LANDFILL DISPOSAL OF HAZARDOUS WASTES AND SLUDGES

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Foreword

The Resource Conservation and Recovery Act (RCRA), passed in 1976, created a federal and state regulatory authority over both solid and hazardous wastes. The projected regulations will become fully effective by June 30, 1980. These will have profound effects on industrial waste disposal practices, particularly those for hazardous wastes.

The proposed Federal Guidelines list a number of categories of industrial and nonindustrial wastes which fit into the hazardous waste classification. Some of these wastes may be disposed of by landfill techniques.

In this book, the landfill technology and the directions for the disposal of unwanted hazardous and toxic substances are based on reports and guidelines mostly issued by the EPA. Excerpts from pertinent recent U.S. patents are also included.

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The expanded Table of Contents is organized in such a way as to serve as a subject index and provides easy access to the information contained in this book. The bibliography at the end of the volume lists the important government reports under the heading Sources Utilized.

Contents and Subject Index

Introduction

As a consequence of a variety of factors, we are faced with ever-increasing waste disposal problems. Some of these factors are:

- Our ever-increasing population.
- The increased industrial commitment required to support the needs of that population with its consequent production of waste products and by-products which must be housed somewhere in our environment or destroyed.
- Increased consciousness of the consequence of environmental damage to present and future generations by indiscriminate or careless dumping of materials ranging from household sewage to toxic metals to lethal organic compounds.

Landfills may mean a variety of things to a variety of people. First there are the traditional sanitary landfills for the disposal of mixed municipal wastes (5)(6)(11). Then there are landfills for the disposal of sewage treatment sludges (3)(4). Depending on the ratio of domestic to industrial waste handled by the sewage treatment works, there may be a variety of hazardous materials introduced in discharges from electroplating plants and the like. Then, finally, one has the problem of disposing of known hazardous wastes in specially designed, constructed and operated landfills (1)(2)(9)(28).

As pointed out by Maugh (20), there are a great many materials that are too low in value to recycle, too difficult to degrade, too thick to inject into deep wells and too contaminated with heavy metals and other noninflammable materials to incinerate.

The disposal operation of last resort, according to Maugh, is ground burial of such materials. He goes on to say that it is not an ideal solution, not necessarily even a good solution, but the only solution we have. The problem then is to regulate landfills in such a manner that potential problems which would be created by the escape of toxic materials are minimized.

Wastewater authorities today are faced with a dilemma. As improved treatment technologies, more stringent regulatory requirements, and increasing flows all produce greater quantities of sludge, phased prohibition of ocean dumping, other regulatory constraints, and spiraling costs are combining to limit sludge disposal alternatives (3). Wastewater authorities are effectively limited to two methods of disposal: conversion processes (incineration, pyrolysis, and composting), and land disposal (landspreading and landfilling).

Many communities have found conversion processes to be quite costly. Specifically, incineration is becoming more costly because of energy cost escalations and stringent air emission regulations. Whereas sludge incineration appeared quite attractive when capital costs were financed with Federal and State funds, operating expenses are now a burden for the local taxpayer. For this reason some communities have closed their incinerators and implemented other disposal alternatives.

Composting, of course, produces a beneficial substance which can be used as a soil conditioner by farmers, homeowners, highway departments, and park authorities. Initial pilot and plant-scale operations with sludge composting have been favorable. However, composting is labor-intensive and cost-effectiveness of the operation is keyed to the market for the resulting soil conditioner.

As noted above, landspreading and landfilling are generally recognized as the two types of land disposal for sludge. Landspreading is a land-intensive disposal option and its use many be limited by the lack of available open land areas in many developed areas. Also some sludges, because of their chemical constituents, may not be suitable for landspreading. For these reasons, landfilling of sludges will continue to be a viable disposal alternative.

Sludge landfilling generally can be defined as the burying of sludge, i.e., the application of sludge to the land and subsequent interment by applying a layer of cover soil atop the sludge. To be defined as a landfill, the thickness of the soil cover must be greater than the depth of the plow zone. For this reason, subsurface injection of sludge is a landspreading, not a landfilling operation (3).

It is obvious that there are many things not known, or known imperfectly, and thus, there are many technical questions which need to be answered if hazardous wastes are to be properly controlled in a secured landfill (1).

More work is required to fully answer such questions as:

(a) Which hazardous materials can be satisfactorily landfilled?

(b) How must a hazardous waste material be prepared before deposition in a landfill?

(c) How must the landfill site be prepared before deposition of the hazardous waste material?

(d) What monitoring requirements are necessary for effective landfill site operation?

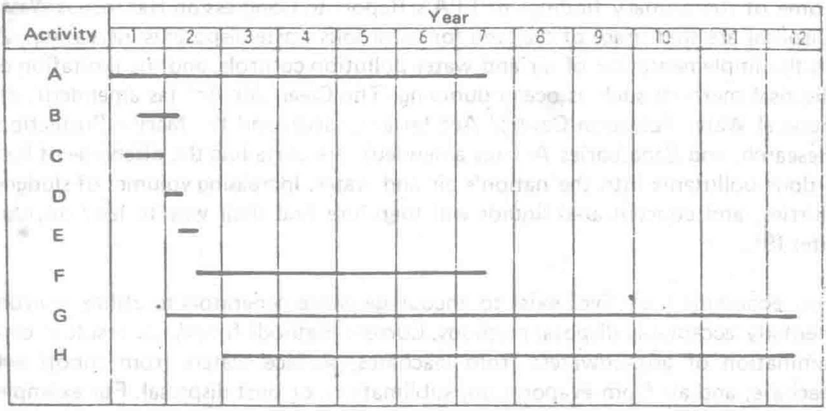
(e) How might a landfill site be prepared for re-use at a future date?

(f) What are the requirements for long-term surveillance of such sites?

EPA, in cooperation with other governmental agencies and the private sector, is endeavoring to find answers.

The chronology of a landfill is complex as shown in Figure 1. Some of the tasks are concurrent. All of these tasks will be discussed in the pages to come.

Figure 1: Suggested Timing of Planning, Design, and Operation Activities for Sample Landfill with Five-Year Life



A = Public participation program
B = Landfilling method selection
C = Site selection
D = Design
E = Construction
F = Operation
G = Monitoring
H = Completed site

Source: Reference (3)

Waste Sources

Waste sources for landfilling, as discussed previously, run the gamut from liquid to solid and from inert to toxic.

HAZARDOUS WASTES

Some of the primary findings of EPA's Report to Congress on Hazardous Waste Disposal are that usage of the land for hazardous waste disposal is increasing due to the implementation of air and water pollution controls, and the limitation of disposal methods such as ocean dumping. The Clean Air Act (as amended), the Federal Water Pollution Control Act (as amended), and the Marine Protection, Research, and Sanctuaries Act (as amended), are curtailing the discharge of hazardous pollutants into the nation's air and water. Increasing volumes of sludges, slurries, and concentrated liquids will therefore find their way to land disposal sites (9).

Few economic incentives exist to encourage waste generators to utilize environmentally acceptable disposal methods. Current methods frequently result in contamination of groundwaters from leachates; surface waters from runoff and leachate; and air from evaporation, sublimation, or dust dispersal. For example, toxic heavy metals create a chronic hazard when deposited in the land environment. As a result of arsenic buried more than 30 years ago, several people in Perham, MN, had to be hospitalized in 1972 due to arsenic poisoning of drinking water from a groundwater supply source contaminated by leachate from the buried deposit.

Because of the lack of effective controls, many hazardous wastes are currently being disposed of in dumps and conventional sanitary landfills. As an example, for several years a large municipal land disposal site in Delaware accepted both domestic and industrial wastes. In 1968, this disposal site had to be closed because chemical and biological contaminants had leached into the groundwater. By 1974, two major groundwater supply fields which had provided water for about 40,000 households in the area were contaminated. The clean-up costs are expected to be over $10 million. Although this situation has not directly been linked to the hazardous nature of any of the industrial waste constituents, this example serves to point up the potential problem caused by disposing of any wastes in an unacceptable land disposal site.

Definition of Hazardous Wastes

Hazardous wastes have been defined (1) as any "wastes or combinations of wastes which pose a substantial present or potential hazard to human health or living organisms because they are lethal, nondegradable, persistent in nature, can be biologically magnified, or otherwise cause, or tend to cause, detrimental cumulative effects." The five general categories of hazardous wastes are: (1) toxic chemical, (2) radioactive, (3) flammable, (4) explosive, and (5) biological. There is overlap, of course. For example, flammable and explosive wastes may be toxic as well; however, in this case, the primary waste characteristics of concern are flammability and explosiveness, rather than toxicity.

The same logic applies to many radioactive and some biological wastes as well. Most of the nonradioactive hazardous waste generated in this country (about 10 million tons annually) fall into the toxic chemical category. Most toxic wastes can be subcategorized as: (a) inorganic toxic metals, salts, acids or bases, and (b) synthetic organics.

Some of the primary findings of EPA's Report to Congress on Hazardous Waste Disposal, which was mandated by Section 212 of the Solid Waste Disposal Act as amended, are that current hazardous waste management practices are generally unacceptable, and that public health and welfare are unnecessarily threatened by the uncontrolled discharge of such waste materials into the environment, especially upon the land. It was also concluded that usage of the land for hazardous waste disposal is increasing due to the implementation of air and water pollution controls, and the limitation of disposal methods such as ocean dumping.

The Clean Air Act (as amended), the Federal Water Pollution Control Act (as amended) and also the Marine Protection, Research, and Sanctuaries Act (as amended) are curtailing the discharge of hazardous pollutants into the nation's air and water. The basic objective of the latter is to prohibit the dumping of some materials, and strictly regulate the dumping of all materials (except dredge material controlled by Army Corps of Engineers). Increasing volumes of sludges, slurries, and concentrated liquids will therefore find their way to land disposal sites.

A definition of hazardous waste and listings of hazardous wastes have been presented by the U.S. Environmental Protection Agency (29) in connection with the implementation of the Resource Conservation and Recovery Act of 1976 (Public Law 94-580).

Industrial Categories of Hazardous Wastes

The proposed Federal guidelines (29) list a number of categories of industrial wastes which fit into the hazardous waste classification and which are categorized in each case by the property or properties which give rise to the designation as hazardous. The categories of material designated as hazardous are shown in Table 1.

The letters in parenthesis after each type of waste indicate properties as follows:

- I – ignitable
- C – corrosive
- R – reactive
- T – toxic
- N – infectious
- A – radioactive
- M – mutagenic, carcinogenic or teratogenic
- B – bioaccumulate
- O – toxic organics

Table 1: Hazardous Waste Sources by Process

SIC	Process Description
1094	Waste rock and overburden from uranium mining (A)
1099	Chlorinator residues and clarifier sludge from zirconium extraction (A)
1475	Overburden and slimes from phosphate surface mining (A)
2874	Waste gypsum from phosphoric acid production (A)
2819-2874	Slag and fluid bed prills from elemental phosphorus production (A)
2231	Wool fabric dyeing and finishing wastewater treatment sludges (T,O)
2261-2	Woven fabric dyeing and finishing wastewater treatment sludges (Y,O)
2250	Knit fabric dyeing and finishing wastewater treatment sludges (O,T)
2269	Yarn and stock dyeing and finishing wastewater treatment sludges (O,T)
2279	Carpet dyeing and finishing wastewater treatment sludges (O,T)
2299	Wool scouring wastewater treatment sludges (T)
2812	Mercury-bearing sludges from brine treatment from mercury cell process in chlorine production (T)
2812	Sodium-calcium sludge from production of chlorine by Down Cell process (R)
2812	Mercury-bearing brine purification muds from mercury cell process in chlorine production (T)

(continued)

Table 1 (continued)

SIC	Process Description
2812	Wastewater treatment sludge from diaphragm cell process in production of chlorine (T)
2812	Chlorinated hydrocarbon bearing wastes from diaphragm cell process in chlorine production (O,M)
2816	Chromium bearing wastewater treatment sludge from production of chrome green pigment (T)
2816	Chromium bearing wastewater treatment sludge and other chromium bearing wastes from production of chrome oxide green pigment (anhydrous and hydrated)
2816	Ferric ferrocyanide bearing wastewater treatment sludges from the production of iron blue pigments (T)
2816	Mercury bearing wastewater treatment sludges from the production of mercuric sulfide pigment (T)
2816	Chromium bearing wastewater treatment sludges from the production of TiO_2 pigment by the chloride process (T)
2816	Chromium bearing wastewater treatment sludges from the production of TiO_2 pigment by the sulfate process (T)
2816	Arsenic bearing sludges from purification process in the production of antimony oxide (T)
2816	Antimony bearing wastewater treatment sludge from production of antimony oxide (T)
2816	Chromium or lead bearing wastewater treatment sludge from production of chrome yellows and oranges (lead chromate) (T)
2816	Chromium or lead bearing wastewater treatment sludge from production of molybdate orange (lead molybdate, lead chromate) (T)
2816	Zinc and chromium bearing wastewater treatment sludge from production of zinc yellow pigment (hydrated zinc potassium chromate) (T)
2816	Ash from incinerated still bottoms (paint and pigment production) (T)
2819	Arsenic bearing wastewater treatment sludges from production of boric acid (T)
2834	Arsenic- or organo-arsenic-containing wastewater treatment sludges from production of veterinary pharmaceuticals (T,M,O)
2851	Wastewater treatment sludges from paint production (C,T)
2851	Air pollution control sludges from paint production (T)
2865	Vacuum still bottoms from the production of maleic anhydride (O)
2865	Still bottoms from distillation of benzyl chloride (O)
2865	Distillation residues from fractionating tower for recovery of benzene and chlorobenzenes (O,B)

(continued)

Table 1 (continued)

SIC	Process Description
2865	Vacuum distillation residues from purification of 1-chloro-4-nitrobenzene (O,M)
2865	Still bottoms or heavy ends from methanol recovery in methyl methacrylate production (O)
2869	Heavy ends (still bottoms) from fractionator in production of epichlorohydrin (M,O)
2869	Heavy ends from fractionation in ethyl chloride production (M,O)
2869	Column bottoms or heavy ends from production of trichloroethylene (O,B)
2869	Residues from the production of hexachlorophenol, trichlorophenol and 2,4,5-T (O)
2869	Heavy ends from distillation of vinyl chloride in production of vinyl chloride from ethylene dichloride (O)
2869	Heavy ends from distillation of ethylene dichloride in vinyl chloride production (O)
2869	Heavy ends or distillation residues from carbon tetrachloride fractionation tower (B,O)
2869	Heavy ends from distillation of ethylene dichloride in ethylene dichloride production (O)
2869	Purification column wastes from production of nitrobenzene (O)
2869	Still bottoms from production of furfural (O)
2869	Spent catalyst from fluorocarbon production (T,O)
2869	Centrifuge residue from toluene diisocyanate production (O)
2869	Lead slag from lead alkyl production (T)
2869	Stripping still tails from production of methyl ethyl pyridines (I,O)
2869	Still bottoms from aniline production (O)
2869	Aqueous effluent from scrubbing of spent acid in nitrobenzene production (O)
2869	Bottom stream from quench column in acrylonitrile production (O)
2869	Bottom stream from wastewater stripper in production of acrylonitrile (O)
2869	Still bottoms from final purification of acrylonitrile (O,M)
2869	Solid waste discharge from ion exchange column in production of acrylonitrile (O,M)
2869	Waste stream from purification of HCN in production of acrylonitrile (O,M)
2869	Waste stream (column bottoms) from acetonitrile purification in production of acrylonitrile (O)
2890	Sludges, wastes from tub washer (Ink Formulation) (T,C,O)

(continued)