** is an aqueous foam manufactured by Rusmar, Inc., of West Chester, Pennsylvania. According to the manufacturer, one part of the foam concentrate is diluted with six parts of water, before application. Therefore, like **Terrafoam™**, **Rusmar AC-645™** is less than 50% solids and should be subject to Chapter 15 2520(d)(3). Similarly, USEPA Subtitle D exclusion of liquid wastes should be applied.

TCLP leachate analysis data available to State Water Board staff indicate that concentrations of metals do not exceed water quality goals. The TCLP leachate analysis for organics reported concentrations for four common solvents, none of which exceeded water quality goals.

Attachments

## REFERENCES

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