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June 11, 2003

To: NFDA Executive Board
NFDA Policy Board
State Association Executives

Fr: Christine Pepper
Chief Executive Officer

Re: NFDA Septic Study – "Investigation of the Removal of Formaldehyde and Phenol by Funeral Home Septic Systems:

I am pleased to share the definitive study on funeral home discharge into septic systems that NFDA commissioned two years ago is now a reality. In addition to the Executive Summary, I'm including NFDA's recommended Environmental Best Management Practices, for your information and use.

In sum, the scientific documentation substantiates our position that funeral home wastewater discharges to septic systems and sewer systems do not jeopardize the safety of drinking water sources or public health. NFDA committed substantial resources to this project and we hope you and members, as well as regulators, find value in using this new tool.

The septic study was designed to be generally applicable to funeral homes on septic systems throughout the United States. The complete document with attachments (the White Paper and two technical appendices) is available from NFDA for \$125.00. Each state association will receive one complimentary copy upon request.

I am interested in your comments and reaction to this Executive Summary, especially with regard to its value to you in your business operations and in your dealings with regulators. NFDA is looking forward to sharing additional environmental education and training later this year related to how best to use results from the septic study and environmental best practices that have been developed.

Enclosures



National Funeral Directors Association

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National Funeral Directors Association

Investigation of the Removal of Formaldehyde and Phenol by Funeral Home Septic Systems

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Preface

by the National Funeral Directors Association

The United States Environmental Protection Agency ("USEPA") has recognized that onsite wastewater systems are "potentially viable, low-cost, long-term, decentralized approaches to wastewater treatment if they are planned, designed, installed, operated and maintained properly." (USEPA, 1997) The study that is the subject of this paper – "An Investigation of the Treatment of Formaldehyde and Phenol by Funeral Home Septic Systems" – confirms the viability of onsite wastewater systems for funeral home wastewater. This paper describes the removal of formaldehyde and phenol by such septic systems.

Funeral homes located in small, particularly rural, communities often lack access to municipal wastewater treatment systems and instead, use onsite wastewater systems, called septic systems, to treat the wastewater that the funeral homes produce. The National Funeral Directors Association ("NFDA")¹ has conducted a study of the fate of funeral home

¹ The National Funeral Directors Association is headquartered in Brookfield, Wisconsin, with an office in Washington, D.C. It is the world's oldest and largest nationwide funeral service association, serving about 13,500 members. To learn more about NFDA, visit its Website at www.nfda.org. This study is one of several that NFDA has conducted in the environmental area in order to provide its members, regulators and members of the public with the information and skills they need to ensure compliance with the environmental laws and to protect the public health and environment of the communities in which funeral homes are located. NFDA regularly provides training to its members on various topics, including environmental compliance.

wastewater discharged to septic systems in order to confirm that such conventional systems can properly handle the wastewater without risk to human health or to the environment. Aware of the priorities of USEPA² and state environmental agencies to protect drinking water sources and to improve the performance of onsite wastewater treatment systems, NFDA began this study of funeral home septic systems to provide information to both regulators and funeral directors about the systems' capabilities and to evaluate how best to operate and maintain them to achieve established standards for environmental protection.

NFDA retained Dr. Judy LaKind, a leading health and environmental scientist³, and Dr. Edward Bouwer, a professor of Environmental Engineering at the Johns Hopkins University⁴, to design and conduct the study of the efficacy of funeral home septic systems. Although septic systems have been extensively studied, Drs. LaKind and Bouwer reported that there are no studies in the published literature that examine the performance of funeral home septic systems, including the biodegradation

² NFDA's study coincided with USEPA deadlines under the Safe Drinking Water Act, Underground Injection Control Program ("UIC"), requiring it to examine the need for additional regulation of septic systems and other underground injection control facilities. In September, 1999, USEPA completed a comprehensive study of shallow injection wells. Overall, USEPA found that the likelihood of contamination from these wells appeared low when compared to their usage. In regulations issued in December 1999, USEPA banned the construction of new large capacity cesspools (defined as cesspools that accept solely sanitary waste and have the capacity to serve 20 or more persons daily) and required the closure of such existing cesspools by April 5, 2005. In June, 2002, USEPA announced its final determination not to add further federal requirements because existing authorities were considered adequate to prevent endangerment of drinking water sources. 67 Fed. Reg. 39583 (June 7, 2002).

³ Dr. LaKind is President of LaKind Associates, LLC, and an adjunct associate professor at the Pennsylvania State College of Medicine. Her research includes risk assessment and management, state-of-the-science reviews, and scientific and technical analyses of environmental issues.

⁴ Dr. Bouwer is responsible for teaching courses in environmental engineering, engineering microbiology, biological processes, biofilms and hazardous waste management at the Johns Hopkins University. His research covers biotransformation of organic contaminants, groundwater contamination, biological processes design in wastewater, industrial and drinking water treatment, and transport and fate of microorganisms in porous media.

of formaldehyde and phenol in such systems. Their report, which is contained in a comprehensive white paper and two extensive, technical appendices, confirms, through a combination of modeling and field sampling, that septic systems are capable of treating wastewater from funeral homes by biodegradation and other processes at rates that will result in little or no impact to groundwater. The study determined that the length of time that the wastewater resides in the septic tank and leach field is a critical factor in assuring proper treatment of the wastewater.

EXECUTIVE SUMMARY

by the National Funeral Directors Association

NFDA's Previous Environmental Studies. Since the early 1990's, NFDA has sponsored research on funeral home wastewater. Its initial study was an analysis of the composition and fate of funeral home wastewater when discharged to municipal treatment works. At that time, there was no information available about the constituents of the wastewater, its volume, or the ability of the treatment works to handle the wastewater.

NFDA's first study, *The Funeral Home Wastestream Audit Report (Killam Associates, 1995)*, included an extensive review of the products that funeral directors use by examining the material safety data sheets for those products and the wastewater produced by sampling the wastewater. The Wastestream Audit determined that a funeral home's wastewater would have virtually no impact when discharged to a local treatment system. That is because the volume of the wastewater is small when compared to the volume of wastewater that the treatment works receives and the primary chemical constituents of the wastewater, formaldehyde

and phenol, can be expected to undergo extensive treatment by biodegradation in the sewers and treatment works.

NFDA next studied funeral home wastewater discharged to septic systems. The *Septic System Treatment of Funeral Home Wastewater (RSA, 1998)*, utilized the results of the Wastestream Audit, an extensive literature search, and the findings of an investigation conducted by the Sanitary Engineering Laboratory at the University of California at Berkeley to evaluate the treatment of funeral home wastewater in a septic system. The study concluded that septic systems are capable of treating funeral home wastewater to low concentrations that ordinarily will not endanger drinking water sources.

Overview of Funeral Homes Discharging to Septic Systems. Funeral homes that discharge to septic systems are typically smaller in size than other funeral homes, when measured by the number of embalmings conducted. NFDA has determined that funeral homes using septic systems perform an embalming every 7 to 35 days, amounting to between 10 and 52 embalmings annually, as compared to the average 135 embalmings conducted annually by funeral homes that discharge to treatment works. NFDA has estimated that somewhat more than twenty percent of the 22,000 funeral homes in the United States utilize septic systems. Funeral homes using septic systems tend to be located in non-urban settings (population 1,000 to 5,000) and serve a smaller population than funeral homes discharging to treatment works, which are located in metropolitan and other more populated areas.

Characteristics and Quantity of Funeral Home Wastewater. A large group of products is available to funeral directors today to assure that an embalming produces desired results. As described in the Wastestream Audit, these products, such as arterial fluids and cavity fluids, co-injection

National Funeral Directors Association
Funeral Home Septic System Biodegradation Study

fluids, non-arterial preservative, supplementary products, cosmetics, cleansers (sealants, antiseptics, disinfectants, deodorizers), and other miscellaneous products (tissue builders, feature builders, and the like) serve a variety of purposes. Funeral directors are trained to employ the proper products in the proper amounts and to meet the high standards of the funeral profession for correct chemical handling and disposal.

The Wastestream Audit documented that funeral home wastewater contains water, residues of the preservative products that funeral directors use in embalming, bodily fluids, and sanitary wastewater from other activities that take place at the funeral home and possibly from a private residence in the funeral home. Virtually all embalming products contain formaldehyde, which continues to be the primary and most common preservative compound used in embalming. As expected, formaldehyde was detected in all of the wastewater effluent samples collected in the Wastestream Audit sampling. Phenol also is a preservative in embalming products, primarily in cavity formulations. It is widely used as a disinfectant and antiseptic and considered one of the most effective germicides. Phenol also is included in an array of household products commonly used at funeral homes, including cleansers and toilet disinfectants. Phenol was detected in all but one of the wastewater effluent samples collected in the Wastestream Audit sampling. The fate and transport of formaldehyde and phenol is the subject of this study of funeral home septic systems because these preservative and disinfectant compounds were detected in the funeral home wastewater that was sampled.

The formaldehyde and phenol detected in embalming wastewater do not make the wastewater a "hazardous waste" under the Resource

Conservation and Recovery Act ("RCRA")⁵, when the wastewater is disposed of. Embalming wastewater is not "hazardous", as some mistakenly think, because formaldehyde and phenol appear on the list of RCRA-regulated commercial chemical products (40 CFR 261.33).⁶ That is because a commercial chemical product, as defined under the RCRA regulations, does not include wastes that result from the intended use of a product. Thus, embalming fluid consisting of formaldehyde or phenol plus various inert ingredients, such as colorants and perfumes, would be a hazardous waste if discarded unused. However, if the fluid has been used in embalming, then its disposal would not constitute disposal of a hazardous waste because of the presence of formaldehyde or phenol.⁷

With the exception of residues of formaldehyde and phenol, sanitary wastewater from funeral homes should be very similar to conventional sanitary wastewater.⁸ The volume of wastewater ordinarily discharged

⁵ RCRA provides for the cradle to grave regulation of "hazardous wastes". (42 U.S.C. Sections 6901 to 6991i). The nature of a waste and whether it is "hazardous" is determined by process knowledge and/or testing by reference to the characteristics of the waste (40 CFR 261.21 (ignitability); 261.22 (corrosivity); 261.23 (reactivity); and 261.24 (toxicity characteristic) or whether the waste consists of a compound that appears on a particular list that EPA has established (40 CFR 261.31 (hazardous wastes from non-specific sources); 261.32 (hazardous wastes from specific sources); or 261.33 (discarded commercial chemical products).

⁶ Memorandum from Eileen Claussen, Director, Characterization and Assessment Division, Office of Solid Waste, to Paul Baltay, Director, State Programs Division, Office Drinking Water, "RCRA Input to Region IV Inquiry: UIC Well Inventory update", No. 9444.1985(07) (October 10, 1985), concerning embalming fluid.

⁷ At the time the Wastestream Audit was published, NFDA also issued recommended Environmental Best Management Practices, intended to assist funeral directors in achieving the standards of "environmental good citizens" to which they aspire. NFDA has continued to modify and to update the best practices as laws change and information available expands. NFDA's best practices recommend that funeral directors (i) know the composition of the products they use; (ii) avoid products that may result in the production of hazardous wastes; and (iii) caution against the commingling of embalming wastewater with wastes that could possibly be considered "hazardous".

⁸ The Wastestream Audit sampling detected miscellaneous organic constituents only in trace concentrations, less than 1 mg/l. EPA has acknowledged the similarity of sanitary wastewater from funeral homes and that of conventional sanitary wastewater. "The Class V Underground Injection Control Study, Volume 5, Large Capacity Septic Systems"

from a funeral home is small, on average 632 gallons daily, with an average of 120 gallons of that wastewater produced when an embalming is performed. Like residential wastewater, funeral home wastewater is likely to contain some amount of blood and bodily fluids. However, this should not pose a problem. The Centers for Disease Control has determined that wastewater containing blood may be safely discharged to septic tanks and that conventional on-site wastewater treatment will satisfactorily inactivate bloodborne pathogens. See "Draft Guideline for Environmental Infection Control in Healthcare Facilities, 2001", Centers for Disease Control and Prevention, Healthcare Infection Control Practices Advisory Committee at 1, 99, 166, 167 and accompanying footnotes (updated November 8, 2002). (This document may be accessed at www.cdc.gov/ncidod/hip/enviro/env_guide_draft.pdf.) CDC identified several factors that enhance the inactivation of bloodborne pathogens in wastewater disposal and treatment. These factors include dilution of the discharged materials with water and inactivation of pathogens due to exposure to cleaning chemicals, disinfectants, and other chemicals in the wastewater.

According to NFDA, the standard practice when an embalming the wastewater discharge only after bodily fluids have commingled with the embalming solution. This means that, as embalming proceeds but prior to wastewater discharge, the preservative and disinfecting compounds will become mixed with the bodily fluids and will principally disinfect the bodily fluids and the blood and their microbial contents prior to discharge.

The Funeral Home Septic System Biodegradation Study. In this study, Dr. LaKind and Dr. Bouwer build upon NFDA's prior studies with: (1) a model that explains the extent to which biodegradation in a septic system

US EPA, Office of Ground Water and Drinking Water, EPA/816-R-99-014e (Sept. 1999), p. 23.

will remove formaldehyde and phenol from funeral home wastewater entering the system; and (2) a field study that corroborates the model with actual data from a funeral home on a septic system. They designed the investigation so that its results are broadly applicable to funeral homes on septic systems throughout the United States, regardless of the size of the funeral home, its design, or its location. The model indicates that extensive and, in some cases, complete biodegradation of formaldehyde and phenol will take place in the septic tank and that formaldehyde and phenol remaining when the wastewater enters the septic leach field after tank treatment will ordinarily be completely treated in the leach field.

The Methodology for the Study. The septic study presents a model based upon the basics of biodegradation occurring in a typical septic system. ("The Funeral Home Septic Biodegradation Model") The model is conservative in that its exclusive focus is biodegradation. It does not consider dilution in the septic tank or the leach field or other physical processes that may reduce compound concentrations. Biodegradation, which is the breakdown of chemicals by microorganisms, is the primary process for their removal by septic systems. Processes that control biodegradation of organic matter in wastewater are well understood, which means that the model is based upon well-established biodegradation process fundamentals and common mathematical equations describing the rate of biodegradation. The model incorporates extensive information about the characteristics of the septic system in which treatment occurs. The mathematical expressions that the model employs for predicting biodegradation of formaldehyde and phenol are similar to those used in other models for biological waste treatment processes, such as trickling filters, packed-bed bioreactors, and conventional activated sludge

systems. A detailed explanation of the model equations and assumptions appears in Appendix A to the septic system study.⁹

Dr. LaKind and Dr. Bouwer determined that the extent of biodegradation of formaldehyde and phenol in the septic system tank and the leach field is based upon three key parameters: 1) detention time, which controls the time available for microorganisms to biodegrade the organic material; 2) the biodegradation rate constant, which determines the speed at which the microorganisms decompose the organic material; and 3) temperature, which directly influences the biodegradation rate constant. In order to quantify the extent of biodegradation, a range of values was selected for each of the parameters from the scientific literature on septic systems and on the biodegradation of formaldehyde and phenol. The values were chosen to resemble the various conditions experienced by funeral homes in different locations and with different seasons and different subsurface conditions. The range of parameters selected for model inputs is summarized in Table I in the white paper.

Detention Time. Values selected: 1 to 5 days in the septic tank and 25 to 500 days in the leach field.

Detention time in the septic tank is determined with regard to the daily volume of wastewater produced and the size of the tank. Septic system guidance documents do not prescribe specific detention times for septic

⁹ The model is based upon the following three key assumptions: 1) biodegradation is the exclusive mechanism for removing formaldehyde and phenol from the septic system and a first-order rate expression most closely describes the rate of biodegradation because, in this situation, compound concentrations are fairly low and biomass concentrations are fairly constant; 2) wastewater flow most closely resembles plug flow (as opposed to complete mix) in which the wastewater passes through the system in packets, in the same general sequence in which it enters the system; and 3) the septic tanks and the leach field residence times are distinct components of the septic system and require separate evaluation.

tanks, although US EPA has recommended a 24-hour detention time in the tank with maximum solids accumulation. A review of literature describing septic system designs and pilot studies indicates that the minimum detention time in a septic tank should be one day; a septic tank is likely to have an effective detention time between 1.5 and 2 days; and the detention time with low wastewater flows and large tank sizes is likely to range from 3 to 5 days.

Detention time in the leach field is more complicated. It is based upon providing adequate subsurface capacity and adequate setback distance from specified boundaries or receptors so that the distance available for the effluent to travel is sufficient to provide for the required treatment. Knowledge of the hydraulics of flow through soil and information about the leach field size are needed to estimate the range of residence times in the leach field. The hydraulic capacity of the subsurface is determined primarily by soil texture, that is, whether the soil is principally gravel, sand, loam, silt, or clay. Gravel and clay are unfavorable leach field soils because the former allows a too high percolation rate and a too short residence time and the latter allows only a limited percolation rate and an inadequate hydraulic capacity. The potential wastewater flow velocity can be estimated by combining information about the application rate and the percolation rate. Typical travel distances were determined to range from 50 to 100 feet. Coupling the average pore water velocity, which is a measure of the movement of water in soils suitable for leach fields, with the travel distance in the leach field results in a range of residence times in typical leach fields. Under actual conditions, dispersion during the flow and dilution from surrounding groundwater will result in lower concentrations of formaldehyde and phenol than those calculated with the model. The assumptions that were used to model leach field residence times make the model more conservative than actual conditions.

Biodegradation Rates for Formaldehyde and Phenol.

Values selected for formaldehyde: half-lives¹⁰ between 0.25 and 2.0 days in the septic tank and half-lives between 0.14 and 1.39 days⁻¹ days in the leach field.

Values selected for phenol: half-lives between 0.5 and 2.5 days in the septic tank and half-lives between 0.14 and 1.39 days⁻¹ in the leach field.

Both formaldehyde and phenol are considered “readily biodegradable” compounds and the pathways for their biodegradation are well understood. As with most organic compounds, the rate of their biodegradation depends upon a number of factors, including temperature, whether the system under consideration is aerobic or anaerobic, the concentration of the chemical, and whether the microorganisms are acclimated or accustomed to the presence of the compound. There is limited information about the rate of biodegradation of formaldehyde and phenol in septic systems and the behavior of formaldehyde and phenol in similar systems provided rate information from which inputs were selected for the model. Dr. Bouwer has extensive experience with biodegradation as a result of conducting biodegradation rate experiments and his hands-on experience guided the selection of rate information.

Temperature. Values selected: 10 to 25° Centigrade (“C”) for both the septic tank and the leach field.

Biodegradation rates are higher in warmer seasons and in warmer geographic locations and the temperature in the septic tank and in the leach field will affect the rate of biodegradation. Reported national wastewater temperature data indicate that there is an approximately 10° C difference in the high and low annual wastewater temperatures in typical

¹⁰ A half-life is the time needed for one-half of the compound to biodegrade.

climates for a given location in the United States. The temperature of the wastewater entering the septic tank is considered indicative of the temperature of the wastewater within the tank because the temperature of the entering wastewater will not usually change during the wastewater's short residence time in the septic tank. The temperature of the wastewater entering the leach field and the insulating quality of the subsurface will control the temperature of the wastewater in the leach field and the temperature of the wastewater entering the leach field is expected to be very close to the temperature of the incoming wastewater.

Conclusions of the Funeral Home Septic System Biodegradation

Study. The model designed for this investigation, the Funeral Home Septic Biodegradation Model, demonstrates that septic systems located at funeral homes throughout the United States are capable of complete removal of formaldehyde and phenol from wastewater discharges to septic systems. In some instances, complete removal of the formaldehyde and phenol will take place in the septic tank before the wastewater reaches the leach field. However, for the formaldehyde and phenol that is not biodegraded in the septic tank and is released to the leach field, the leach field is capable of essentially complete removal of the remaining formaldehyde and phenol from the wastewater. The model indicates that optimal conditions for complete biodegradation of formaldehyde and phenol in the septic system include warmer temperatures, more rapid biodegradation rates, and longer residence times.

Sampling and analysis conducted at a funeral home discharging wastewater to a septic system corroborated the conclusions of the Funeral Home Septic Biodegradation Model. The field study entailed sampling the funeral home's septic tank effluent to indicate the concentrations of formaldehyde and phenol exiting the tanks and the groundwater upgradient and downgradient of the septic system to

document the treatment provided by the septic system.: The funeral home, which has been in operation since 1991, conducts approximately 50–60 embalmings annually. Water quality measurements for pH, temperature, conductivity, redox, turbidity and dissolved oxygen were taken, in addition to the analyses for formaldehyde and phenol. EPA sampling methods and guidance were closely followed. Both formaldehyde and phenol were detected in the effluent in the septic tank in both rounds of sampling. Samples collected from locations adjacent to the leach field, which received the treated wastewater effluent from the septic tank, showed reductions in concentrations of formaldehyde and phenol consistent with the model.

The Funeral Home Septic Biodegradation Study demonstrates that funeral home septic systems are capable of effectively reducing the concentrations of formaldehyde and phenol in the wastewater to concentrations that will result in little or no impact to groundwater. Partial to complete biodegradation of formaldehyde and phenol will occur in the septic tank and whatever concentrations of formaldehyde and phenol enter the leach field will be removed by treatment in the leach field under a variety of conditions relating to temperature, residence time and rate.

National Funeral Directors Association
RECOMMENDED ENVIRONMENTAL BEST PRACTICES

1. Be familiar with and follow each federal, state and local environmental requirement that applies when embalming is performed.
2. Periodically re-evaluate the products used in the preparation of the remains and throughout the funeral home. Review and be familiar with the Material Safety Data Sheets for the products used and make every effort to limit the toxicity of chemicals used and the amount of waste produced. Use only the amount of chemicals needed to assure proper embalming. Substitute environmentally friendly products as they become available.
3. Assure that any onsite wastewater or septic or other system used for the disposal of embalming and sanitary fluids is properly sized, correctly operated and regularly maintained. Be aware of and immediately investigate and correct any problems discovered, using the services of trained licensed professionals for assistance. If the funeral home has expanded, assure that the capacity of the waste disposal system meets current needs. Make sure that the contents of the septic tank are regularly inspected and periodically pumped-out on a schedule that considers the volume of the wastewater and the capacity of the septic tank. All material removed from the septic tank should be properly disposed of.
4. Know the constituents of and the required method of disposal of any and all waste materials and fluids that the funeral home produces. Different requirements govern the handling and disposal of Hazardous Waste, Medical Waste, and other wastes produced in the course of funeral home operation. Be certain that any disposal firms with which you deal are licensed and reputable. Know where the wastes are taken for disposal and the compliance status of the disposal facility. Maintain copies of all waste disposal receipts. Each funeral director bears personal responsibility for the proper disposal of the wastes generated, as required by federal, state, and local law.
5. Cosmetics, adhesives, tissue builders, cleaning agents and other products that contain solvents or chlorinated compounds, such as trichloroethylene ("TCE") and perchloroethylene ("Perc"), should only be used topically – if used at all. These compounds, including gauze or cotton containing such compounds and product residues in empty containers, should never be poured into a drain or sink, added to an embalming tank, tossed into a dumpster, commingled with other wastes, or discharged to the ground. Such wastes may be Hazardous Wastes requiring special handling.

Beginning in 1992, the National Funeral Directors Association conducted an evaluation of wastewater that funeral homes produce in order to fill a void in information about the origin, nature, quantity, and fate of that wastewater. Published in 1995, as NFDA's "Wastestream Audit", the information developed has assisted regulators and funeral directors alike in making informed decisions about compliance with environmental requirements. The Environmental Best Practices accompanied the initial publication of the Wastestream Audit and is periodically revised as requirements and practices are updated.