G R A D I E N T

TRENDS

Risk Science & Application

Fall 2002

Land Disposal of Non-Hazardous Materials

The growing magnitude of society's non-hazardous waste issue is making environmental quality everybody's business.

Unlike with hazardous wastes, there is no unified voice among regulators that defines adequate risk management measures for non-hazardous wastes. Decisions are made largely on a local basis, which can lead to a wide range of management approaches and attendant risks.

> *The best outcome occurs when a balance is struck between the level of risk posed by a waste and the level of protection afforded by the disposal site.*

Non-hazardous solid wastes, or high-volume, low-toxicity wastes, have been historically disposed of on land or through incineration. Early land disposal sites were simple "open dumps" lacking proper controls to protect air, water, and soil from emissions, leachate, and disease vectors. Early in the 20th century, public health concerns prompted the gradual establishment of engineering standards and controls for "sanitary landfills," variations of which are the structures currently used for land disposal.

The definition of hazardous *vs*. non-hazardous wastes and minimum federal requirements for landfills are established in the Resource Conservation and Recovery Act (RCRA). Solid wastes that do not fit RCRA's definition of hazardous wastes are, by default, non-hazardous (40 CFR 261). Hazardous wastes exhibit characteristics of ignitability, corrosivity, reactivity, or toxicity in standardized tests. Certain types of wastes are explicitly classified as hazardous through "listing" (*e.g.*, refinery tank bottoms) or as non-hazardous through regulatory exemption (*e.g.*, coal ash). Most mining wastes are classified as non-hazardous based on the Bevill Amendment to RCRA.

continued on pg. 2

I N S I D E

Letter to our Readers

September 2002

Dear Colleague,

Welcome to Gradient's 25th edition of *Trends*! Our first edition was in January 1996, and considered issues associated with lead risk assessment. Today, we examine disposal and management of large volume, low-toxicity wastes: a societal, not just an industrial, issue. Municipal landfills have figured prominently as disposal sites for these wastes, while beneficial reuse of biosolids sometimes starts the neighbors complaining. As with hazardous wastes, risk assessment is a key tool for evaluation.

Contributors to this issue include Dr. Jennifer Saxe, a Senior Associate at Gradient with a specialty in chemical fate and transport, Dr. Rosalind Schoof, a DABT toxicologist who recently served on the NRC panel that evaluated biosolids risks, and Mr. Manu Sharma, Gradient Principal and groundwater modeling expert. I'm using the editorial portion of this edition to share some of my perspectives on issues surrounding hazardous and non-hazardous materials.

We hope this "Silver Edition" of *Trends* will provide you with new insights into the growing issue of non-hazardous materials management.

Yours truly,

Neil Shifrin, Ph.D.
President

Trends is a free publication of Gradient Corporation, a national leader in risk assessment and negotiation of risk-based remediation. If you have a colleague who would benefit from this publication, please contact Alison F. Barlow at (617) 395-5000 or email us at *trends@gradientcorp.com.*

Gradient CORPORATION

Land Disposal of Non-Hazardous Materials

continued from pg. 1

Despite their “non-hazardous” regulatory status, leachate arising from these non-hazardous waste landfills can result in human health and ecological risks, if released to groundwater or surface water in sufficient amounts. This is because even non-hazardous wastes often contain a small percentage of potentially toxic materials. For example, non-hazardous municipal solid waste (MSW) can include paint, pesticides, and solvents; and non-hazardous construction and demolition (C&D) debris can include solvents, oil and grease, lead from solder and piping, sulfate in gypsum drywall, and coatings on wood.

Risk management at non-hazardous waste landfills is primarily accomplished through three strategies: (1) careful siting, (2) well-designed construction including a liner, leachate collection system, and cap after closure where appropriate, and (3) establishment and execution of standard operating procedures including monitoring the types of wastes accepted for disposal.

The proximity of a proposed site to groundwater, especially groundwater used as a drinking water supply, and to surface water, residential areas, and parks, are factors considered when siting new landfills. Design and construction requirements are generally matched to the types of wastes accepted. After construction, permits typically mandate that landfill operators be constantly vigilant for incompatible materials in the wastes accepted. Older landfills still in operation may not meet current standards for siting or construction, so additional efforts in operation practices such as waste sorting often are necessary to minimize the risk of problematic leachate migration.

Minimum design requirements are established for MSW landfills in RCRA, including a composite liner consisting of a 30-mm flexible membrane and two feet of compacted, low hydraulic-conductivity soil. States either default to federal standards for MSW landfill design or establish their own, stricter standards (*e.g.*, double landfill liners) and in some cases empower local authorities to decide major design components in landfills. States also specify siting, design, and operational requirements for specialized facilities like incinerator ash monofills and C&D landfills, which usually incorporate variations of the design elements used in MSW landfills.

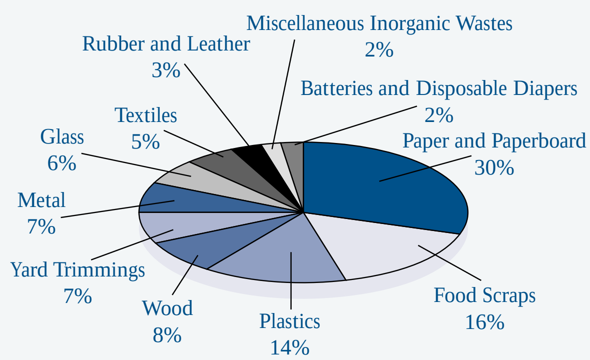
Most states allow certain “inert” wastes to be disposed in unlined landfills, because the potential for environmental risks due to leaching is negligible. Materials that may be disposed in unlined facilities differ among states. For example, unlined C&D landfills in Florida accept materials such as treated wood and sulfate-containing gypsum drywall, whereas lined landfills are generally used for these wastes in California and New York. In this gray area where wastes are substantially, but not completely inert, no data are published that clearly define circumstances when a liner is necessary. In some cases, data evaluation is complicated by the co-location of new sites and older defunct “dumps” containing hazardous components.

As the number and complexity of engineering controls for non-hazardous landfills increase, disposal costs in these units rise accordingly. In areas where disposal costs are high, recycling industries have developed to compete with landfills. However, increased prices have also encouraged illegal dumping in some communities.

The best outcome occurs when a balance is struck between the level of risk posed by a waste and the level of protection afforded by the disposal site. Disposal costs can be limited without compromising environmental quality when solid wastes are sorted by hazard level, even within the “non-hazardous” category, to allow increasingly inert materials to be disposed of with appropriately less extensive engineering controls. Since non-hazardous waste management is an issue that impacts everyone in society, it is in everyone’s best interest to strike this balance soon.

Jennifer K. Saxe, Ph.D.
Email: jsaxe@gradientcorp.com

Composition of the Unrecovered 162 Million Tons of Municipal Solid Waste in the U.S. in 2000



Source: U.S. EPA. 2000. Municipal Solid Waste in the United States. 2000 Facts and Figures. Office of Waste and Emergency Response, Washington, D.C. EPA530-S-02-001.

For Additional Information:

NYSERDA. 1992. Wood Products in the Waste Stream: Characterization and Combustion Emissions, Vol. 1. Albany, NY. NYSERDA 92-08 Vol. 1.

U.S. EPA. 1995. Construction and Demolition Waste Landfills. Office of Solid Waste. Washington, D.C. EPA/530/R-95/018.

Biosolids Management and Risks

A recent NRC study has identified the strengths, weaknesses, and unknowns of the land management of biosolids.

Recent decades have seen enormous improvements in surface water quality as a result of responsible sewage management (see related article). One side effect of this effective program to prevent sewage from fouling our rivers and lakes has been the creation of ever increasing quantities of sewage sludge.

> *Properly managed land application of biosolids can be a sustainable way to reuse a valuable resource…*

Since ocean dumping was banned, the only options for the management of sewage sludge are landfills, incineration, and land application. Sewage sludge treated to meet land application standards is termed "biosolids." Biosolids may be applied as a fertilizer to agricultural land (*e.g.*, pastures), to forests, and to reclaim damaged land. Standards for land application are established for the chemical components of biosolids by considering human and ecological exposure or risk, and for the pathogenic components by operational requirements to ensure pathogen reduction.

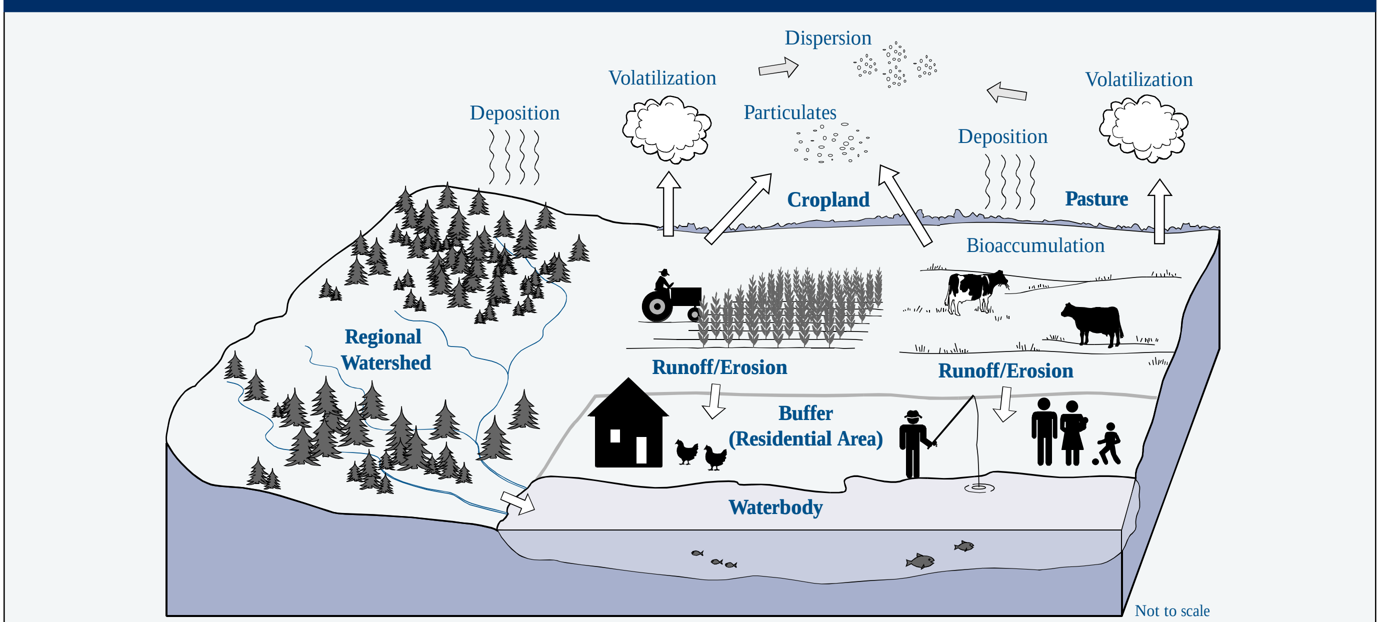
Recently, the National Research Council (NRC) undertook a review of the methods used to develop the chemical standards required for acceptable land application. The NRC report, released in July 2002, found no evidence that the U.S. EPA's standards failed to protect human health.

The original risk assessment used to establish the land application standards for chemicals was based on a 1988 survey of sewage sludges that identified chemicals of concern, and examined 14 potential exposure pathways for human and ecological or agricultural receptors. The current NRC report examines only human health-related issues. Due to increasing stringency of pretreatment standards, metal concentrations in sewage sludge have fallen markedly in the last 10 years, reducing the likelihood that the current standards will be exceeded. However, new concerns have arisen over organic chemicals that had high detection limits in the original survey, and over classes of chemicals not included in the survey that might be expected to be present in domestic sewage (*e.g.*, dioxins). Consequently, the NRC report recommends that a new survey of sewage sludges be conducted to identify the current chemicals of concern that will then form the basis for a new risk assessment.

An additional concern identified by the NRC report is odors associated with biosolids application. These have been a particular complaint of nearby neighbors. In many cases, odor problems reflect inadequate treatment and handling of biosolids, and could be reduced markedly if management requirements

continued on pg. 4

Agricultural Application Conceptual Site Model



Examination of the risks from biosolids land application considers a wide variety of direct and indirect exposure pathways.

Source: Figure 3-1, Center for Environmental Analysis, Research Triangle Institute. 2001. Exposure Analysis for Dioxins, Dibenzofurans, and CoPlanar Polychlorinated Biphenyls in Sewage Sludge (draft). Prepared for the U.S. EPA, November 30.

A Look at Deep Well Injection

Deep well injection is an environmentally-sound technology for managing large volumes of low toxicity liquid wastes.

Although many people may be unaware of deep well injection technology, every year over 75 million pounds of low-toxicity liquid wastes are managed using this environmentally-sound technology. Deep injection wells, typically half a mile to two miles in depth, are an approved and environmentally safe means of disposing hazardous and non-hazardous wastewater. Deep wells inject fluids into conductive and porous formations (*e.g.*, limestone), which are generally overlain by a relatively impermeable layer(s) of rock, hence isolating the injected waste at depths well below drinkable groundwater. In order to protect overlying groundwater and minimize migration-related concerns, deep injection wells are sited in seismically stable areas and away from bedrock fractures and faults. In addition, deep wells are constructed using multi-layer well construction and redundant safety features to further safeguard against potential releases.

> *...an applicant must demonstrate that these constituents will not migrate from the disposal site for 10,000 years, or as long as the wastewater remains hazardous (U.S. EPA, 2001).*

Deep well injections are regulated under state-specific and federal Underground Injection Control (UIC) regulations. These regulations require a demonstration that the injected wastewater will not migrate out of the targeted geologic formation, and a risk assessment to examine the consequences if such a migration were to occur. In order for wastewater containing hazardous constituents to be permitted (referred to as Class I injection wells), an applicant must demonstrate that these constituents will not migrate from the disposal site for 10,000 years, or as long as the wastewater remains hazardous (U.S. EPA, 2001).

Geologic conditions in the Gulf Coast and Great Lakes regions are ideally suited for deep injection wells. Hence, these regions have a majority of the permitted facilities (U.S. EPA, 1994). Approximately 25% of the permitted wells accept hazardous wastes, with the highest number of such facilities being in Texas (U.S. EPA, 1994; 2001). Although a wide range of wastewaters from municipal and industrial processes are disposed through injection wells, the vast majority of the injected fluids consist mainly of salt water.

The safety and risks associated with the use of Class I injection wells have been evaluated by the EPA and other stakeholders over the past 20 years. The EPA's overall conclusion has been that "when properly sited, constructed, and operated, injection wells can be an effective and environmentally safe means of fluid waste disposal" (U.S. EPA, 1994). A probabilistic risk assessment undertaken to evaluate this issue also concluded that the risk of loss of waste isolation from Class I injection wells was less than one in a million (Ijaz *et al*., 1999).

Although the use of this approach has proven to be safe, the EPA's Toxic Release Inventory data indicate that the overall volume of wastes disposed using this technology has declined by 39% from 1988 to 1998, due in part to the high cost and onerous regulatory demonstrations necessary to put a well into service. However, as the volume of low-toxicity wastewaters continues to increase, the popularity of this time-tested technology may (unlike the wastes they manage) resurface.

Manu Sharma, M.S.
Email: msharma@gradientcorp.com

References:

Ijaz, T., T. Long, and W. Rish. 1999. A Probabilistic Risk Assessment of Class I Hazardous Injection Wells. McLaren/Hart, Inc., Cleveland, OH.

U.S. EPA. 1994. Class I Injection Wells and Your Drinking Water. Office of Water. EPA/813/F-94/002. July.

U.S. EPA. 2001. Class I Underground Injection Control Program: Study of the Risks Associated with Class I Underground Injection Wells. Office of Water. EPA/816/R-01/007. March.

Biosolids Management and Risks

continued from pg. 3

were better enforced. Nonetheless, the data set characterizing the specific odorants released from biosolids is very small. Additionally, it is not clear if health effects are associated with exposure to biosolids-related odors, and many of the odorants identified to date do not have adequate toxicity assessments to support risk assessment.

The NRC committee noted particularly the need for development of conceptual site models and estimation of aggregate exposures for relevant receptors, rather than continued reliance on the individual pathway approach used to set the standards. The EPA successfully used this more contemporary approach in a recent reassessment of exposures associated with dioxins in biosolids (U.S. EPA, 2001). In this assessment, aggregate exposures are assessed for a farm family using both deterministic and probabilistic approaches (see figure). Notably, regional differences in climate and geology are included in the underlying database used to estimate fate and transport of chemicals, and to calculate a distribution of exposure point

continued on pg. 5

What's New at Gradient

Dr. Barbara Beck has been made a Fellow of the Academy of Toxicological Sciences.

Dr. A. Dallas Wait has been appointed to the Editorial Board of *Soil & Sediment Contamination.*

Dr. Lorenz R. Rhomberg was an *ad hoc* member of FIFRA Scientific Advisory Panel to review the EPA Preliminary Cumulative Risk Assessment for Organophosphorus Pesticides. Alexandria, VA. February 2002.

Upcoming Presentations

Frankenmuth, MI. September 14, 2002. Peter Valberg. "Health Effects of Air Pollutants." Talk at the Michigan Occupational and Environmental Medicine Association on Current Topics in Occupational and Environmental Medicine, 2002.

Amherst, MA. October 24, 2002. Eric Butler. Presentation on "Arsenic Geochemistry: Ponding, Slime, Iron, and Elevated Arsenic in Groundwater" at the 18th Annual International Conference on Contaminated Soils, Sediments, and Water. October 21-24, University of Massachusetts.

Newark, NJ. November 15, 2002. Lorenz R. Rhomberg. "A Probabilistic Empirically-Based Approach to Characterizing Extrapolation Uncertainty in Noncancer Risk Assessment." Talk at the 6th Annual Workshop on Evaluation of Default Safety Factors in Health Risk Assessment.

Recent Articles

Beck, B.D., R.L. Mattuck, and **T.S. Bowers**. 2002. "Adult:child differences in the intraspecies uncertainty factor: A case study using lead." *Human and Ecological Risk Assessment* 8(4):877-884.

Beck, B.D., T. Slayton, C. Farr, D. Sved, E. Crecelius, and J. Holson. 2002. "Systemic uptake of inhaled arsenic in rabbits." *Human and Experimental Toxicology* 21:205-215.

Rhomberg, L.R. 2002. "Dose scaling and extrapolation across age groups." *Human and Ecological Risk Assessment* 8(4):783-803.

Rhomberg, L.R. 2002. "The *a posteriori* probability of a kidney cancer cluster attributed to trichloroethylene exposure [letter]." *Environmental Health Perspectives* 110(5):A15.

Kuo, J., I. Linkov, **L.R. Rhomberg**, M. Polkanov, G. Gray, and R. Wilson. 2002. "Absolute risk or relative risk? A study of intraspecies and interspecies extrapolation of chemical-induced cancer risk." *Risk Analysis* 22(1):141-157.

Rhomberg, L.R. 2002. "It's time for risk assessment to step up to the challenge of informing benefits analysis." *Risk Policy Report* 9(2):35-37.

To request copies of articles or presentations, or to receive *Trends* by email, please contact us at trends@gradientcorp.com or telephone Alison F. Barlow at (617) 395-5000.

Biosolids Management and Risks

continued from pg. 4

concentrations for a variety of direct and indirect exposure pathways.

For pathogens, the NRC committee recommended continued reliance on pathogen reduction standards and monitoring of indicator organisms; however, updated pathogen detection techniques and a new national survey of pathogens in biosolids are needed. Additionally, pathogen risk assessment methodology was judged to have advanced sufficiently to be useful in establishing treatment requirements, management practices, and monitoring requirements.

Properly managed land application of biosolids can be a sustainable way to reuse a valuable resource that is certainly preferable to landfilling or incineration. Continued public acceptance of land application of this material will be dependent on adequate funding of the EPA and state oversight of these programs, as well as ongoing research to evaluate emerging concerns.

Rosalind A. Schoof, Ph.D., DABT

References:

NRC. 2002. Biosolids applied to land: Advancing standards and practices. National Academy Press, Washington, D.C. http://www.nationalacademies.org.

U.S. EPA. 2001. Exposure analysis for dioxins, dibenzofurans, and coplanar polychlorinated biphenyls in sewage sludge. NTIS PB2002-105133. November.

Environmental Issues in Modern Times

Environmental issues have gone full circle from capturing the attention of nearly everyone, to being of interest to an affected few, to being a societal issue.

The 20th century witnessed a revolution in waste management, environmental science, and societal views toward pollution. Although some pollution problems remain unsolved today, our progress has been astounding as we enter the 21st century with scientific understanding unimaginable in 1900. The development of waste management through the last century churned with scientific discovery, societal priorities, societal debate, and government awakening.

> *Our obsession over the last 20 years with hazardous waste issues captivated the attention of our legislators and scientists, while our non-hazardous waste problems piled up around us.*

Our first and most enduring pollution priority through most of the 20th century was sanitary waste management in surface waters. This was because of the devastation threatened by contagious disease, and because of the nature of population expansion in our growing cities. It began primarily as a municipal wastewater issue. Air pollution next quickly became a high priority, because its impact was so observable and immediate to so many people. The management of liquid and solid industrial hazardous wastes followed on the heels of sanitary landfill management, as regulatory programs were put in place to deal with these materials.

Today, society struggles with the very costly, seemingly insurmountable problem of how to manage its growing volume of non-hazardous wastes. Even while discrete segments of the industrial community are already stepping up to their hazardous waste management challenges, non-hazardous waste management problems that can present real issues for all of us continue to grow. Our obsession over the last 20 years with hazardous waste issues captivated the attention of our legislators and scientists, while our non-hazardous waste problems piled up around us.

As we enter this new millennium, it is time to deal with non-hazardous waste issues as part of a sensible and systematic approach to sustainability. That approach has to marry reasonable regulation with technologically-sound risk assessment and scientific objectives. To do otherwise will ignore what we have learned from the past, and jeopardize what we hope for in the future.

Neil Shifrin, Ph.D.
Email: nshifrin@gradientcorp.com

By The Way...

The Fresh Kills Landfill on Staten Island, NY, is one of the largest manmade structures in the world, 25 times larger than the Great Pyramid of Khufu at Giza and about the volume of the Great Wall of China. It is also the highest geographic feature along a 1,500 mile stretch of the Atlantic seaboard running north from Florida to Maine.

Source: Rathje, W. and C. Murphy. Rubbish! The Archeology of Garbage. New York: Harper Collins Publishers, 1992.

In the next issue:

Environmental Data: Providing Context

Understanding Exposure Databases

Making Sense of Hazard Data

Guest Editorial: Looking Back at California's Proposition 65

Look for *Trends* on the Web at: www.gradientcorp.com

GRADIENT TRENDS
Risk Science & Application

Produced by:
Gradient Corporation
238 Main Street
Cambridge, Massachusetts 02142
Phone: (617) 395-5000
Fax: (617) 395-5001
Internet: trends@gradientcorp.com

Printed on recycled paper with soy inks