Hazardous Waste Land Disposal Bans: Where Will The Waste Go?

Thomas Armstrong

Introduction

In 1976 Congress passed the Resource Conservation and Recovery Act (RCRA) to encourage environmentally sound methods of disposal of household, municipal, commercial, and industrial waste. The goals of RCRA are to protect human health and the environment from the potential hazards of waste disposal; to conserve energy and natural resources; to reduce the amount of waste generated, including hazardous waste; and to ensure the wastes are managed in an environmentally sound manner (EPA, 1986b). Both Congress and the U.S. Environmental Protection Agency (EPA) believe that treatment and recovery should be the preferred methods for managing the nation's hazardous waste, in order to reduce the potential harm to human health and the environment. Under the Hazardous and Solid Waste Amendments of 1984 Congress mandated that land-disposal of certain hazardous wastes be prohibited (EPA, 1986d). The EPA has issued rules to implement the congressional prohibitions.

The state of California has developed its own land-disposal restrictions program. The Hazardous Waste Management Act of 1986 (SB 1500) advocates limiting land disposal and promoting alternatives for hazardous waste management (Shelander, 1987).

As a large generator of hazardous waste, the University of California at Berkeley (UCB) will be affected by these restrictions. UCB currently disposes a variety of wastes which by 1990 will be banned from land disposal, and therefore must begin to take steps to ensure compliance with these restrictions.

The purpose of this paper is to review and outline federal and state policies on land disposal of hazardous waste; to analyze UCB's hazardous waste stream to identify the portion of waste

which will be affected by the restrictions; to determine the magnitude of the impact upon UCB's waste management program; and to explore possible alternatives to the land-disposal of these wastes.

Background

Land-Disposal: Land-disposal refers to the placement of hazardous waste in landfills, surface impoundments, waste piles, injection wells, land treatment facilities, salt domes or salt bed formations, underground mines or caves, or concrete bunkers (EPA, 1987a). Land-disposal is not a thoroughly safe means of managing hazardous waste. Once it is emplaced in some type of landfill, it can migrate off-site, exposing humans and the environment to its toxic constituents. Even state-of-the-art designs, such as double liners and leachate collection systems, cannot guarantee containment (Cox, 1985). Liners can be degraded or punctured, injection well bores can fail, and containment beds can fracture. All of these incidents can lead to leakage and contamination of the environment, especially groundwater aquifers. EPA records indicate that all of California's Class I dumps, those that may accept hazardous waste, are leaking (Calif. State Assembly, 1986). All of the dumps are sources of air pollution, and most facilities have been cited for serious violations of state and federal laws regulating hazardous waste disposal (Calif. State Assembly, 1986).

Alternatives: Prior to the late 1960s few facilities existed to provide alternatives to the land-disposal of hazardous waste. Many different alternatives are now possible including source reduction, in which the amount of waste generated is reduced by using more efficient processes or substituting less toxic chemicals; recycling and resource recovery, in which contaminants are removed and the waste is reused in the same process or as a raw material for a different process; physical, chemical, or biological treatment, where the physical or chemical composition of the waste is changed to remove one or more of its toxic characteristics; and incineration, which uses high temperature destruction to reduce the waste to a residual ash which is easier and safer to dispose of on land (Cox, 1985).

Many specific alternatives to land-disposal are available to UCB. The most easily available alternative, in terms of cost, storage space, and capital investment, is thermal destruction or incineration. Incineration is a cheaper method of disposal by volume than landfilling (Belk,1988, pers. comm.). The cost for incineration is $505 per 55-gallon drum compared to $195 per lab pack drum for landfilling (Burger, 1988). But lab packs have at least a 2 to 1 ratio of absorbent to waste. Therefore, the relative cost for disposing the same volume is

roughly $505 to $585. However, because of possible toxic airborne emissions from the exhaust, new incinerators are not being permitted. The demand for use of the capacity of the existing incinerators is increasing as the amount of hazardous waste being restricted from land disposal increases. Consequently, the cost of incineration is rising, making other disposal methods economically attractive.

Other possible disposal methods include distillation, neutralization, or precipitation. Distillation is a technique in which components of the waste can be separated. Through distillation waste solvents can be recovered for reuse or they can be used as fuel for industrial boilers and furnaces (Olexsey, 1987). Corrosive wastes can be neutralized and metals can be precipitated out to render the waste less toxic.

Many factors must be considered in making decisions about which alternative to use. Legal liability, cost feasibility, and the regulatory environment, must be considered. Waste management plans need to minimize liability because generators are held liable for their waste until it is no longer hazardous, even if it is disposed of in a permitted facility (Air Pollution Control Association, 1986). Sufficient quantities of specific wastes are necessary to make alternatives economically feasible because of the capital investment needed to implement these alternatives. Finally, appraisal of the regulatory environment is necessary to anticipate future trends in regulation that will affect alternative disposal methods, such as stricter standards for incinerators.

UCB: The EPA defines a large-quantity generator as any generator which produces more than 1,000 kg of hazardous waste per month. UCB's position is rather unusual for a large generator because it produces small quantities of a variety of chemical wastes which add up to a large overall quantity (Belk, 1987, pers. comm.). This characteristic is a disadvantage for UCB in that other large-quantity generators typically produce a significant amount of a few chemicals, which makes disposal more cost-effective. Small quantity generators (those that produce less than 1,000 kg per month) have difficulty in disposing of their wastes because federal regulations prohibit them from storing wastes longer than 90 days (EPA, 1986b). Small quantity generators have expensive disposal costs because many disposal facilities charge a flat fee regardless of how much waste the generator wants to dispose of. UCB faces many of these same problems because it produces relatively small quantities of a wide variety of chemicals.

Currently, UCB's hazardous waste disposal is handled by the Office of Environmental Health and Safety (EH&S). EH&S collects the wastes from various campus departments and holds them at a transfer station. At the station the waste is separated by hazard class and packaged for transport. The wastes are picked-up by a transport company which takes them to a disposal facility, typically a landfill or incinerator (Belk, 1987, pers. comm.).

Methodology

I first reviewed federal and state regulations to determine the framework within which the land-disposal bans are being implemented. I then developed a list of chemicals within each of the federal ban classes. Then I analyzed the EH&S disposal manifests for 1986 to generate a waste profile for each of the thirty-two departments that produced banned chemicals. The department profile shows how much hazardous waste of each banned class is being disposed of by the department. Using the profiles I assessed the significance of the land-disposal bans on UCB's hazardous waste management program.

Data

Federal Regulations: On November 8, 1984, the Hazardous and Solid Waste Amendments (HSWA) were enacted into law, imposing substantial new responsibilities on those who handle hazardous waste (EPA, 1986c). HSWA prohibits the land-disposal of certain hazardous wastes after specific dates, unless it is shown that there will be no migration of hazardous constituents from the land-disposal unit for as long as the waste remains hazardous (EPA, 1986c). The statute also requires the EPA to set levels or methods of treatment which minimize the short-term and long-term threats to human health and the environment (EPA, 1986d).

In HSWA, Congress restricts the land-disposal of various classes of hazardous waste through a series of deadlines. At each deadline, further land disposal of a particular group of wastes is prohibited, unless the EPA has set treatment standards that prevent the migration of hazardous constituents (EPA, 1986d). The first statutory deadline, the solvent and dioxin ban, became effective on November 7, 1986. The second set of restrictions, for the "California list", was implemented on July 7, 1987. By August 8, 1988, EPA is required to identify wastes and establish treatment standards for approximately one-third of the hazardous wastes listed under RCRA. The EPA must set standards for an additional one-third by June 8, 1989, and the remaining one-third by May 8, 1990. Table 1 shows the deadlines for the different classes of the land-disposal bans. Under what the EPA calls a "hammer" provision, solvent, dioxin, and

California list wastes are automatically banned from land disposal if the EPA fails to set treatment standards. A "soft hammer" provision exists for the scheduled wastes. If the EPA fails to set treatment standards for the wastes then facilities may continue to landfill scheduled wastes until the EPA sets standards, or until May 1990 if they: 1) comply with minimum requirements; and 2) certify to EPA that treatment capacity is not available (Bureau of National Affairs, 1987).

Land Ban Classes	Date Effective
Solvents and Dioxins	November 8,1986
California List	July 7,1987
Schedule I-RCRA Listed Wastes	August 8,1988
Scehdule II	June 8,1989
Schedule III	May 8,1990

Table 1- Land Disposal Ban Schedule
Source- EPA, 1987a

The first phase of the land-disposal restrictions for certain solvents and wastes containing dioxins was implemented on November 7, 1986. The rule set treatment standards for solvents based on the Best Demonstrated Available Technology (BDAT), which means that the technology must be commercially available, present less risk to human health than land disposal, and provide substantial treatment (EPA, 1987b). The rule also prohibits dilution as a substitute for adequate treatment (EPA, 1987a). The rule does allow generators to store wastes, for the purpose of accumulation, for 90 days prior to disposal (Shelander, 1987).

The EPA issued regulations for certain "California list" wastes on July 8, 1987. The "California list" constituents include liquid waste containing polychlorinated biphenyls (PCBs) or halogenated organic compounds (HOCs) above certain concentrations; corrosive wastes with a pH of less than or equal to two; and liquid wastes containing certain metals and free cyanides (EPA, 1987d). These hazardous wastes are referred to as the California list because Congress adopted the provisions into HSWA from regulations developed by the state of California (EPA, 1987d). A waste containing a California list constituent is banned from

disposal only if it is a hazardous waste listed in RCRA, is a liquid (except HOCs), and contains constituents above the specified standard. A non-liquid hazardous waste may continue to be disposed of in a landfill until it is restricted under a future ban (Shelander, 1987).

State Regulations: RCRA encourages states to develop and manage their own hazardous waste programs. For a state to have jurisdiction over its own program, it must receive authorization from the EPA by showing that its regulations are at least as stringent as the federal regulations (EPA, 1984). The state of California has a "reversion agreement" with EPA which allows it to manage its own hazardous waste program even though it is not up to federal standards. The California Department of Health Services (DHS) is the lead agency in enforcement of the regulations but the EPA maintains a more active role than it would if the state were authorized.

The Hazardous Waste Management Act of 1986 (SB1500) was enacted by the state legislature in response to problems state-permitted facilities were having containing their waste (Shelander, 1987). The bill declares that it is in "the public interest to establish a program to limit the use of land disposal practices which do not meet certain prescribed standards and promote alternatives for hazardous waste management" (Steel, 1986). SB1500 prohibits the disposal of liquid waste, liquid hazardous waste, or hazardous wastes containing free liquids in hazardous waste landfills. By January 1, 1988, DHS must adopt certain criteria for the disposal of non-liquid hazardous wastes. By May 8, 1990, DHS must prohibit land-disposal of any hazardous waste unless it has been treated (Steel, 1986). The treatment standards must adhere to a "no migration" standard similar to HSWA, and be achievable through BDAT just like the federal program.

Under the "reversion agreement" with the EPA, DHS is the agency which directly oversees UCB to ensure compliance with hazardous waste regulations. UCB also has consent decrees with the District Attorney of Alameda County and the EPA concerning past violations (Belk, 1988, pers. comm.). A consent decree is an admission of guilt for past violations and a promise not to commit future violations. Any future violations which break these decrees will result in harsher penalties for UCB.

Generator Compliance With Facility Restrictions: UCB must also comply with the requirements of the treatment, storage, and disposal facilities (TSDF) to which they send their wastes. Disposal sites are not required to accept wastes that meet the standards. For example, although California list restrictions allow the disposal of PCB wastes with concentrations of less than 50ppm, Casmalia Resources in Santa Barbara County will not accept any PCB wastes

(Shelander, 1987). The same conditions apply to dioxins, which are disposable in landfills under a two-year variance from federal regulations, but are not accepted by any facility in the country (Belk, 1987, pers. comm.). So another set of restrictions, unique to each TSDF, is imposed on the generator.

Waste profiles: In compiling the waste profiles I analyzed 32 departments, representing 90 percent of the hazardous waste disposed of by UCB. EH&S disposed of 44,914 pounds of hazardous waste for the 1986 calendar year. The ten departments with the highest amount of waste accounted for 68 percent of UCB's hazardous waste. Figure 1 shows the amount of waste disposed of by each of the ten departments. The graph discloses that the Department of Public Health disposed of the highest amount of waste, 5067 pounds, and the Chemistry Department was second with 4429 pounds. Following these two departments there is a group of five departments which disposed of 3500-3000 pounds. The amount of waste disposed by the remaining departments drops off sharply.

The waste profiles for the top ten departments are presented in Table 2. The profiles indicate the total amount of waste disposed in 1986 and the amount of waste which fell under each land disposal ban category. They also show how much of the departmental waste was not affected by the bans. In addition, the profiles also list the percentage of the department waste that falls under each ban. The amount of hazardous waste under the solvent class represents only solvent waste, as UCB did not produce any dioxin wastes in 1986.

The profiles reveal that the amount and distribution of banned waste can vary greatly from department to department. Restricted waste accounts for 64 percent of the total waste for Chemistry and the Electronics Research Lab (ERL), while only contributing to 2 percent of the hazardous waste disposed by the Department of Facilities Management (DOFM). The distribution of wastes within the various classes also varies. Solvents account for 64 percent of the waste generated by ERL and 38 percent of Chemistry's waste while only accounting for 2 and 3 percent of waste disposed of by DOFM and the Genetics Department respectively. Some departments, such as Nutritional Science and Electrical Engineering and Computer Science (EECS), dispose of the most waste under the California list class. while the dominant class for Genetics is the Schedule I wastes.

The totals for the ten departments appear in Table 3, which reveals that the banned wastes for the ten departments make up 20 percent of the hazardous waste disposed of by UCB. The solvent ban is the dominant class for UCB as a whole, accounting for 5096 pounds or 11 percent

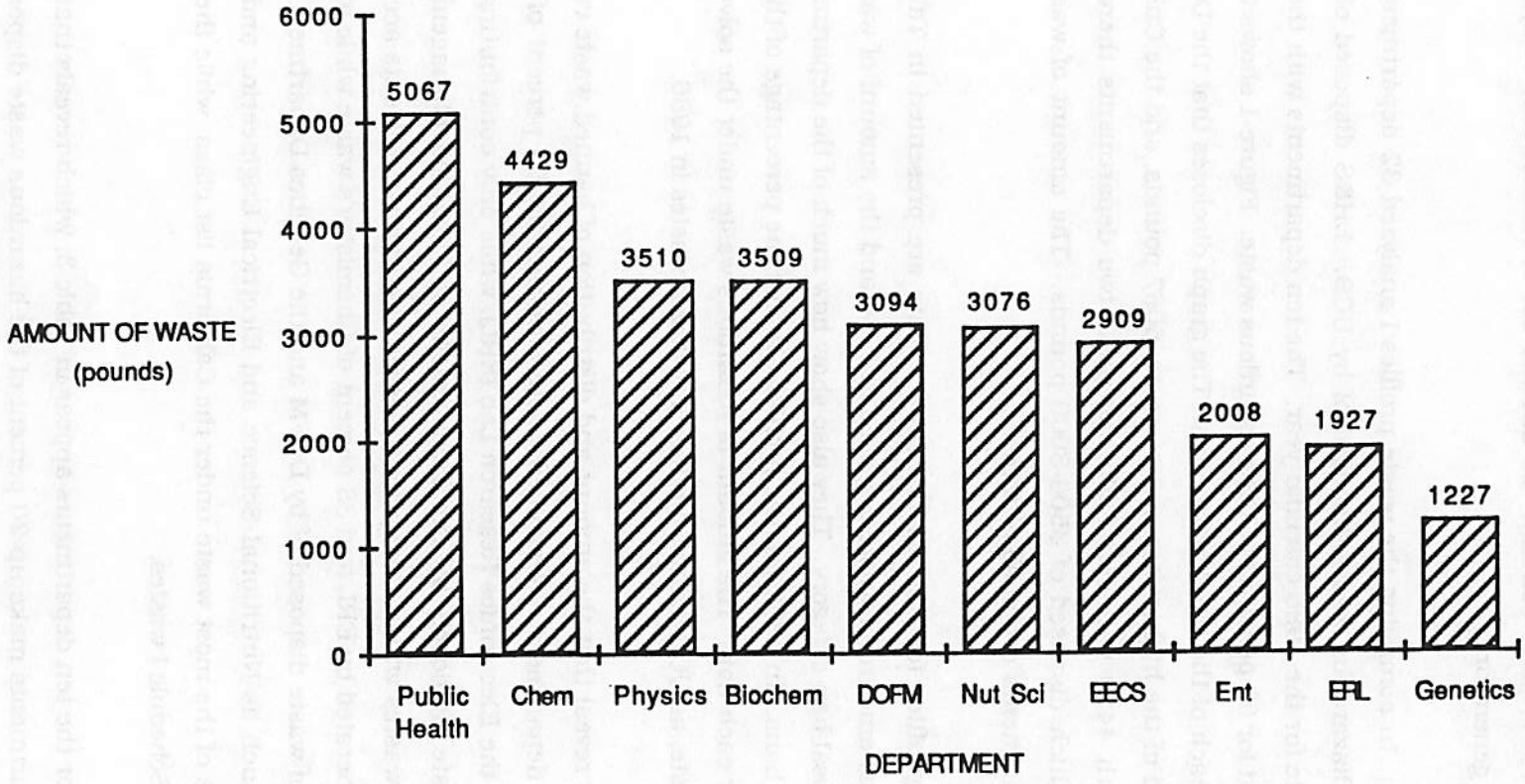

Figure 1- Total Waste Disposed For Top Ten Departments
Source- 1986 EH&S Disposal Data

	PUBLIC HEALTH		CHEMISTRY		PHYSICS		BIOCHEMISTRY		DOFM	
	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%
Total Waste Disposed	5067	100	4429	100	3510	100	3509	100	3094	100
Land Disposal Ban Classes										
Solvents	348	7	1663	38	571	16	225	6	50	2
California List	20	-	176	4	276	8	324	9	17	1
Schedule I	71	1	716	16	38	1	290	8	-	-
Schedule II	40	1	210	5	10	-	111	3	-	-
Schedule III	-		50	1	-	-	13	-	-	-
Subtotal of Banned Wastes	479	9	2815	64	895	25	963	27	67	2
Wastes Not Affected By Bans	4170	82	260	6	1986	57	2468	70	2551	82

	NUTRITIONAL SCI		EECS		ENTOMOLOGY		ERL		GENETICS	
	lbs	%	lbs	%	lbs	%	lbs	%	lbs	%
Total Waste Disposed	3076	100	2909	100	2008	100	1927	100	1229	100
Land Disposal Ban Classes										
Solvents	583	19	169	6	220	11	1234	64	33	3
California List	840	27	235	8	22	1	-	-	91	7
Schedule I	212	7	-	-	79	4	-	-	218	17
Schedule II	15	-	-	-	-	-	-	-	33	3
Scehdule III	-	-	-	-	-	-	-	-	-	-
Subtotal of Banned Wastes	1650	54	404	14	321	16	1234	64	375	30
Wastes Not Affected By Bans	1064	35	2257	78	1489	74	563	29	663	54

Table 2- 1986 Waste Profiles For Top Ten Departments
Source- 1986 EH&S Disposal Data

of the total hazardous waste. The solvents and California list bans are already in effect. The wastes within these two classes compose approximately 75 percent of UCB's banned waste. As of August 8, 1988 the Schedule I land-disposal restrictions will be implemented, and another 18 percent of UCB's restricted waste will be affected.

	Pounds	Percentage of Total Hazardous Waste Disposed by UCB
Total Waste Disposed	30758	68
Land Disposal Ban Classes		
Solvents	5096	11
California List	2001	4
Schedule I	1624	4
Schedule II	419	1
Scehdule III	63	-
Subtotal of Banned Wastes	9203	20
Wastes Not Affected By Bans	17471	39

Table 3- Top Ten Department Waste Profile Totals Within Ban Classes
Source- 1986 EH&S Disposal Data

Discussion

The EH&S disposal data had a number of limitations that made certain assumptions necessary to construct the waste profiles. Generic quantities, such as organic solvents, and mixtures, like N-Butyl Acetate/Xylene, were classified under the earliest deadline. Also, because concentrations were not given, all wastes were assumed to exceed the treatment standards for land disposal. Dry lab debris was counted as if it were wet waste because it has been shown that the contaminant can leach out of the debris under pressure (Cox, 1985). Lastly, only wastes of amounts larger than ten pounds were considered. Many of the wastes

listed in the EH&S disposal data were in quantities of less than one pound, consequently the waste profiles do not classify all of the wastes for a given department (thus the percentages given for each department may not sum to 100). Despite the incompleteness of the profiles, the data given for banned classes is reliable. Profiles were compiled for all thirty-two departments that disposed of banned wastes, especially those chemicals that were covered by the solvent and California list categories.

The analysis was focused on the department level for a number of reasons First, it reveals the variety of waste compositions that exist, and illustrates how UCB faces the same problems as a small quantity generator. The department analysis provides insight into who is producing the wastes, and in what quantity. Also, alternatives such as recycling would be more effective if they were implemented on a departmental scale where there might be use for the end product. For example, the Chemistry Department and ERL dispose of large quantities of solvents which might be recycled and used with the departments.

In terms of the amount of waste that needs to be redirected away from landfills, UCB has already had to redirect about 75 percent of the banned wastes. Most of this waste is being incinerated. Currently UCB incinerates approximately 60 percent of its hazardous waste (Belk, 1988, pers. comm.).

The land-disposal bans do not present any problem for UCB in their ability to properly dispose of wastes. The problem lies in what the bans promise for the future. They reflect a general trend in the regulations, moving from regulating disposal to reducing the amount of waste generated. This shift presents a potential problem for UCB because its hazardous waste management plan is based on disposal. UCB still landfills 40 percent of its wastes, which at some time in the near future will face restrictions similar to the bans currently being implemented. Most of the remaining 60 percent of the waste is incinerated, but incinerators are facing increasingly strict regulation, similar to what happened to landfills. The potential risks involved with exhaust emissions are forcing a reconsideration of incinerators as a viable alternative disposal method.

UCB does have alternatives immediately available to it. Because it is a research institution, source reduction methods would be difficult to implement. However, other alternatives appear promising. The area with the most potential is the recycling of solvents, which make up 11 percent of the total hazardous waste stream. Even if the end product is not useable on campus, an off-campus market still might make the costs cheaper in the long run.

Conclusion

The current land-disposal restrictions represent a coming trend of stricter regulations concerning the disposal of hazardous waste. Incinerator capacity will not grow rapidly because new facilities are not being permitted; this will drive prices higher. UCB needs to develop a long-term strategy which takes into account the trend of regulations away from disposal and towards source reduction and recovery.

UCB is not alone in its problems with hazardous waste disposal; all of the University of California (UC) campuses have similar difficulties. I propose a UC-systemwide approach to solving the disposal problem rather than leaving it up to the individual campuses. The systemwide facility would be centrally located, and the hazardous waste from the nine UC campuses would be transported there. The advantages of a system facility include the availability of large quantities of waste (to make alternatives more economically feasible), and the necessary space to implement programs, such as distillation and neutralization (each individual campus is limited by the amount of available space). Finally, such a facility could be sited in a rural area where alternative treatment technologies could be permitted, avoiding problems with urban communities surrounding many of the campuses.

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40 CFR Part 268, Subpart B- Schedule For Land Disposal Prohibitions and Establishment of Treatment Standards.