

HAZARDOUS MATERIALS: EVOLVING PERCEPTIONS AND POLICY

by

SUELLEN M. MELE

A THESIS

Presented to the Interdisciplinary Studies Program:
Environmental Studies
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Master of Science

September 1986

APPROVED:

A large black rectangular redaction box covering the signature of Dr. John H. Baldwin.

Dr. John H. Baldwin

A handwritten signature, possibly "J", written in ink below the line for Dr. John H. Baldwin.

Dr. Daniel Goldrich

An Abstract of the Thesis of
Suellen M. Mele for the degree of Master of Science
in the Interdisciplinary Studies Program: Environmental
Studies

to be taken September 1986

TITLE: HAZARDOUS MATERIALS: EVOLVING PERCEPTIONS AND POLICY

Approved: _____

Dr. John H. Baldwin

Dr. Daniel Goldrich

Perceptions of public problems evolve over time in response to changing information and political conditions. The public problem of hazardous materials is no exception. In the past ten years this problem has been defined as one of irresponsible corporations, leaking landfills, and, more recently, the dangerous and wasteful properties of industrial residues. Each definition differs in materials considered, perceived cause of the problem, attitude toward technology, locus of political responsibility, predominant actors, and appropriate solutions. This paper describes each of the three definitions based on these factors.

Such descriptions are useful because they reveal trends that suggest new definitions of the public problem and because they provide a basis for policy analysis. It is

seen that existing national policy lags the current definition and is therefore inadequate. New policy is recommended.

VITA

NAME OF AUTHOR: Suellen M. Mele

PLACE OF BIRTH: Oceanside, New York

DATE OF BIRTH: June 20, 1954

UNDERGRADUATE AND GRADUATE SCHOOLS ATTENDED:

University of Oregon
Wesleyan University

DEGREES AWARDED:

Master of Science, 1986, University of Oregon
Bachelor of Science, 1976, Wesleyan University

AREAS OF SPECIAL INTEREST:

Hazardous Materials
Citizen Participation

PROFESSIONAL EXPERIENCE:

Graduate Teaching Fellow, University of Oregon,
Eugene, Oregon, 1985-86

Hazardous Waste Specialist, Alaska Center for the
Environment, Anchorage, Alaska, Summer 1985

Administrative Coordinator, Prudence Crandall Center
for Women, New Britain, Connecticut, 1982-83

Special Events Coordinator and Administrative
Assistant, Easter Seal Society of Connecticut,
Amston, Connecticut, 1980-82

ACKNOWLEDGEMENTS

My sincere appreciation is extended to the members of my committee, John Baldwin and Daniel Goldrich, for their direction and support. In addition, I wish to express my gratitude to Helen Liggett, who introduced me to the analytical framework used throughout this essay and offered invaluable guidance to its application.

I'd also like to thank my friends in Eugene and the Bay Area who shared their editorial skills, political philosophies, and general good spirits throughout the many seasons of this thesis.

Finally, I acknowledge the women and men working in innovative hazardous materials programs throughout the country. Through their insight and work, new ways of looking at the problem are emerging.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION.....	1
	Purpose.....	1
	Boundaries.....	5
	Method.....	6
	Overview.....	8
II.	IRRESPONSIBLE CORPORATIONS.....	14
	History.....	14
	Problem Description.....	22
	Industrial Hazardous Waste.....	25
	Medium of Contamination.....	30
	Attitude toward Technology.....	33
	Causal and Political Responsibility.....	34
	An Individual Problem.....	39
	Ownership.....	41
	Actors.....	43
	Solutions.....	46
	Effectiveness of Solutions and Paradigm Status.....	49
III.	LEAKING LANDFILLS.....	52
	Problem Description.....	52
	Industrial Hazardous Waste.....	57
	Medium of Contamination.....	60
	Engineering Mentality and Technological Solutions.....	64
	Technology and Values.....	71
	Causal and Political Responsibility.....	77
	An Aggregate Problem.....	81
	Ownership and Actors.....	82
	Policy Solutions.....	87
	Paradigm Status.....	98
IV.	DANGEROUS AND INEFFICIENT WASTE.....	104
	Problem Description.....	104
	Industrial Hazardous Waste.....	108
	Medium of Contamination.....	111
	Technological Solutions: Prevention and a Hierarchy of Approaches.....	114

Technological Feasibility.....	121
An Economic Paradigm.....	127
Causal and Political Responsibility.....	132
Actors and Ownership.....	134
Policy Solutions.....	138
National Policy and Paradigm Status.....	155
Recommended Policy.....	165
 V. THE META-PROBLEM OF HAZARDOUS MATERIALS.....	 168
Introduction.....	168
Projection of Trends: Materials, Media of Contamination, and Causal Responsibility.....	 169
Problem Description.....	175
Interaction among Problem Areas.....	179
Implications for Political Responsibility and Ownership.....	 183
Implications for Solutions.....	185
Implications for Policy.....	191
Prospects for Transition.....	199
 REFERENCES.....	 204

LIST OF TABLES

Table	Page
1. Summary of Paradigm Characteristics.....	13
2. Proper and Improper Methods of Hazardous Waste Disposal, 1978.....	34
3. Representative Unit Costs for Commercial Hazardous Waste Treatment and Disposal.....	49
4. States with Policies Encouraging Alternatives to Landfilling of Hazardous Waste.....	90
5. Environmental Consequences of Hazardous Waste Management Alternatives.....	116
6. Estimated Damage Costs of Uncontrolled Pollution.....	139
7. Illustration of a Hazardous Waste Generator Tax Structure.....	151

LIST OF FIGURES

Figure	Page
1. Materials Balance Model for the Irresponsible Corporation Definition.....	27
2. Materials Balance Model for the Leaking Landfill Definition.....	58
3. Molten Salt Destruction.....	69
4. Corporate Decision Making Process for Hazardous Waste Management.....	74
5. Waste Treatment and Disposal Options versus Waste Types.....	75
6. Materials Balance Model for the Dangerous and Inefficient Waste Definition.....	110
7. Comparison of Waste Treatment, Recycling, and Reduction: A Hypothetical Example for Air Emissions from a Storage Tank.....	125
8. Materials Balance Model for the Meta-Problem Definition.....	170
9. Growth in U. S. Chemical Production Between 1900 and 1978.....	173

CHAPTER I

INTRODUCTION

Purpose

She cupped the fire again, this time in both hands, and began slowly to shape it. . . . She had drawn the flames into a hundred varied shapes, flowers that opened then melted away, fiery birds that took wing from her hands. . . . Glimpses of power, knowledge, elusive as the fire, passed before her mind's eye (McKillip, 1977, pp. 179-180)

In recent years, numerous means of responding to the hazardous materials problem have emerged. These range from bans on landfilling certain hazardous or toxic materials to the creation of institutions that expedite the exchange and reuse of valuable "wastes"; from technologically advanced processes for incineration to industrial housekeeping measures that reduce the amount of waste produced. Given this gamut of alternatives, the central question is whether these approaches provide an adequate solution to the hazardous materials problem. The answer to this question, however, is all but obvious. It depends, of course, on our capabilities to formulate and implement appropriate programs. Even more importantly, it depends on how we choose to define the problem.

In titling and introducing this paper, the problem of

"hazardous materials" has already been given a name and molded (like the fire in the opening quote) into a certain shape. That shape both creates and limits the character of the public problem. With knowledge and power in the public arena, other shapes might be formed. A number of the shapes might share certain characteristics (like the similar design of each flower) and some of the shapes might exist simultaneously. Yet each shape is unique.

In The Culture of Public Problems, Joseph Gusfield (1981) explains that a problem definition "represents a selective process from among a multiplicity of possible and potential realities" (p. 3) and an "application of values to an objective set of conditions" (p. 8). Each definition represents a distinct interpretation of reality, i.e. a different mode of looking at the problem which entails certain responses and political practices. These different ways of looking at and conceptualizing the problems will be referred to as paradigms.

The first task of this paper is to show that the problem of hazardous waste has been shaped in three distinct ways: as a problem of "Irresponsible Corporations," of "Leaking Landfills," or of "Dangerous and Inefficient Waste." Evidence will be offered as to the existence, character, and strength of these paradigms and each will be described according to materials included, attitude toward technology, causal responsibility, political responsibility,

and ownership.

In addition, the paper will broadly trace the emergence and development of the definitions over time. This is possible because "human situations and problems have histories; they have not always been construed and recognized as they are today or will be in the future" (Gusfield, 1981, p. 4). This historical analysis will demonstrate the mutability of interpretations and the relationship between paradigms.

This exercise leads to the heart of the paper, which is to look beyond the currently operating paradigms in order to imagine and describe previously neglected alternatives. There are dangerous consequences in accepting any one definition of a public problem as the only possible definition:

This homogenous consciousness . . . eliminates conflict or divergence by rendering alternative definitions and solutions unthinkable. . . . What we cannot imagine, we cannot desire. (Gusfield, 1981, p. 7)

Thus, "the definition of alternatives is the supreme instrument of power" (E. E. Schattschneider cited in Kazis & Grossman, 1982, p. 58). By tracing the trends uncovered through analysis of the currently operating paradigms, a new way of looking at the problem is discovered.

Once alternatives are defined, it is possible to return to the central question of adequacy of available solutions. The set of solutions that exists in current

public consciousness about hazardous materials is inherent in the operating paradigms. If we accept the current paradigms, then the available solutions are indeed adequate. If we envision and choose other paradigms, then the solutions must respond to them. The third and final purpose of this paper is to show how currently accepted solutions inadequately respond to the emerging and potential definitions and to recommend solutions.

In describing solutions, frequent reference will be made to federal legislation. This is done for two reasons. First, national policy represents public consciousness of what constitutes adequate solutions to a problem. It therefore can be used as an indicator--albeit often a lagging indicator--of accepted paradigms. This analysis is possible, of course, because policy changes over time. For example the central piece of hazardous waste legislation, the Resource Conservation and Recovery Act (RCRA), was enacted in 1976, reauthorized and revised in 1980, and amended in 1984. The corresponding regulations were promulgated in 1979 and 1980, with changes and additions occurring from that time to the present. As policy is rewritten, definitions are re-presented.

Second, federal hazardous waste policy is a strong tool for constituting paradigms. Solutions not only stem from definitions but also are means of creating and shaping those definitions. The involvement of federal government in

hazardous waste problems is extensive. Yet the regulations that it produces are so difficult to understand that attention gets focused on minute (albeit important) detail. By instead looking at definitional changes, it is possible to see broader changes in approach. Once the paradigm is clarified, decisions about policy--although still difficult to implement--are also clarified. Understanding paradigms is an incisive approach to policy analysis which can guide political action. What we have imagined, we can desire. And what we desire, we can begin to create.

Boundaries

To summarize, the purpose of this paper is to describe and understand the currently operating definitions of the hazardous materials problem, to discover new potential paradigms, and to describe inherent solutions. In focusing on these tasks, it is necessary to exclude other important related areas. Although these areas will be apparent as the thesis progresses, it is useful to at least acknowledge them here.

To begin with, this paper recognizes that public problems are not "given the same meaning at all times and by all peoples" (Gusfield, 1981, p. 3) by showing how the public perception of the hazardous materials problem has shifted over time in the United States. It does not, however, examine in detail the relative status of the

paradigms at any one time or place. Since definitions of the hazardous materials problem differ in strength and character by state and geographic region, this analysis will be at best a generalized composite of what in actuality is a diverse, rapidly changing scenario.

It is also not claimed that this description will provide comprehensive analysis of the relative power of actors to shape the public perception. Nor will it provide a comprehensive theory of why and how paradigms can be manipulated. This has an important consequence for the portion of this paper dealing with the creation of new paradigms. A shift in definition requires not only the ability to imagine a different future reality but also a sense of how to transform the present conception to the future one. Thus, this paper will not provide analysis sufficient for the creation of a new future. However, by discovering new definitions, it will provide analysis necessary for that creation.

Method

Since the thesis relies heavily on the interpretation of secondary and some primary research, it can best be described as a research essay (Gusfield, 1981, chap. I). The methodology consists of political analysis based primarily on Gusfield's theoretical framework. This framework is built on the factors of causal responsibility,

political responsibility, and ownership (Gusfield, 1981, chap. II).

Factual and explicative material has been utilized in two ways. In the initial search through the hazardous materials literature, it became obvious that there were different ways of defining the problem. Definitions were abstracted from general information. Once paradigms were uncovered, factual and explicative material provided evidence supporting the definitions and solutions.

In the search for evidence to support the existence of these alternatives professional non-technological books on hazardous substances, government publications, and federal legislation were used. A complete list of references is provided at the back of the thesis.

It was impossible, of course, to do anything close to a complete reading of the literature. The Monthly Catalogue of U.S. Government Publications alone contains over 800 titles. Nonetheless, a more thorough literature review on waste reduction was completed. This allowed the thesis to focus on the "Dangerous and Inefficient Waste" paradigm that is emerging today. In addition, two conferences, one on Hazardous Waste Exchanges and the other on Solid and Hazardous Waste Reduction, provided up to date information on recycling and reduction. During those conferences, interviews were conducted with representatives of organizations--corporate, government, and non-profit--that

are on the leading edge of promoting the emerging "Dangerous and Inefficient Waste" paradigm.

Overview

There is one characteristic which all the hazardous material paradigms have in common and which therefore forms a good starting place for discussion. No matter who or what is perceived to be the cause of the problem, no matter which causal sequence is envisioned or solution applied, a grave risk to human health and the environment is perceived. Whether the material considered is hazardous substance or hazardous waste, it is that material's hazardous nature that is the issue. Evidence of this threat to human health can take various forms: descriptions of victims, statistical reports, and epidemiological studies. A number of examples are included here to show the prevalence of this concern over health issues.

In any case study of hazardous disasters, human health problems and deaths are described. In the Love Canal incident, one resident "remembers how children were often burned by liquids oozing from the canal" (Epstein, Brown, & Pope, 1982, p. 95). The death of a seven-year-old child was linked to high levels of dioxin (TCDD), "the most toxic synthetic organic chemical known to man," which was found in a creek running through his backyard near the Love Canal (p. 91). In a petition drive coordinated by Lois Gibbs, it

was discovered that sickness was common in the neighborhood. Multiple birth defects, asthma, skin problems, hyperactivity, miscarriage, stillborn children, and crib deaths were all numerous (pp. 100-101). Other reports of Love Canal and report of other incidences such as in Times Beach, Missouri, Hardeman County, Tennessee, Lathrop, California, etc. all cite comparable problems (M. Brown, 1981; Epstein et al., 1982; Jackson, Weller, & the Waterloo Public Interest Research Group, 1982).

The relationship of health deterioration and toxic chemicals is also presented in studies that attempt to link a concentration of chemicals to disease in a particular geographic area. For example, "investigators have found 112 organic chemicals in New Orleans' drinking water, including several known and suspected carcinogens" (Banks, 1984, p. 38). It has also been found that the "rate of cancer mortality in New Orleans is 32 percent higher than the national average" (p. 38). Therefore, the "polluted drinking water may account for 10 to 20 percent of the city's cancer death rate" (p.38). Similar studies have been performed at Love Canal and other hazardous waste dump sites (M. Brown, 1981; Epstein et al., 1982; Jackson et al., 1982).

Another similar method of connecting hazardous chemicals to human health problems is to point to epidemiological studies linking a particular substance with

certain diseases and then showing statistics on the level of that chemical in the human body.

This concern about health and environmental consequences is also reflected in the federal legislation dealing with hazardous substances. In the Resource Conservation and Recovery Act of 1976 (RCRA):

The term 'hazardous waste' means a solid waste, or combination of solid waste, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may--
(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise mismanaged. (P.L. 94-580, Sec. 1004 (5), (5)(A) and (5)(B))

Health and environmental dangers are the consequences of the hazardous substance problem no matter how it is defined.

Not all paradigms, however, are built on the same perceptions of the cause of these consequences. In naming the public problem as hazardous materials, it is shaped one way and includes the dangers of both hazardous waste and substances: occupational accidents, groundwater and air contamination by industrial pollutants, leaching of toxics from consumer products in municipal landfills, transportation accidents, etc. If the problem is instead named as hazardous waste, only a few of these dangers are considered. Certain characteristics are the same as the hazardous material problem while others are excluded or

different.

In current thought, the public problem that has "reached national prominence" is "nonnuclear industrial hazardous waste" (Office of Technology Assessment, 1983b, p. 3) or "industrial chemical wastes that are hazardous" (Epstein et al., 1982, p. 38). This further articulates the definition and narrows the range of materials and dangers considered.

Even within the industrial hazardous chemical waste category, different ways of looking at the problem are possible. The first two paradigms discussed in this paper, "Irresponsible Corporations" and "Leaking Landfills," are two different interpretations of the industrial hazardous waste problem. In the first way of looking, the cause of the problem is the irresponsible actions of individual corporations. This implies that the solution must be control of those corporations. In the second mode, the cause of the problem is failure of landfill technology which implies that the solution is control of the technology. These two interpretations are the topics of Chapters II and III.

The third paradigm continues to deal with industrial chemical waste but shifts the focus from control of waste to prevention. All of the dangers and inadequacies of hazardous waste are considered. In order to reduce the generation of waste at source, the production process is

examined. This means that leaks of materials into air and water are included in the definition of waste, and that recycling of residuals is considered. Solutions emphasize changes in production technology and strategy rather than disposal. This "Dangerous and Inefficient Waste" paradigm is the topic of Chapter IV.

In the fourth paradigm, the problem is defined to include all dangers related to hazardous materials. This "Meta-Problem" is comprised of numerous problem areas such as workplace safety, occupational health, and disposal and use of hazardous consumer products. Industrial hazardous waste is only one of these problem areas.

Just as the hazardous waste problem has alternative definitions, each of these problem areas can be defined in various ways. It is beyond the scope of this paper to look at each of the alternative definitions for each individual problem areas. Nonetheless, in recognizing that problem areas are intricately linked, solutions to hazardous materials problem are affected. The Meta-Problem paradigm will be discussed in Chapter V.

The unique aspects of each paradigm as well as shared characteristics are summarized in Table 1. This Table is presented as an overview and as a reference for the detailed discussion of each paradigm which comprises the remainder of this thesis.

TABLE 1. Summary of Paradigm Characteristics

Paradigm	Consequence	Type of Material	Medium	Cause of Problem	Solution
Irresponsible Corporations	Dangers to Environment and Health	Industrial Hazardous Waste	Land	Corporation	Control of Corporations
Leaking Landfills	Dangers to Environment and Health	Industrial Hazardous Waste	Land	Landfill Technology	Control/Ban of Landfill Technology
Dangerous and Inefficient Waste	Dangers to Environment and Health	Industrial Hazardous Waste	Land, Water, Air	Intrinsic Nature of Waste	Reduction of Waste at Source
Meta-Problem Of Hazardous Materials	Dangers to Environment and Health	All Hazardous Material	Land, Water, Air, Direct Human Contact	Intrinsic Nature of Material	Reduction of Material

CHAPTER II

IRRESPONSIBLE CORPORATIONS

History

Love Canal signaled a turning point in public awareness of hazardous waste as a public problem. "Prior to 1978, disposal of hazardous wastes was seen as so unimportant that most major opinion polls did not even question the level of public concern" (Epstein et al., 1982, p. 37). In contrast, by 1980, a major poll reported that "two-thirds of the responding public expressed a 'great deal of concern (about) disposal of industrial chemical wastes that are hazardous'" (pp. 37-38).

Paradoxically, the major piece of federal legislation on solid and hazardous waste, The Resource Conservation and Recovery Act (RCRA), was passed prior to Love Canal in 1976. Obviously, Congress was aware of a problem but that problem was not "hazardous waste." Rather, the problem was "pollution" of which hazardous waste was only a small part.

Public concern about air and water pollution grew throughout the 1960's and 1970's. Congress responded by passing numerous pollution laws including the Clean Air Act of 1970, the Clean Water Act of 1972 and the Safe Water Drinking Act of 1974. The laws did indeed regulate a number

of toxic pollutants but such regulation was not their sole or primary purpose (Epstein et al., 1982, chap. 8). For example, because a central purpose of the Clean Air Act is to control pollutants that lead to the destruction of the ozone layer (p. 185), it only regulates six hazardous air pollutants (Sarokin, Muir, Miller, & Sperber, 1985, p. 508). As reflected in these laws, hazardous pollutants were perceived as one small part of a larger pollution problem.

The public problem of "hazardous waste" eventually evolved into a separate public problem. Its initial setting within the pollution scenario, however, influenced the way the hazardous waste problem was first defined. Examination of the pollution problem can therefore provide insight into how and why the hazardous waste problem evolved as it did.

Three pollution characteristics that shape the hazardous waste problem are found. These are emphasis on point source industrial pollution; the connection between hazardous waste and land pollutants; and the focus on the actions of individual corporations.

To begin with, the shaping of the hazardous waste problem came out of a tradition which initially focused on large, point sources of pollution. The air and water laws were concerned with factories, municipal waste streams and automobiles. Although the 1976 RCRA legislation covered "discarded material . . . resulting from industrial, commercial, mining, and agricultural operations, and from

community activities" (Sec. 1004(27)) and did not specifically exclude non-point sources, the resulting RCRA Regulations focused on large industrial generators producing at least 2200 pounds of hazardous waste per month.

Second, by the mid 1970's it was realized that although air and water pollution was regulated, land pollution was not. RCRA was enacted to both close the land pollution gap and to control hazardous wastes. Thus, the dangers of hazardous waste became connected to land disposal.

The early pollution control laws dealt only with air and water pollutants, i.e. the problems that were visible to most citizens. "We could see the smoke from chimneys or watch sudsy water collecting near outfall pipes" (M. Brown, 1981, pp. xiii-xiv). Only gradually did government begin to understand that "what we have taken out of the air or taken out of the water we tended to put on the land and not always in the best manner" (D. Dubois cited in Transcript: Regional Public, 1977, p. 42). In fact, the Environmental Protection Agency (EPA) has estimated that approximately two-thirds of the increase in industrial waste generation was a direct result of air and water pollution regulations (Epstein et al., 1982, p. 191).

The Resource Conservation and Recovery Act (RCRA) was an attempt to close the regulatory gap by regulating what the Federal Water Pollution Control Act and Safe Drinking Water Act did not (RCRA, 1976, Sec. 1006(a)).

RCRA regulates solid wastes which include:

any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities . . . but does not include . . . industrial discharges which are point sources subject to permits under . . . the Federal Water Pollution Control Act . . . or source, special nuclear, or byproduct material as defined by the Atomic Energy Act . . . (RCRA, 1976, Sec. 1004(27))

Clearly, the Act is aimed at regulating the residuals collected by water and air pollution control technology as well as other institutional residuals. These residuals are not necessarily solid but rather are any materials that tend to be put into the land. Tom Williams, Chief of the Technical Information and Communication Branch of the EPA's Office of Solid Waste, emphasized that the "great significance of this act is . . . that we protect the third medium, we protect the air and the water and now we are going to protect the land" (EPA Region X, 1977, p. 32).

RCRA has become the central piece of legislation concerning hazardous waste. The Act recognizes that "hazardous waste presents, in addition to the problems associated with non-hazardous solid waste, special dangers to health and requires a greater degree of regulation" (RCRA, 1976, Sec. 1002(b)(5)). RCRA specifies the actions needed to respond to those special dangers of hazardous wastes in Subtitle C, one of eight major sections of the

Act. Because RCRA deals only with solid wastes rather than air and water pollutants and because it is the major piece of hazardous waste legislation, the hazardous waste problem has become synonymous with dangerous solid wastes that are land disposed.

Finally, the pollution problem shaped perceptions of the hazardous waste problem by stressing the fault of individual corporations rather than entire industries. Perhaps the most critical factor in sustaining this perception was the utter lack of understanding of the scope and magnitude of the hazardous waste problem at the time of RCRA's enactment. This ignorance is demonstrated by the minimal amount of attention paid to the hazardous waste section of RCRA and in the text of RCRA itself.

The activities of interest groups during Congressional consideration of the Act were directed away from the hazardous waste sections. In the 1974-75 and 1975-76 Legislative sessions, numerous political forces interacted to focus the debate on the solid waste portions of the bill rather than on Subsection C. The 1974 Nixon Administration worked to keep municipal trash and garbage disposal a state and local responsibility. With this in mind, the Administration tried to limit the federal role in the solid waste area to disposal of hazardous waste (Epstein et al., 1982, pp. 186-189). Tom Williams of the EPA's Office of Solid Waste believed that support for the hazardous waste

legislation was a strategy used to "prevent the EPA from pursuing its interest in efforts to reduce the volume...of solid waste generated" (p. 187). No solid waste legislation was passed in that Session.

In 1976, there was a very different political scenario. Gerald Ford was President and the Toxic Substance Control Act (TSCA) was a focal point of environmental debate. Chemical companies and environmental groups spent their energy and time on shaping that bill rather than RCRA. The RCRA debate itself focused on controversial solid waste topics such as State solid waste management plans, a ban on throwaway beverage containers, and resource recovery facilities. The only voice opposing the hazardous waste section of RCRA came from hazardous waste disposal firms and haulers. Their credibility was effectively destroyed when a Committee report was released describing widespread waste disposal practices which endangered the public and the environment. In 1976, RCRA was passed with very little discussion of the Hazardous Waste section (Epstein et al., 1982, pp. 189-194).

The second potent example of public lack of awareness is in the text of RCRA itself. Subtitle C sets out an ambitious program for regulating hazardous wastes. It requires the EPA to set criteria for identification of hazardous waste (Sec. 3001); establish standards for generators and transporters including recordkeeping,

labeling, container specifications, and a manifest system (Sec. 3002 and 3003); establish standards for owners and operators of hazardous waste treatment, storage and disposal facilities (TSDFs) (Sec.3004); develop a permit system for such disposal facilities (Sec. 3005); and promulgate guidelines to assist States in the development of State programs (Sec. 3006).

All of this was to be accomplished by the EPA within 18 months (RCRA, 1976, Subtitle C). However, the "18-month task grew into a six-year odyssey during which the hazardous waste rules were promulgated in three major phases--in May 1980, January 1981, and July 1982" (Dietrich, 1984, p. 20). Although this could be interpreted as sluggishness by the EPA (Hall, 1984, pp. 27-35), the short 18 month timeframe at least in part reflects Congress' (and the public's) lack of awareness of the scope and complexity of the problem and their naive belief that they were simply plugging a gap in the pollution problem. Thus, the lack of understanding perpetuated the perception that the problem was the domain of individual corporations rather than industry-wide.

The lack of awareness, however, should not be interpreted to mean that hazardous waste consequences were a new phenomenon. Dating the developments at Love Canal should dispel this myth. Hooker Chemical had begun using the Canal as a dumpsite for still-bottoms from the manufacture of pesticides and plastics in the late 1930's or

early 1940's. From 1947 through 1952, over 43 million pounds of chemicals were dumped there. In the 1950's, children playing in the area were often burned or covered with hard pimples. By 1959, residents had noticed black sludge leaking into their basements. In the 1960's, health problems including birth defects were reported (M. Brown, 1981, pp. 5-7; Epstein et al., 1982, pp. 92-102). To summarize, health problems from the chemicals had arisen well before national media focused attention on the story. Similar, although not always as dramatic, scenarios were occurring throughout the country.

A few industrialized states became aware of the problem and began to respond to it well in advance of the federal legislation. Texas, for example, enacted one of the first comprehensive industrial hazardous waste laws in 1969. Prior to the 1976 enactment of federal legislation, both Texas and California had a "cradle to grave" manifest system that was later imitated by Congress (Epstein et al., 1982, p. 147).

When Love Canal occurred, it dramatically separated the hazardous waste problem from the pollution problem by raising public consciousness of the inherent dangers. However, it also reinforced the perception that the hazardous waste problem is caused by individual corporations who were irresponsibly landfilling hazardous wastes.

Problem Description

The hazardous waste problem thus emerged as one of Irresponsible Corporations. A summary of this paradigm follows. Many corporations--generators, disposal companies, and waste haulers--have disposed of hazardous waste irresponsibly; some continue to do so today. This disposal, sometimes illegal and often immoral in its lack of concern for public consequences, is characterized by the dumping of wastes directly into the land with little or no attempt at containment. Such irresponsible behavior causes contamination of groundwater, surface water, and land, and results in harm to human health and the environment.

This perception of the hazardous waste problem is widespread. For example, Michael Brown (1981) in his book Laying Waste, describes the problem succinctly:

The central reason why human damage from pollution has startlingly risen is a simple one: Industrial wastes are being ignored by our regulators and dispersed with abandon by our industrial firms and indeed by those companies whose sole responsibility is the supposed safe handling of the debris. (p. 231)

Albert Gore, Congressperson from Tennessee, states that "90 per cent of the wastes disposed of each year are dumped in an irresponsible and environmentally unsafe manner" (Epstein et al., 1982, p. x). Others perceive mismanagement as resulting from "unknowing, inexperienced, and unconcerned companies" (Jackson, Weller, & the Waterloo Public Interest

Research Group, 1982, p. 18).

Evidence of mismanagement, as provided in numerous case studies made available by media and research reports, includes descriptions of wrongdoing and consequences suffered by "victims." The descriptions of irresponsible actions are common and contain examples of illegal and/or unethical dumping and descriptions of companies acting deceitfully. In Hardeman County, Tennessee, one company (Velsicol) used shallow burial to dispose of pesticides. Trucks would dump fifty-five gallon steel drums and fiber cartons of wastes into shallow trenches:

A bulldozer would then deliberately crush the drums and cover them and their spilled contents with a few feet of dirt. . . . The trenches were not lined with impermeable materials, so nothing prevented the liquid wastes from leaching directly into the underlying soil. (Epstein et al., 1982, pp. 51-52)

Wastes being dumped into unlined lagoons or on plant grounds or through pipes into rivers or off the backs of moving trucks in residential neighborhoods are all common scenarios as are descriptions of company coverups, refusal to accept responsibility, and attempts to "buy off" individuals (M. Brown, 1981; Epstein et al., 1982; Jackson et al., 1982).

Examples of the health consequence for individuals living or working near these dump sites have already been described in some detail. These individuals are "victims" because they are faced with health effects they have no

control over but also because of economic loss and lack of legal redress. One Love Canal resident found that "decisions are being made for my family by people who have probably never been here, who don't even know us" and believed that her rights were gone (Epstein et al., 1982, pp. 107,109).

During the mid to late 1970's, many federal government officials and members of Congress also perceived the problem to be one of individual corporate mismanagement of hazardous waste. RCRA was a direct response to Congressional findings that disposal of hazardous waste "without careful planning and management can present a danger to human health and the environment" (RCRA, 1976, Sec. 1002(b)(2)). In fact, RCRA defines hazardous waste to be solid waste that poses "present or potential hazard to human health or the environment when improperly (emphasis added) treated, stored, transported, or disposed of, or otherwise managed (Sec. 1004(5)).

Government officials speaking at public hearings also perceive the problem to be one of mismanagement, particularly by waste disposal companies and transporters. While describing RCRA's transportation requirements, John Lehman, Director of the Hazardous Waste Management Division of EPA's Office of Solid Waste, points to "fly-by-night" operations. These are businesses that will:

Back into a loading dock of a manufacturer and say "well, I will take your waste for so many dollars per ton" and away they go and no one ever sees them again; and that is precisely what we are trying to avoid here because no one knows where those wastes go. I can tell you where some of them go. They go to very bad places.
(Transcript: Regional Public, 1977, p. 80)

In describing the purpose of the section of RCRA requiring standards for owners and operators of treatment, storage, and disposal facilities (TSDFs) for hazardous waste, Lehman again points to mismanagement:

What we are talking about there is to avoid some of the problems we have had in the past where people will go into business to accept these wastes that are toxic or hazardous for a fee and stack them up somewhere or pile them in a back yard or somewhere and walk away and therefore leave a mess for somebody, usually a state or local or federal government, to clean up.
(Transcript: Regional Public, 1977, pp. 82-83)

From this overall description of the Irresponsible Corporation paradigm, a number of characteristics are evident: concern for health and environment; an emphasis on industrial chemical wastes and land disposal; individual corporate responsibility; the important role of government; and faith in technology. The concern for human health and the environment has already been discussed. Each of these other characteristics, however, requires further examination.

Industrial Hazardous Waste

With its origin in pollution control, it is not

surprising that the hazardous waste problem concerned itself with industrial chemical hazardous waste. Each of these words used to describe the material--"industrial", "chemical", "hazardous", and "waste"--shapes the problem in a particular way and places it in a particular context. Not only do they tell us what materials are included but also what materials are excluded from consideration.

The words "industrial waste" denote a particular material in the industrial process and is connected to a particular activity in the economy. The production and consumption model used in conventional economic theory is therefore a useful tool for clarifying the "industrial waste" designation. Figure 1 is a representation of this model modified to recognize the function of the biophysical environment as the "source for resources and sink for residuals" (Baldwin, 1985, p. 19). The graphics have been further modified to clarify certain characteristics of the Irresponsible Corporation paradigm. Because this model will be used to describe each of the hazardous waste paradigms presented in this paper, it is now discussed in detail.

All resources used by humans in the production process come from the natural or biophysical environment. The purpose of production is to create products for consumption or for use in the production process. Some resources, however, are wasted during the production process. These materials leak directly into the air (as air pollutants) or

water (as water pollutants) or land. Other residuals remain at the end of the production process. These can either be deposited back into the environment--through the medium of land, water, or air--or they may be recycled.

As Figure 1 indicates, these industrial residuals are not the only materials that find their way back into the environment. Eventually, consumer products either wear out, dispersing fragments into the environment, or are discarded and disposed of into the environment. Again, they may be recycled rather than disposed.

The Irresponsible Corporation definition of the hazardous materials problem is only concerned with industrial residuals which are returned to the environment. Consumer wastes and substances used in the production of goods are excluded from the problem definition. In other words, process waste is included while products and product waste are not. The dark lines in Figure 1 indicate the materials and activities encompassed by the Irresponsible Corporation paradigm.

This concern with waste implies a lack of concern for economically useful material. A chemical destined for a landfill is part of the problem, while the same chemical headed for a factory as feedstock is not. The problem is concerned only with "poisons that nobody wants" (Epstein et al., 1982, pp. 5-6). "We are not talking about commodities. We are talking about waste which could be red slime, yellow

goo; you name it" (J. Lehman cited in Transcript: Regional Public, 1977, p.77).

This perception of economic worthlessness effects the paradigm in a number of important ways. First, it confirms that solid waste and hazardous waste are two separate problems. Congress' main purpose in the solid waste portion of RCRA is to conserve energy, material and land. These purposes are all but absent in the hazardous waste section (Subtitle C) of the Act. Second, the worthlessness of the materials provides an explanation of why corporations might act irresponsibly. If the materials were valuable, corporations would use them for profit. Instead, they are considered worthless and therefore treated carelessly. Because no one wants the wastes, "no one can be relied upon to safeguard" them (Epstein et al., 1982, p. 37).

So far, the perception that the Irresponsible Corporation paradigm is concerned only with industrial waste has been discussed. The hazardous and chemical nature of the material are yet to be described. The traditional Materials Balance Model utilized in Figure 1 refers to all materials, whether hazardous or non-hazardous. The Irresponsible Corporation paradigm, however, only includes non-radioactive materials that are hazardous.

Nuclear waste is excluded from the shaping of this hazardous waste problem. Indeed, it is seen as a separate

problem with a separate shape. This is perhaps in part due to the fact that state or local government control of nuclear materials has been historically preempted by federal government control and because the degree of danger inherent in nuclear waste is perceived as being significantly higher than that of other hazardous waste.

The hazardous nature of the material has already been implied in the descriptions of environmental and health consequences. There are, however, a number of different public health hazards possible depending on the particular hazardous nature of the material. Wastes included in the Irresponsible Corporation paradigm are those which are flammable, reactive, corrosive, and toxic (Baldwin, 1985, p. 184). Toxic effects may be either acute or chronic and include mutagenicity, teratogenicity, and carcinogenicity. Determination of which materials fit these characteristics has, of course, been a matter of animated political debate. It is this growing concern about hazards that shifted the problem from the pollution and solid waste contexts.

Medium of Contamination

In addition to delineating the problem as "industrial chemical hazardous waste," one other factor is helpful in characterizing the materials included in the Irresponsible Corporation paradigm. This factor is the medium of environmental contamination. As we have already seen, the

evolution of the problem from the context of pollution led to the perception that air and water were already being protected. The hazardous waste problem became connected to the protection of the remaining medium--land. Contamination already covered by the air and water pollution acts are excluded from the problem.

This discrete differentiation between air, water, and land comes easily undone. To begin with, the three media themselves form an interlocking and interacting system. Materials deposited initially in the land, for example, will not necessarily remain stationary but will migrate into groundwater and surface water. In addition, residuals prevented from entering one medium do not disappear but remain to threaten the environment through other media.

This interconnection is certainly recognized in the Irresponsible Corporations paradigm. RCRA, for example, regulates all hazardous waste disposal alternatives whether or not they involve the land (1976, Sec. 1004 (7)). In other words, incineration and treatment are regulated as well as landfilling, land treatment, and deep well injection. In addition, land disposal is known to potentially result in emission of materials into air or water (Sec. 1004 (3)). RCRA charges the Administrator with the task of integrating all provisions of RCRA with appropriate provisions in the Clean Air Act, the Federal Water Pollution Control Act, and the Safe Drinking Water Act

(Sec. 1006(b)).

Epstein et al. (1982) also acknowledges the varied pathways of contamination:

The general populace is exposed in daily life to trace quantities of many hazardous wastes. Virtually all Americans carry in their bodies burdens of lead, DDT, PCBs, and other toxic chemicals. Such exposures result from broad environmental dissemination of these hazardous materials in the form of air pollutants, food-chain contaminants, and through direct use of toxic consumer products. (p. 32)

Despite this recognition, "these exposures have not been incriminated in any dramatic and documented incidents of death or disease" (p. 32). Rather, it is high concentrations of hazardous wastes that are at issue. These concentrations are found near hazardous waste disposal sites that are mismanaged, in groundwater contaminated by wastes from unlined ponds, and in areas of soil contaminated by industrial leaks (pp. 32-34). In other words, the significant sources of the problem are sites of indiscriminate dumping on the land.

Even the definition of toxicity set out by RCRA regulations is related to land disposal. In the draft regulations, wastes were regulated based on whether their toxic components dissolved in water at greater than a specified rate. This is based on the assumption that hazardous wastes that are relatively insoluble could be safely disposed of in an ordinary municipal landfill (Epstein et al., 1982, p. 236). Although the final 1980

regulations were revised, one of the criteria for listing a waste was the determination of:

the potential of the constituent or any toxic degradation product of the constituent to migrate from the waste into the environment under . . . improper management. ("Hazardous Waste Management", 1980, 40 CFR 261.11 (3)(iii))

In other words, the definition of "hazardous" is dependent on the media and technology used. Since dumping into the land is the main concern, the degree with which materials can migrate in the land is the main criteria for including wastes as part of the problem.

Attitude toward Technology

Only improper land disposal is perceived as being a problem. As indicated in Table 2, on-site land disposal and secure landfill are considered to be proper methods of disposal. In general, the use of land as a storage place for hazardous waste is not questioned. Unlike air and water pollution control which prevents pollutants from getting into the media of air and water, land pollution control only attempts to prevent movement of the materials that are placed purposefully on the land. Land is used as permanent storage.

The adequacy and appropriateness of available disposal technology is not questioned. In the Irresponsible Corporation paradigm, the word "dumped" means abandoned or ignored and does not refer to purposeful and managed land

TABLE 2. Proper and Improper Methods of Hazardous Waste Disposal, 1978

Method	Pounds (billions)
Properly disposed of:	
On site disposal	5
Secure landfill	2.6
Improperly handled:	
Unlined lagoons and ponds	34
Nonsecure landfills	20
Ocean dumping, sewers, roads, deep-well injection, ordinary incinerators	14.4
Total	76

Note. From Hazardous Waste in America (p. 9) by S. S. Epstein, L. O. Brown, and C. Pope, 1982, San Francisco: Sierra Club Books.

disposal. The problem is not a failure of the technology that is utilized but rather a fault of companies that do not utilize available technology. "The flaw has been in our thinking and planning, not in our machines" (Piasecki, 1984a, p. xvii). If disposal technology was used, the problem, in theory, would disappear.

Causal and Political Responsibility

As indicated by its name and my initial description, the primary characteristic of the Irresponsible Corporation paradigm is the placement of responsibility for environmental and health damage on individual corporations. This

responsibility is both causal as well as political and legal. The distinction between these two meanings of responsibility is useful in understanding the paradigms.

Causal responsibility is "a matter of belief or cognition, an assertion about the sequence that factually accounts for the existence of the problem" (Gusfield, 1981, p.13). Different causal sequences are possible and reflect different interpretations of reality. In the sequence accepted in the Irresponsible Corporation paradigm, it is the careless or negligent action of a particular company that eventually causes human health and environmental damage. Irresponsible disposal of hazardous waste results in a dangerous situation--open dumps, toxic drinking water, leaching into residential areas, etc.--which leads to human contamination. The irresponsible corporation might be a generator, waste management company, or hazardous waste hauler.

Political responsibility "asserts that someone or some office is obligated to do something about the problem, to eradicate or alleviate the harmful situation" (Gusfield, 1981, pp. 13-14). This is close to legal responsibility in that the person who is legally responsible for wrongdoing can be blamed, punished, or made to pay (p. 14). In the Irresponsible Corporation paradigm, political responsibility is also lodged in corporations. The company that causes human health problems is the entity that is held legally

liable just as they are perceived to be causally responsible.

Since alternative causal sequences are possible, the relationship between causal and political responsibility is not surprising:

It is not that a theory of causal responsibility establishes a specific locus of political responsibility. It may be that the reverse is more frequent; a belief in the political reality lends credence to causal theories which sustain that locus. The relationship between the two is at least a two-way road. (Gusfield, 1981, p. 47)

In the Irresponsible Corporation paradigm, political liability is based on negligence or nuisance laws. In popular usage, the word "negligent" denotes a failure to exercise the care that a "prudent person" usually exercises. In law, negligence has a similar meaning:

Negligence is traditional liability for a breach of a duty of care owed by the defendant. To prove negligence the plaintiff must show: 1) that the defendant was under a duty to conform to a standard of care in the conduct of his activities; 2) that the defendant breached that duty of care; and 3) that there was a reasonably close connection between the defendant's conduct and the plaintiff's injury. (Davis, 1986, p. II-6)

Thus, carelessness or failure to act in a reasonable manner is negligence.

In the Irresponsible Corporation paradigm, companies can be both causally and politically negligent. In the literature describing this paradigm, it is common for companies to be depicted as negligent. For example, a Congressional Investigation found Browning-Ferris Chemical

Services Industries (BFI) "grossly negligent" even though it did not intend to deliberately dump hazardous waste on public roads (Epstein et al., 1982, p. 144).

It is also common for companies to disown such responsibility by denying that they were part of the causal sequence, by claiming that they were not politically responsible because they utilized due care by the industry's standard, or by shifting the political responsibility to another actor. In Hardeman County, for instance, Velsicol tried to remove itself from the causal sequence by announcing "that it was 'highly improbable' that the chemicals had come from its dump site" (Epstein et al., 1982, p. 56). In 1979, Hooker Chemical maintained that it was protected from liability because it used proper care in burying chemicals at Love Canal. This proper care consisted of "standard industry methods" that would have "met current disposal standards" (pp. 118-119). Velsicol also claimed that it followed a "time-honored practice (of) shallow burial of toxic wastes" (p. 51). These companies claimed that a standard of care existed and that they followed that standard.

Others attempt to shift the responsibility to state government. One indicted recycler, for example, blamed the problem on "the state's continued failure to provide approved hazardous waste disposal facilities . . . 'Honest' recyclers have no place to dispose of their toxic wastes"

(Epstein et al., 1982, p. 159).

This emphasis on corporate responsibility is reflected clearly in RCRA. By passing RCRA, Congress mandated that the EPA determine and enforce a standard of care. If a corporation follows RCRA regulations, then they conform to the standard of care. If they disobey the regulation, they breach their duty and are irresponsible.

Although the government is not causally responsible for the problem, it is perceived as being politically responsible. In the Irresponsible Corporation paradigm, both state and federal governments have this political responsibility. While industry is responsible for making the managerial decisions and inventing and implementing the technologies that will dispose of hazardous waste in a safe way, government is responsible for setting and enforcing the safety standards.

Federal government has assumed political responsibility as an extension of its involvement in pollution control. This is based on its power to regulate businesses engaged in interstate commerce as provided in the Commerce Clause of the U. S. Constitution (Epstein et al., 1982, p. 183). Congress and the EPA are the primary federal bodies involved. RCRA authorizes the EPA to delegate authority to state government as long as state programs are at least as strict as the EPA program (RCRA, 1976, Sec. 3006).

Because of their political responsibility, both federal

and state governments are often accused of being irresponsible for not strictly enforcing hazardous waste standards, for delaying rulemaking, or for writing weak standards (Hall, 1984, pp. 27-35).

An Individual Problem

The placement of causal and political responsibility in individual companies is closely connected to another characteristic of the Irresponsible Corporation paradigm:

The legal discussion, and subsequent statute laws defining negligence and the responsibilities of business enterprise, are couched in a language that fixed responsibility in individual cases and "proximate causes" rather than in aggregate elements. (Gusfield, 1981, p. 36)

Only certain corporations cause the problem, not all corporations. The problem is therefore an individual rather than an aggregate or collective one.

This perception is clearly stated by John Lehman, Director of the Hazardous Waste Management Division of EPA's Office of Solid Waste:

I should say most people in the transport business that I have talked to are very much in favor of these (RCRA's) standards, because they are hurt. The reputable people are hurt by the fly by night operators. They would like to see them forced out of business. (Transcript: Regional Public, 1977, p. 81)

Mismanagement does not characterize all transporters only those individual companies that are irresponsible.

The placement of blame on individual companies is

reinforced by the use of individual case studies rather than aggregate data and the use of a particular type of rhetoric that accuses specific companies of being irresponsible. Commentators clearly and openly point fingers of blame. Michael Brown (1981) outrightly states that Hooker Chemical despoiled land, poisoned groundwater, and fouled the biosphere:

The pattern confirmed that systematic and arrogant attitude within the firm that condoned the degradation of the earth's green mantle and the violation of the nation's laws. (p. 86)

Epstein asks "is Hooker the worst offender in the nation?" (1982, p. 132) and points to the fact that the Wall Street Journal called Velsicol a "corporate renegade that seems totally lacking in public responsibility" (p. 50). Statements like these brand particular companies as irresponsible, thereby implying that other companies are responsible.

Responsible management is possible. Irresponsible disposal of hazardous waste is "a choice by a willful person" (Gusfield, 1981, p. 6) and can therefore be prevented. This belief results in the use of enforcement mechanisms in RCRA. In the original 1976 Act, civil action could be brought by the federal government against any company not complying with the Act (Sec. 3008(a)). In addition, legal action may be taken when there is:

Evidence that the handling, storage, treatment, transportation or disposal of any solid waste or hazardous waste presents an imminent and substantial endangerment to health or the environment (Sec. 7003(a))

When RCRA was reauthorized in 1980, the EPA had not yet issued regulations so Congress had no experience on which to base revisions. In the four years since RCRA's enactment, however, large numbers of irresponsible disposal cases had been brought to public attention. This did not change the perception that the problem was an individual one but rather seemed to strengthen it. Congress responded by strengthening the enforcement provisions. The Imminent Hazard section was changed so that legal action could be taken prior to the actual occurrence of a hazard (Sec. 7003 (a)). Criminal penalties were included for those persons who knowingly breach specified standards (Sec. 3008(d)) or who knowingly places another person in imminent danger of death or serious bodily injury (Sec. 3008 (e)). These changes reinforce the perception of the hazardous waste problem being one of willful acts by knowing individuals.

Ownership

In the Irresponsible Corporation paradigm, the hazardous waste problem is perceived as being caused by individual corporations acting negligently. Corporations that act correctly are therefore not part of the problem. Certainly, it is to a corporation's advantage to be

perceived publicly as being separate from the problem. Thus, a representative of Hooker claimed that the company acted as a "responsible corporate citizen" (M. Brown, 1981, p. 27). Also, it was noted earlier that most corporations did not participate in Congressional Hearings on the 1976 RCRA. This, too, could be interpreted as an attempt to keep the problem from being perceived as a collective one.

Again, Gusfield (1981) utilizes a concept that is useful--"ownership of public problems." Ownership is the "ability to create and influence the public definition of a problem." This recognizes that "in the arenas of public opinion and debate all groups do not have equal power, influence, and authority to define the reality of the problem" (p. 10) It also recognizes that such power and influence can change in the course of the history of the problem.

In addition, some powerful groups might be "interested in avoiding the obligation to be involved in the problem creating or problem solving process" (Gusfield, 1981, p. 12). They disown the problem in order to avoid joining in the debate. This is clearly what the corporations in the Irresponsible Corporation paradigm are attempting to do. It would be in the interest of any corporation dealing with hazardous waste--irresponsible or not--to disown the problem.

Actors

Actors in the public arena are persons or associations who have the power and influence to own or disown the public problem. In some instances ownership coincides with causal or political responsibility; in other instances it does not.

Generators, waste disposal companies and haulers all are seen as being responsible for the hazardous waste problem. Of these, individual generators have attempted--sometimes successfully, sometimes not--to disown the problem. Waste companies and haulers have have had less luck in disowning responsibility for the problem. They are not perceived as being credible and therefore have little power to own (or disown) the problem. For example, haulers were the one group that lobbied extensively on Subtitle C of RCRA but they had little influence. Recyclers also provided input into the RCRA regulations with little success (Transcript: Regional Public, 1977).

Government is not only politically responsible for finding a solution to the hazardous waste problem, but also owns the problem:

Today the state appears more often as an active agent, the owner of the problems it seeks to solve. Governmental officials and agencies operate to define public issues, develop and organize demands upon themselves, and control and move public attitudes and expectations.
(Gusfield, 1981, p. 15)

The government strongly reinforces belief in the Irresponsible Corporation paradigm by creating legislation and regulations that reflect it, by producing statistics that provide evidence of it, and by entering into litigation with individual irresponsible corporations.

Other actors with power in the political arena are environmental groups and citizen interest groups. Some of these are national groups such as Sierra Club and the National Resources Defense Council (NRDC) which are involved in numerous issues. Others such as the Home Owners' Association started by Lois Gibbs in Love Canal evolved as a result of a particular hazardous waste threat. These groups are neither causally or politically responsible but do have some influence in the political arena. As previously indicated, these groups were not initially active in the 1976 RCRA debate. Blake Early, a lobbyist for Environmental Action, describes this lack of involvement as a "conscious decision not to try to generate much public attention to RCRA" because such attention would only serve to "attract attention from industry, which otherwise might remain preoccupied with TSCA" (Epstein et al., 1982, p. 190). Whatever the reason, these groups became more active as public media drew attention to the problem.

Finally, it is interesting to investigate potential actors that are conspicuously absent. Certain government science and health agencies such as the National Institute

of Science and the National Institute of Health provide statistics describing the problem. Public and private health agencies in general, however, seem to be uninvolved as independent actors. One good example of this is the role of the National Cancer Institute (NCI) as described by Daryl Chubin (1984, pp. 109-129) in an article entitled "Research Missions and the Public: Over Selling and Buying the U.S. War on Cancer." The National Cancer Act of 1971 specified that the NCI was to research the hypothesized link between RNA viruses and cancer. This funded mission preempted other possible directions, such as research on environmental carcinogens. It was not until 1980 when the National Toxicology Program was instituted that the shift to environmental carcinogens became public policy for the NCI. Thus, NCI did not independently influence the shift in missions, but rather followed a federal government policy change that had already occurred.

Even so, the quality and totality of the shift is questionable. In 1981, for example, President Reagan appointed the Chairperson of Occidental Petroleum's board to serve as chair of NCI's National Cancer Advisory Panel. Two years prior, this man had stated that the danger of Love Canal was minimal and had "been blown out of context" (Epstein et al., 1982, p. 132). In this instance at least, NCI seems to have acted to deny rather than demonstrate the connection between hazardous materials and cancer. In

disowning the problem, it has reinforced the concept that the problem is minimal and caused by individual corporations rather than by the hazardous materials and industry as a whole.

Solutions

Certain solutions are inherent in the Irresponsible Corporation paradigm. Since the problem is defined as one of individual companies acting negligently in the management of their hazardous waste, then the solution must be to get those companies to act in a proper way i.e. "to ensure that those who generate such hazardous wastes do not simply dump them, but handle them without creating public health or environmental problems" (Epstein et al., 1982, p. 7). The solution must therefore include the creation of a standard for responsibility (a definition of "proper" disposal) and a way of insuring that companies meet that standard. This is, of course, exactly what RCRA--both the 1976 legislation and the regulations promulgated in 1980--does.

RCRA sets both management and disposal standards. The management standards include generator, hauler, and disposer requirements to use the manifest system, label materials, and keep records. These are clearly aimed at preventing midnight or illegal dumping. In addition, owners and operators of treatment, storage, and disposal facilities must acquire permits, have a contingency plan and emergency

procedures, and monitor groundwater. Financial requirements include assurance of closure and post-closure abilities and responsibility for the site for 30 years after closure.

Disposal standards are physical specifications for incineration and land disposal. Land disposal includes landfills, land treatment, surface impoundments, and injection wells. Technological specifications are given for tanks, liners, construction materials, leachate collection systems, hydrogeologic settings, monitoring systems, etc. These standards are not performance standards or best available technology (BAT) requirements but are aimed simply at containing the hazardous materials. For incinerators, performance standards are set.

Once the standard for responsibility is set, compliance must be insured. As we have already seen, this is accomplished through criminal and civil law enforcement. In addition to the direct promulgation of compliance mandates, RCRA requires the collection of data through reports and manifests that is critical for such enforcement.

Land disposal and incineration share a critical characteristic: both are means of disposing of hazardous waste that has already been produced. Neither prevent the production of that waste. Congress, in fact, stipulated that the EPA was not to disrupt or alter the production process (Berlow, 1986, p. V-3). Therefore, up until 1984 reduction of the amount or degree of hazard of waste at

source and recycling are not mandated or even encouraged. The primary approach to solving the Irresponsible Corporation paradigm is disposal. As long as a particular technology meets the standard for responsibility set by RCRA, it is acceptable.

In actuality, this response to the Irresponsible Corporation is in effect a call for better dumps:

Dumps that are properly identified and policed 24 hours a day--and monitored for generations. Dumps that confine waste in corrosion-resistant containers. Dumps with impermeable liners to prevent groundwater contamination. Dumps that aren't right next door to housing developments, drinking water supplies, and children's playgrounds. But dumps nevertheless. (Piasecki, 1984a, p. xiv)

Company engineers have responded by designing new landfills, known as scientific landfills or secure landfills. "Both government officials and private consulting engineers developed a religious faith in these new technologies" (Montague, 1984, p. 4). Politically, any technology that meets the standard for responsibility is an acceptable solution to the hazardous waste problem. Economically, landfills were the most inexpensive and available, and therefore the most widely accepted, solution. A cost comparison of disposal options is provided in Table 3. Since as much as 80 percent of hazardous wastes are disposed of on land (Office of Technology Assessment, 1983b, p. 8), it is not surprising that RCRA focused on setting standards for landfilling.

TABLE 3. Representative Unit Costs for Commercial
Hazardous Waste Treatment and Disposal

Category	\$\backslash\$tonne
<u>Typical Ranges:</u>	
<u>Land disposal</u>	
Landfills (low to high hazard drummed waste)	\$13-\$240
Deep well injection--oily waste waters	\$16-\$40
Land treatment, farming or spreading	\$5-\$24
Chemical treatment--acids or alkalines	\$21-\$92
Incineration (clean combustible liquids to highly toxic and refractory solids or drummed waste)	\$53-\$800
<u>Most Costly:</u>	
<u>Land disposal</u>	
Landfills (extremely hazardous waste)	\$168-\$240
Deep well injection--toxic rinse waters	\$132-\$264
Chemical treatment--cyanides, toxic metals, highly toxic wastes	\$66-\$791
Incineration (solid or drummed highly toxic waste)	\$400-\$800

Note. From Technologies and Management Strategies for Hazardous Waste Control (p. 15) by Office of Technology Assessment, 1983, Washington, DC: U. S. Government Printing Office.

Effectiveness of Solutions and Paradigm Status

With some notable exceptions, the general consensus is that the hazardous waste problem has not been solved. When the problem is characterized as Irresponsible Corporations, the solution involves the setting of standards and enforcement. The ineffectiveness of the solutions must therefore indicate either inadequate enforcement or inadequate standards. Both possibilities have been

articulated by various actors.

It has been argued that lack of implementation and enforcement by the EPA has been a result of budget cuts, the complexity of the problem, lack of support from the administration, and pressures from industry. For example, James Moorman, former director of the Sierra Club Legal Defense Fund, believes that "the EPA is in serious need of tough law enforcement investigators" (Epstein et al., 1982, p. 230), and Congressman James Florio states that "it is ridiculous to expect EPA to meet its current responsibilities and take on new ones if it does not have enough money or trained personnel (Florio, 1984, p. x).

Standards have also changed. RCRA had defined responsible disposal which, through compliance by generators, haulers, and disposal companies, would create responsible corporations. Over time, this standard has been tested through use and found lacking. As the standard changed, the definition of a "responsible corporation" also changed. Corporations previously thought of as responsible were perceived as again being negligent. This has allowed the Irresponsible Corporation paradigm to endure.

However as progressive standards have been set and found inadequate, landfill technology itself began to be questioned. If the entire technology is problematic, then the problem concerns all generators and disposal companies rather than individuals. Causal responsibility is altered.

Not only do the solutions change, but the shape of the problem itself begins to shift.

CHAPTER III

LEAKING LANDFILLS

Problem Description

The Leaking Landfill paradigm has evolved gradually in response to new information and actors in the political arena. It is a link joining the Irresponsible Corporation definition to the Dangerous and Inefficient Waste paradigm. Shifts between paradigms, however, are not discrete. Multiple paradigms exist simultaneously with the newer paradigm often borrowing from and building on the older interpretation. This indeed is the case with the Leaking Landfill paradigm. Nonetheless, it is unique and requires separate consideration.

The paradigm of Leaking Landfills can be summarized in the following way. Landfills and other land disposal containment methods eventually leak. This is true even of "state-of-the-art" landfills. The leaked hazardous material finds its way through the land into groundwater and surface water as well as into the air. Harm to the environment and human health results:

There is no such thing as a secure landfill;
there is no such thing as "permanent" disposal of
hazardous wastes in the ground. There is "long
term storage" in the ground but sooner or later

what we put in the ground will move--and the place it is most likely to move to is someone's drinking water supply. (Montague, 1984, p. 11)

Prudent planning requires that we assume the worst: whenever we dump toxic chemicals, someone, somewhere, will be harmed. (Montague, 1984, p. 7)

In the Irresponsible Corporation paradigm, only certain types of "dumping" were dangerous. In this new paradigm, all land disposal is "dumping" and considered dangerous. Because of this, "setting standards for landfills and enforcing those standards is not the ultimate answer" (Florio, 1984, p. viii). Instead, landfilling of hazardous waste must be stopped.

Awareness of the ineffectiveness of landfills has developed as a result of newly accessible information about abandoned sites and state-of-the-art sites. Aggregate statistics about leaking dumps resulting from the irresponsible actions of the past provided a perspective on the magnitude and degree of danger of the problem:

An unreleased EPA study . . . indicates there are 80,263 sites in the Nation with contaminated surface impoundments (pits, ponds, and lagoons). Ninety percent are believed to pose at least a potential threat of ground water contamination. (Office of Technology Assessment (OTA), 1983b, p. 10)

The debate over enactment of the Comprehensive Environmental, Response, Compensation, and Liability Act of 1980 (CERCLA), known as Superfund, focused national awareness on these sites.

Even so, landfilling could have been absolved from the

problem if all the leaking sites were illegal ones or built prior to the setting of the RCRA standards. This was not the case. EPA admitted that "even with the new stricter RCRA regulations in place, eventual releases of hazardous constituents from land disposal facilities are highly probable" (OTA, 1983b, p. 12). Gary Davis (1986), an environmental attorney known for his experience in litigation involving hazardous materials, aptly states that we are "creating a new generation of potential 'Superfund' sites that will require clean up in the future" (p. II-2).

As evidence, Davis (1986) draws attention to the case of the SCA landfill in Wilsonville, Illinois. That landfill was permitted under state and federal regulations and was "considered by regulators to be one of the most secure sites in the nation" (p. II-2). Nonetheless, local concern about contamination of groundwater resulted in a citizens' nuisance suit that forced the company to remove wastes at the cost of over \$20 million (p. II-2). The failure of licensed sites is also obvious in California, where the regulatory program that was the model for RCRA had been in effect since 1972. Licensed sites were fraught with problems throughout the 1970's, and three of them were closed in 1980 when geological investigations showed that they were not secure (Davis, 1984, pp. 74-75). In addition, once legislation was in place many landfills simply could not meet the legal standard. In November of 1985, for

example, 500 of 1246 available landfills were shut down because they could not meet new groundwater monitoring requirements (DeKoltz, 1985, p. 8).

The problem of hazardous wastes, then, is not only a problem of indiscriminate dumping of the past but of the current use of regulated, "secure" land disposal. Past and present problems are connected. Since as much as 80 percent of federally regulated hazardous waste is currently being placed in or on the land (OTA, 1983b, p. 10), and since approximately 245 million tons of hazardous waste is being generated nationally each year--one ton for every man, woman, and child (Florio, 1984, p. ix)--the problem is a significant one.

In addition to individual cases and statistical evidence pointing to failing landfills, scientific and technological theories lend credence to the paradigm. Peter Montague, project administrator of the hazardous waste research program at Princeton University, explains:

How do we know that all landfills must eventually leak? We know this with absolute certainty because of one of the most fundamental laws of the universe . . . the second law of thermodynamics. . . . This law explains what will happen to chemicals placed in a landfill. They will tend--in the long run--not to stay where we put them. They will tend to become dispersed throughout the environment. They will tend to spread, to move into the atmosphere, and into the soil, and into the groundwater. (Montague, 1984, p. 5-6)

The second law of thermodynamics affects three main

components of a landfill: the bathtub which is made up of one or more liners below the waste, the umbrella which is a cap placed above the waste after the landfill is full, and the leachate collection system which is a set of pipes that act to drain off and remove leached materials. As soon as humans stop managing the site, the umbrella and bathtub will begin to deteriorate and the chemicals will begin to leach. Weak spots in the lower liners will develop cracks, holes, and tears allowing hazardous wastes to seep out. Above, precipitation, wind, freeze/thaw cycles, sun, roots of vegetation, and animals will work to erode and destroy the cap. The bathtub will then fill with rainwater, overflow, and contaminate the environment. In addition, liquids will eventually leak out of any barrels of liquid placed in the landfill. The weight from above will then crush the barrels and the cap will crack, letting in water and contributing to the overflow and contamination. Finally, the leachate system will stop working as soon as the pipes clog or humans stop providing energy to power the pumps (Montague, 1982, pp. 3-17).

If a landfill fails before the hazardous waste biodegrades, contamination will occur. Chemicals remain dangerous "in some cases, for decades; in other cases, for hundreds of years; in some cases, basically forever" (Montague, 1984, p. 7). In the standards set up by the 1976 RCRA, however, post closure financial responsibility is only

required of the landfill owner for 30 years. Since control for "hundreds of years" or "forever" is impossible, eventually the landfills will fail and contamination will occur. It is reasoning such as this that leads Montague to conclude that the idea of a secure landfill is "really a figment of optimistic imaginations" (Boffey, 1983, p. A20).

Industrial Hazardous Waste

Like the previous paradigm, the materials included in the Leaking Landfill definition are hazardous industrial chemical wastes. Consumer and product wastes, high level nuclear wastes, and hazardous substances are again excluded from the problem. Two changes, however, are evident. First, reclaimed/reused materials are included, as indicated in Figure 2. Second, hazardous wastes that are particularly dangerous when disposed of in landfills are emphasized. Both these changes are now discussed in greater detail.

Recycled materials are included in the Leaking Landfill paradigm for two reasons. As we will see in the following section on technology, restrictions or bans on landfilling hazardous materials will result in an emphasis on treatment and reclamation/reuse. Thus, recycled materials are part of the solution. But they are also perceived as part of the problem. "Sham" recycling is of particular concern. This occurs when wastes are inappropriately placed directly into the environment, often in the guise of purposeful reuse.

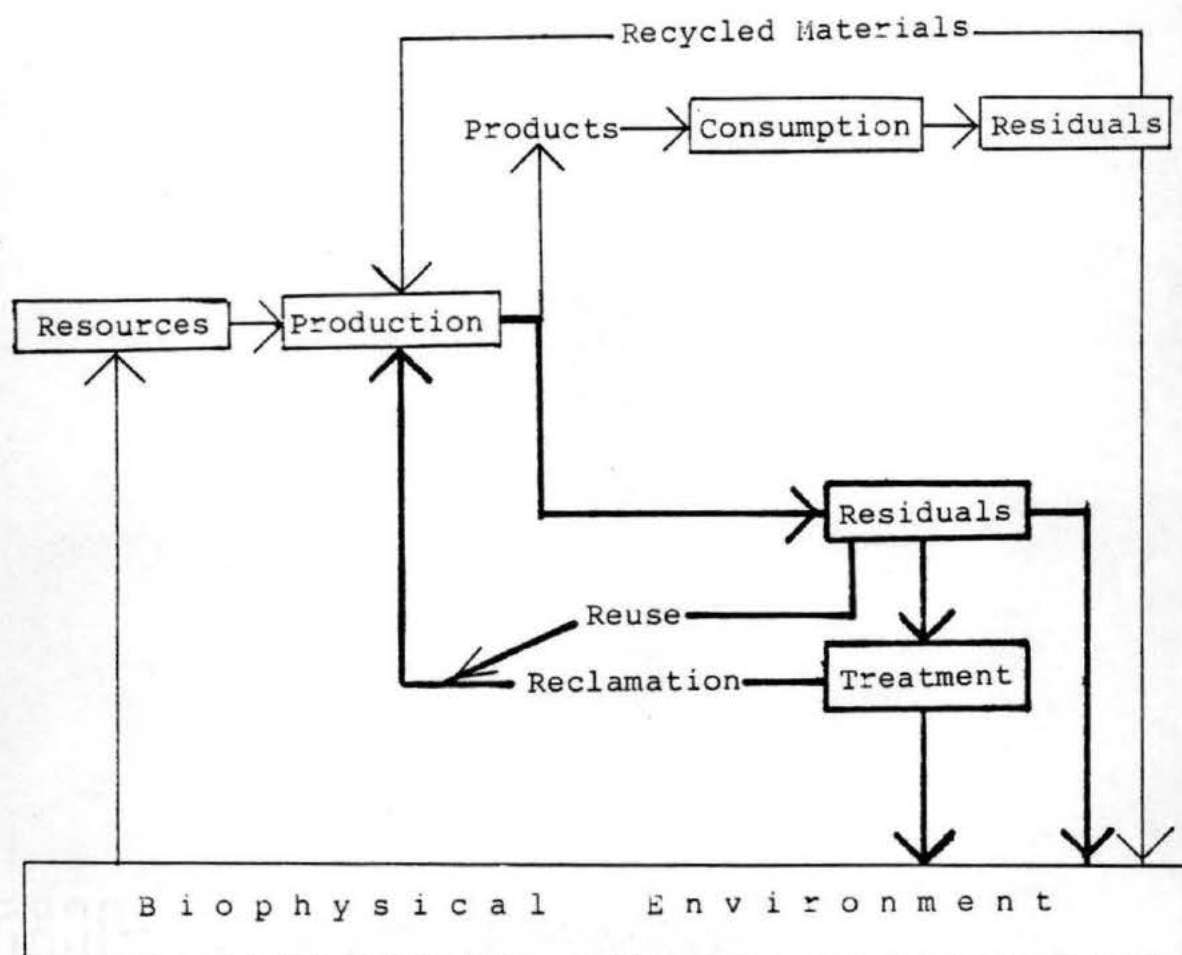


FIGURE 2. Materials Balance Model for the Leaking Landfill definition. Darker lines indicate the scope of the definition.

Note. From Environmental Planning and Management (p. 19) by J. H. Baldwin, 1985, Boulder: Westview Press. Modified by S. M. Mele.

Sham recycling is exemplified by the episode of contamination in Missouri which was a direct result of dioxin being mixed with waste oil and utilized as a dust suppressant (Epstein et al., 1982, pp. 135-140).

Recycling waste obviously does not guarantee protection of the environment and human health. Yet if legitimate recycling is to be encouraged as a solution, some middle ground between regulating all recycled materials and exempting from regulation all such material is needed.

The EPA's attempt to find this middle ground has been lengthy and fraught with complications. In an article entitled "When is a Waste Not a Waste," Barry Garelick (1985) of Versar describes the EPA's most recent delineation between regulated and non-regulated materials:

One must know both what the material is and how it is being recycled before determining whether it is regulated under RCRA. . . . Four types of recycling activities are addressed in the definition: speculative accumulation; placement on the land; burning for energy recovery; and reclamation. These four categories of recycling activities are divided further according to the type of material involved: spent materials, sludges, byproducts, commercial chemical products, or scrap metal. (Garelick, 1985, pp. 26-27)

Storage for "too long" a time is considered to be an indication of a possible sham operation and increases the potential for leaks. Materials placed on the land, with the exception of commercial products for which this is the intended use, e.g. pesticides, are considered to be wastes. Waste materials incorporated into products applied to the

land are not regulated as solid wastes if the waste has "undergone a chemical reaction (bonding) and is essentially inseparable from the product" (Garelick, 1985, p. 30).

Wastes burned for energy recovery are regulated with the exception of fuels and those materials that are commercial products for which burning is the intended use. With a few exceptions, wastes that are being reclaimed are regulated until the reclamation is complete and the usable product recovered. Facilities that reclaim such wastes are therefore subject to the RCRA standards for treatment, storage, and disposal facilities. Some materials such as those containing dioxin are designated as solid wastes regardless of how they are recycled (pp. 26-32). When materials are directly reused, they are not regulated as wastes. This occurs when:

The material is used as an ingredient in an industrial process to make a product; it is used as an effective substitute for commercial products; and the material is returned to the process from which it was generated, to be used as a substitute for raw material feedstocks. (Garelick, 1985, p. 32)

This complex description is in fact an extreme simplification of the RCRA regulations. Nonetheless, it clearly shows that recycling which might result in contamination is defined as part of the problem.

Medium of Contamination

In addition to the inclusion of certain recycled

materials, the Leaking Landfill paradigm emphasizes wastes that are particularly hazardous in relationship to land disposal technology. For example, California--the first state to enact a land ban of certain wastes--established criteria for hazardous wastes that are inappropriate for land disposal and then selected "generic categories" of materials meeting these criteria. The criteria include "high toxicity, persistence in the environment, ability to bioaccumulate, and mobility in a land disposal environment" (Davis, 1984, p. 76). Categories of "high priority wastes" meeting these criteria include pesticide wastes, polychlorinated biphenyls (PCBs), cyanide wastes, toxic metal wastes, halogenated organics, and non-halogenated volatile organics (pp. 72-73).

These wastes are "high priority" and are the focal point of the Leaking Landfill paradigm because they are dangerous when disposed of in the medium of land and using land disposal technology. The definition of "hazard" is dependent on the media and technology used. California's priority wastes might not have been given this priority status if, for example, the technology utilized had been incineration and if the medium of concern had been air. In that case, the "incinerability" of the waste--its capacity to be thermally destroyed--would determine prioritization. Wastes not completely destroyed at high temperatures would be unsuited to that technology, and therefore classified as

"high priority."

As we have already seen, the original RCRA used criteria connected to land disposal. The 1984 Amendments to RCRA, however, do so to a much greater extent. "The new RCRA represents a clear shift in national policy away from land disposal" because of "long term uncertainties about . . . persistence, toxicity, mobility and accumulation in plants, animals and human tissue" (U. S. EPA, 1985, p. 1). California's high priority wastes are banned nationally from all land disposal (except deep well injection) as of 1987. Others wastes including dioxins and discarded solvents are also banned. In addition:

EPA must determine whether to ban the land disposal of a third of wastes listed as hazardous in 45 months, two-thirds of listed wastes in 55 months, all listed and characteristic wastes in 66 months and for wastes listed after enactment, six months after listing. The land disposal of a hazardous waste must be banned unless EPA determines that the prohibition is not required in order to protect human health and the environment. (U. S. EPA, 1985, p. 12)

These schedules are based on the toxicity and volume of waste disposed on land. The most hazardous are to be examined first. (U. S. EPA, 1985, p. 1)

The 1984 RCRA Amendments also prohibits the landfilling of bulk or non-containerized liquids and charges the Administrator with promulgating regulations to "minimize the disposal of containerized liquid hazardous waste in landfills" and "minimize the presence of free liquids in containerized hazardous waste to be disposed of in

landfills" (Hazardous and Solid Waste Amendments, 1984, Sec. 201(4)(c)). These restrictions stem from the previously described tendency for liquids to leak out of barrels thereby causing materials above to subside and caps to crack. Again, we see that the technological characteristics of landfills influence the "hazardousness" of the wastes and their inclusion in the definition of the problem.

With attention focused on particular wastes, others are deemphasized. Wastes characterized as explosive or flammable are still regulated but not stressed because they are not necessarily more dangerous when land disposed than when managed in another way. This is not to say, however, that they are totally excluded from the problem. Wastes which degrade into explosive gases while residing in landfills are certainly included.

From this discussion, we can see that the medium of land has been emphasized as it was in the Irresponsible Corporation paradigm. Ironically, this stems from concern over groundwater and surface water contamination from landfills reported in numerous EPA and state agency studies (Office of Technology Assessment, 1983b, p. 10; Banks, 1984, pp. 37-38).

Also, the Leaking Landfill paradigm does augment concern about air and water contamination. If land is banned as a medium of disposal for many hazardous wastes, then other media will be used to a greater extent and could

become pathways for contamination. Additional standards will be required to insure that these pathways are protected. Nonetheless, focus remains on land.

Engineering Mentality and Technological Solutions

As in the Irresponsible Corporation paradigm, the Leaking Landfill perception of the hazardous waste problem is concerned with inadequate waste management practices. In the newer paradigm, however, the problem lies in the practice of landfilling itself rather than with the actions of companies. Landfilling has failed as a means of disposal for many hazardous wastes. It is, in fact, the problem rather than the solution.

Although landfills have been discussed in detail, it should be noted that two other forms of legal land disposal are also common. These are land treatment and deep well injection. Land treatment is a type of biological treatment in which direct application of hazardous waste to the land results in the decomposition of organic materials. Deep well or underground injection is the pumping of liquid waste into a well or porous underground formation intended to contain the material (McCann, 1984, p. 118).

Land treatment and deep well injection are perceived and regulated differently than land disposal. For example, in the 1984 Amendments to RCRA, the Administrator of the EPA

is charged with making a separate decision about deep wells and has until August of 1988 to do so. Until that time, underground injection of hazardous waste is exempt from the land ban (U. S. EPA, 1985, p. 1). There is little public concensus and much public controversy on these methods. For the purpose of this paper, they will be considered a type of land disposal and part of the problem rather than part of the solution.

In this paradigm, the failure of land disposal technology does not decrease acceptance of other disposal technologies. Although landfilling is inappropriate, other technologies can still solve the problem. An engineering mentality prevails: "Given enough support, science and technology can solve all problems" (Nelkin, 1984, p. 22). An important characteristic of this engineering mentality is its faith in human ability to control the problem:

Once we eliminate the dead end of trying to figure out the best way to dump a certain poison, engineers devise new ways to turn them into harmless chemicals. The pace of this innovation quickens whenever regulations ensure someone a profit from investing in these high-tech solutions. (Piasecki, 1984d, p. 148)

Since control is possible, prevention is unnecessary.

In response to environmental regulations, it is also common for industry to attempt to avoid responsibility:

First, an industry will claim that it can't comply with a proposed standard, because the technology to do so does not exist. Next, the industry will claim that the cost will drive it out of business. Finally, companies announce that they can, but

that it will cost everybody plenty. (Kazis & Grossman, 1982, p. 57)

Despite these claims, evidence of technical feasibility, commercial availability, and economic viability can be found.

In regard to hazardous waste treatment and recycling technology, public perception is gradually shifting to the belief that technology does exist. Joel Hirschhorn (1984), senior associate at the U.S. Office of Technology Assessment, states that "the most important news on the hazardous waste problem is that there are technically feasible alternatives to land disposal for virtually all hazardous wastes" (p. 131). Bruce Piasecki (1984), author of Beyond Dumping, agrees and cites both European examples and recent improvements in the U.S. "detoxification arsenal" as evidence (p. 139). In West Germany, for example, almost 85 percent of all wastes are sent to 15 large treatment plants for destruction or reuse (p. 103). Availability of technology is also confirmed in numerous documents that describe these alternatives in detail, e.g. the Office of Technology Assessment's Technologies and Management Strategies for Hazardous Waste Control (1983a) and the (California) Department of Health Services's Alternative Technology for Recycling and Treatment of Hazardous Wastes (1984).

Alternative technology is not only feasible but in many

cases is commercially available. Although additional capacity will be needed to respond to land bans, a 1982 Hazardous Waste Treatment Council (HWTC) survey found between 30 percent and 50 percent unused capacity in treatment firms. It also found many firms capable of increasing their capacity. A similar 1981 EPA study found unused capacity at 20 percent for incinerators, 40 percent for chemical treatment, and 75 percent for resource recovery (Hirschhorn, 1984, pp. 135-136).

The cost argument against use of alternatives appears sensible when the cost information, previously provided in Table 3, is examined. Similarly, a California report estimated that it would cost over \$50 million per year to recycle, treat, and destroy all of the state's high priority wastes as compared to \$20 million annually to landfill them. However, the cost of the hazardous waste management would still represent less than 1 percent of all business costs and would be spread over industries having combined gross sales in excess of \$30 billion per year. Most importantly, this analysis only considers short term direct costs. If the long term costs of liability and clean up of contaminated sites are included in the analysis, landfilling becomes a "misleading bargain" (Davis, 1984, p. 78). Alternatives to land disposal are technically feasible, commercially available, and cost effective in the long run.

In the Leaking Landfill paradigm, the use of any waste

disposal or management technology other than land disposal is considered adequate. These alternative technologies can be grouped into two categories: treatment and reclamation/reuse.

Treatment can be thermal, physical, chemical, and/or biological. Thermal treatment is incineration, i.e. controlled burning of combustible solid, liquid, or gaseous wastes which thermally breaks down the wastes. Often, residues are produced from this process which may be hazardous. Nonetheless, both the volume and degree of hazard of the waste can be substantially reduced. Rotary kilns, fluidized beds and liquid injection incinerators are examples of different types of incinerators. One emerging technology--molten salt destruction--is depicted in Figure 3.

Physical, chemical, or biological treatment is also designed:

to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste or so as to render such waste nonhazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume. (RCRA, 1976, Sec. 1004(34))

This includes chemical treatment such as neutralization, physical treatment such as sedimentation, or biological treatment such as aerobic digestion. Again, hazardous residues may remain (McCann, 1984, p. 118).

Although treatment is inherently different from land

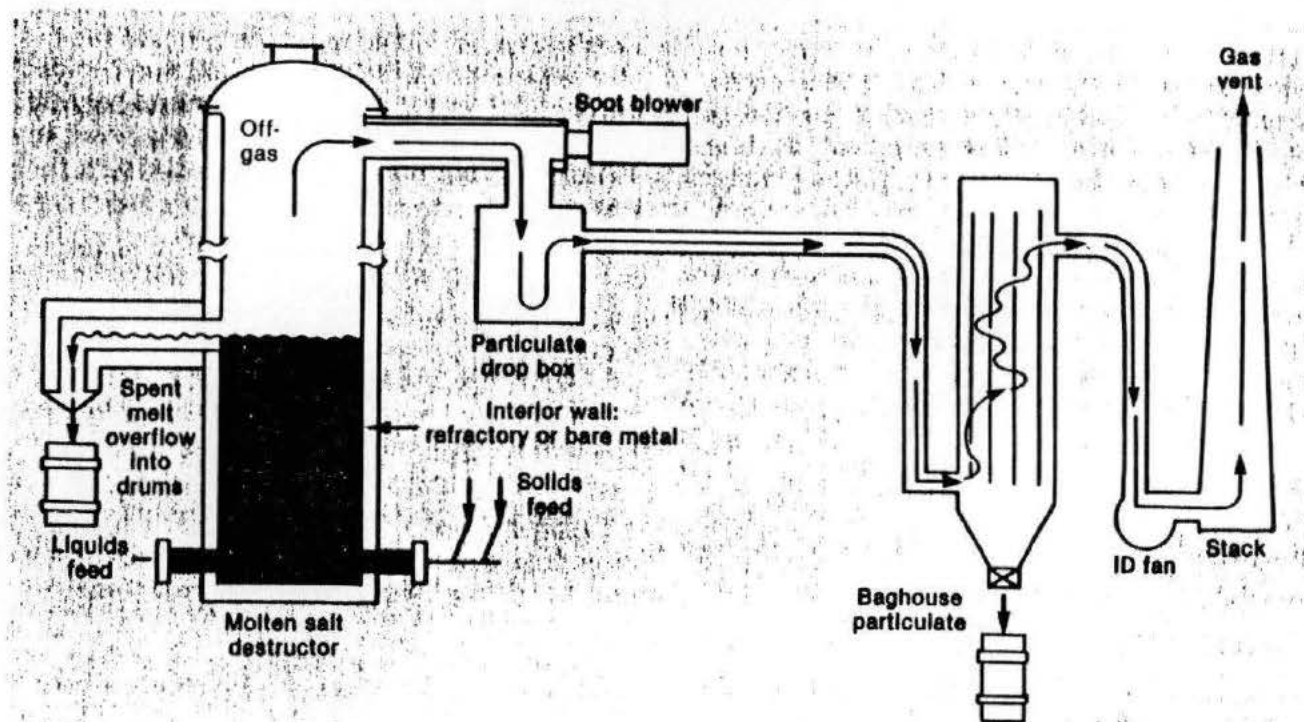


FIGURE 3. Molten salt destruction.

Note. From Technologies and Management Strategies for Hazardous Waste Control (p. 171) by Office of Technology Assessment, 1983, Washington, DC: U. S. Government Printing Office.

disposal in its relationship to the media of land, commonalities exist. Both respond to waste after it is generated. The primary purpose of treatment is to decrease the amount or toxicity of waste that is to be landfilled, not to decrease the amount of waste produced. The production process is not affected. In other words, emphasis is on control rather than prevention. In addition, hazardous residues often remain which require disposal in the land.

Another interrelated pair of alternatives to landfilling is resource recovery and reuse:

(Recovery) often involves processes similar to chemical treatment, which differ only in that the waste is partially or totally transformed into a product for sale. (McCann, 1984, p. 118)

Reuse of materials may occur "directly in the process from which they originated or . . . in an entirely different process" (Sarokin et al., 1985, p. 19). The treatment technology discussed above could be utilized to recover resources: materials in the case of physical, chemical, and biological treatment and energy in the case of thermal treatment.

The reclamation/reuse alternative also deals with wastes after they are produced but connects to the "front end" of the production process by converting "wastes" into usable "substances." This has been shown in the Materials Balance Model for the Leaking Landfill paradigm in Figure 2.

The reclamation/reuse technologies used as solutions in this paradigm do not affect the amount of waste produced initially and do not actually change the production process. Thus, the box representing production in Figure 2 was not darkened because it is not included in the paradigm. Recycling does, however, conserve resources.

When the problem is defined as Leaking Landfills, either treatment or reclamation/reuse are equally preferred solutions. Neither has priority over the other as long as landfilling is eliminated or decreased. Conservation is not the purpose. Avoiding contamination is.

Within the range of options, corporations make hazardous waste management decisions based on cost and liability as well as non-economic factors such as "service, reliability, and public image" (McCann, 1984, p. 115). In addition, each option is appropriate only for certain types of waste streams, and availability of options varies geographically.

Technology and Values

In the Leaking Landfill paradigm, treating or recycling hazardous wastes represents a different value than landfilling those wastes. Treatment and recycling are connected to preserving the environment and valuing human health. Landfilling implies a greater concern for profit and a lack of concern for environment and health. The

choice between treatment and recycling, however, is considered to be a purely technical or economic one. Alvin Gouldner criticizes this belief:

A fundamental vulnerability of the technocratic consciousness is that it is characterized by a prosaic matter-of-factness; it has painted God grey. . . . This . . . makes the technocratic consciousness seem apolitical, possessed of a disinterestedness placing it "above the struggle"; or, from another perspective, over to the side of the struggle. (Cited in Gusfield, 1981, p. 194)

Differing technological approaches reflect different values. Destruction of hazardous material and treatment to decrease the volume or hazard of the material that is then landfilled do not result in conservation. On the other hand, reclamation and reuse conserve resources and decrease the amount of land needed for disposal. If these conservation values were to be expressed as part of the hazardous waste paradigm, recycling would be preferred to destruction or treatment. Since they are not, the two approaches are viewed as being equally desirable and management decisions are made based on technical and economic considerations.

In the Leaking Landfill paradigm, reduction of waste at source is not seriously considered as an alternative to land disposal. This, too, is explained as a technical choice while the value behind the approach is obscured. Waste reduction at source "means that the source of the waste is altered in some way so as to reduce the amount generated or

eliminate it altogether" (Sarokin et al., 1985, p.9). Techniques of reduction include product modifications, chemical substitutions, equipment changes, changes in plant processes, and alterations in plant operations (Sarokin et al., 1985, p. 81). Despite the availability of reduction as an alternative to landfilling, the Leaking Landfill paradigm emphasizes treatment and sometimes recycling with disposal still utilized as a method of last resort.

For example, an intent of California's land ban regulations is to "spur the creation of a system of recycling, treatment, and thermal destruction facilities" (Davis, 1984, p. 71). A California report prepared by the Department of Health Services (1984) occasionally reminds the reader that options for "reducing or eliminating the entry of hazardous materials into the waste stream" should be evaluated (p. 8). However, the 253 page volume deals entirely with specific technology for treating, recycling and recovering priority wastes.

Another excellent example of this tendency to include treatment and recycling while excluding reduction is Patrick McCann's analysis of industry's hazardous waste management decision-making process. McCann is a senior associate for Booz-Allen & Hamilton, a consulting firm often contracted by the EPA to perform industry waste management studies. As indicated in Figures 4 and 5, reduction at source is not considered in McCann's analysis.

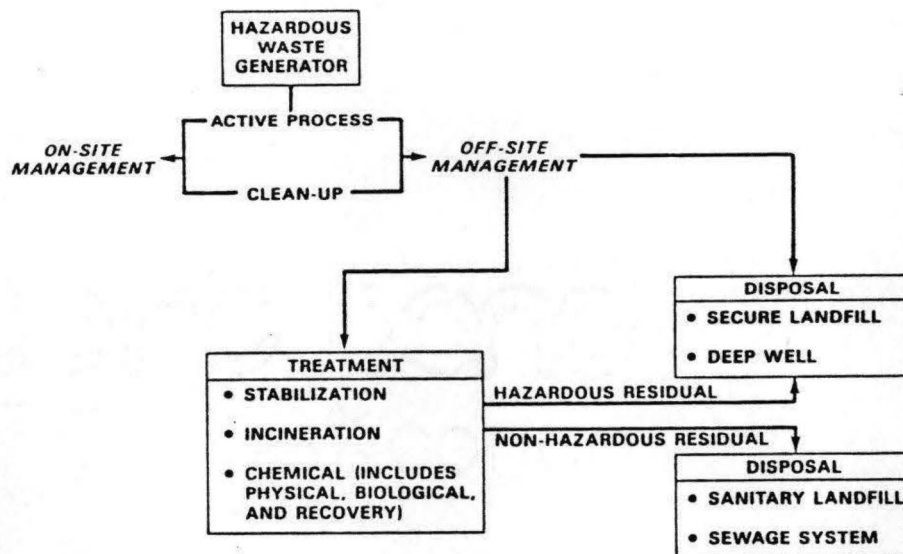


FIGURE 4. Corporate decision making process for hazardous waste management. Reduction and recycling are not considered as alternatives.

Note. From *Preparing Management: The Political Economy of Stronger Controls* by P. G. McCann, 1984, in B. Piasecki (Ed.), *Beyond Dumping: New Strategies for Controlling Toxic Contamination* (p. 117), Westport, CT: Quorum Books.

		TREATMENT/RECOVERY					DISPOSAL				
		CHEMICAL	PHYSICAL	BIOLOGICAL	WASTE EXCHANGE	LANDFILL	LAND FARMING	DEEP-WELL INJECTION	LIQUID INCINERATOR	ROTARY KILN INCINERATOR	
ORGANICS	OIL AND OILY SLUDGE		●	●	●		●	◐	●	●	
	PAINT AND PIGMENT RESIDUE		◐			●				◐	
	PLASTICIZERS					●				●	
	SOLVENTS		●		●				●	●	
	WASTE WATER TREATMENT SLUDGES	◐	◐	◐		●					
	PESTICIDES	◐		◐		●			●	●	
	STILL BOTTOMS		◐			●				●	
	PHARMACEUTICAL WASTE			◐		●			●	●	
	OTHER	◐	◐	◐	◐	◐	◐	◐	◐	◐	
INORGANICS	ACIDS	●			●			●			
	ALKALINE	●			●			●			
	CYANIDE	●						●			
	HEAVY METALS		●			●					
	WASTE WATER TREATMENT SLUDGES		●			●					
	CATALYSTS				◐	●					
	OTHER	◐	◐	◐	◐	◐	◐	◐	◐	◐	

Reduction at source is both economical and feasible, as will be demonstrated in Chapter IV. Its exclusion as an alternative to landfilling reflects the perception inherent in the Leaking Landfill paradigm that the problem is one of waste that comes out the tail end of industrial processes. Reduction directly affects the production process and decreases the amount of waste generated. However, in the Leaking Landfill paradigm, the need to use hazardous substances and produce hazardous waste is not questioned. "Although Americans generate an unprecedented volume of toxic wastes, we needn't poison ourselves with this stockpile" (Piasecki, 1984a, p. xiii). We needn't poison ourselves, but we also needn't stop producing it. Once produced, we can simply control it by treating it.

Reduction also would result in conservation, but as we have already seen, conservation is not a value expressed in the paradigm.

To summarize, choice of technology is not purely a technical decision. Treatment, recycling, and reduction each represent very different approaches and values. In the Leaking Landfill paradigm, however, choice of technology other than landfilling is perceived as a technical decision and left up to corporations. "The fuzzy boundaries between the technical and political dimensions of science policy" (Nelkin, 1984, p. 34) are not recognized.

Causal and Political Responsibility

In the Leaking Landfill paradigm, it is the landfill itself that causes the problem. Land disposal technology has failed, resulting in contamination and harm to the environment and human health. The actor who utilizes land disposal is implicated by the causal sequence, but the failure lies in the technology not with the individual corporation.

Political responsibility for the failure of land disposal technology, however, lies on generators of hazardous waste. Generators are financially and legally liable. "Under law generators are responsible for their wastes from production until destruction" (Johnson, 1986, p. 1). Even if harm to the environment or human health is traced back to irresponsible actions of hauler or waste disposal company, generators can also be held liable. They created the waste thereby ultimately causing its disposal. This is true whether or not they actually placed it in the ground and whether or not they acted negligently. Generators may also be held "liable for wastes that had been 'disposed of' under regulations that provided insufficient protection to the environment" (Johnson, 1986, p. 1).

This is a transition from the fault or negligence liability of the Irresponsible Corporation paradigm to no-fault or strict liability. Strict liability for

clean-up of sites was mandated by the federal Superfund legislation in 1980:

Any person who "caused" wastes to be disposed of is liable regardless of whether he or she was negligent. The exercise of due care by generators in selecting a hazardous waste transporter or disposal site may not absolve them of liability. (Davis, 1986, p. II-3)

In addition, court decisions have extended this strict liability to recovery of damages:

The courts find strict liability with "ultrahazardous" or "abnormally dangerous" activities and have applied this principle to hazardous waste dumping in recent cases. In addition . . . several states have established this standard by statute. (Davis, 1986, pp. II-5-II-6)

To summarize, the result of this transition to strict liability is to shift the focus from individual corporations to all generators who cause land disposal to occur. Strict liability is:

Not concerned with the motives, condition, or intentions of the actors but only with the character of their actions. . . . Doctrines of fault and intention highlight Person while those of strict liability highlight Acts. (Gusfield, 1981, pp. 116-117)

The act of disposing of hazardous wastes is so dangerous that anyone generating such wastes can be held responsible.

Two other important liability provisions under Superfund are connected with the Leaking Landfill paradigm. These are joint and several liability and reduced burden of proof of causation:

Where several parties (including generators) are responsible for the disposal of wastes that are leaking from a dumpsite, the government may recover the full amount of cleanup costs from any one of them. (Davis, 1986, p. II-4)

In addition:

It may be enough to prove that the generator's wastes were disposed at a site which contains wastes of that type that are being released into the environment that result in the necessity for cleanup. The government does not have to prove that the particular generator's wastes are the ones that are leaking. (Davis, 1986, p. II-4)

Again, the political responsibility of generators is emphasized.

There is an important practical reason for these shifts in liability. Cost of cleanup of Superfund sites is extremely high, and concern for victims' rights and compensation has grown. If negligence had to be shown, it would be easier to find haulers and disposers liable because they are often the ones who physically dump the waste. Generators, however, are more likely to be the "deep pockets", i.e. the ones who are capable of paying for cleanup and compensation. Strict liability insures that generators can be held financially liable. Joint and several liability insures that the generator with the "deepest pocket" can be held financially liable.

Industry as a whole has tried to shift this political responsibility. For example Robert Rolands, president of the Chemical Manufacturers Association (CMA) responded to federal hazardous waste regulations with the following

statement:

The solid waste disposal problem, including toxic or hazardous wastes, is not just the problem of the chemical industry. It is a result of society's advanced technology and pursuit of an increasingly complex lifestyle. . . . Everyone should realize that the blame does not belong to a single company, or a single industry, but to all of us as individuals and as an advanced society. (Epstein, 1982, p. 206)

In the Leaking Landfill paradigm, this shift in responsibility has not been accepted.

In addition to financial liability, political responsibility implies that someone is obligated to do something about the problem. In this context, generators, hazardous waste disposal companies, and the government are all somewhat responsible for finding alternative technologies to landfilling. As expected, generators and disposal companies perform technical research. The federal government, however, also does direct research. "Scientists at EPA are working with engineers to develop storage and destruction technologies" (Popkin, 1986, p. 4). The Office of Technology Assessment also plays a role in this process by collecting and disseminating information about hazardous waste management technology.

Enforcement responsibility also lies with the federal government. Through Superfund, the EPA is authorized to clean up leaking dumpsites either by using money from a \$1.6 billion fund raised by a tax on chemical feedstocks or by ordering responsible parties to clean up the sites

themselves (Davis, 1986, p. II-3). The RCRA enforcement mechanisms discussed as part of the Irresponsible Corporation paradigm also continue to be the responsibility of the EPA and state governments.

An Aggregate Problem

The shift to the Leaking Landfill paradigm is a shift to the perception that hazardous waste is an industry-wide problem of all generators. In other words, it is an aggregate problem rather than an individual one. Its aggregate nature both reinforces and is reinforced by the theories of causal and political responsibility described above. Since the cause of the problem is landfilling and 80 percent of hazardous wastes in the United States are landfilled, then most or all generators are involved.

Strict liability and joint and several liability certainly point to an aggregate problem. The actions of all generators are at issue; individual fault is not. One ironic result of this broadening of responsibility is that it alleviates the moral guilt of individual actors:

Doctrines of strict or absolute liability, in avoiding the distinction between good and bad intentions, appear less moralistic and more forgiving in tone even though they create a wider scope of responsibility. (Gusfield, 1981, p. 117)

Any moral flavor that characterizes contemporary discussion about hazardous waste can be interpreted as a response to the Irresponsible Corporation paradigm operating

concurrently with the Leaking Landfill paradigm.

Unlike the case studies that permeate the description of the Irresponsible Corporation paradigm, aggregate statistics are used to describe the Leaking Landfill problem. These include data on the extensive use of landfilling, quantities generated, numbers of generators, numbers of leaking landfills, etc. In addition, the rhetoric used to describe the problem and its solutions is technical rather than accusing. Scientific explanations of pathways traveled, treatment and incineration methods, instrumentation to measure emissions, etc., are common. This rhetoric implies that the problem is aggregate and technical, rather than individual and moral.

Ownership and Actors

In 1981, an Executive Order by Governor Brown of California directed the Department of Health Services to implement a program to reduce dependence on land disposal and encourage recycling, treatment, and destruction. The controversy surrounding this order led to a public hearing in which central actors participated:

The Chemical Manufacturers Association, the Western Oil and Gas Association, and the industry's lobbying organization . . . were the most vocal critics of the program. Supporters included . . . hazardous waste management firms, local government officials, and several environmental groups. (Davis, 1984, p. 79)

The federal lineup of actors is similar. In the March and

May 1983 Hazardous Waste Disposal Hearings before the Subcommittee on Investigations and Oversight of the House Committee on Science and Technology, witnesses included the following:

- Industry organizations representing generators (e.g. the Tennessee Manufacturers Association, and the Chemical Manufacturers Association (CMA));
- Waste disposal companies and related organizations (e.g. the National Solid Waste Management Association (NSWMA), the Hazardous Waste Treatment Council (HWTC), National Association of Solvent Recyclers (NASR), and Cecos International);
- The federal government (e.g. OTA and EPA);
- State and local governments (e.g. the Tennessee Dept. of Public Health, Missouri Dept. of Natural Resources, California Office of Appropriate Technology, Illinois EPA, and New York DEC);
- Environmental groups (e.g. Environmental Action Fund and Natural Resources Defense Council); and
- Consultants (e.g. Argonne National Laboratories, Vanderbilt University Department of Economics, National Academy of Science, CH2M Hill, and the University of Tennessee Department of Microbiology) (p. III).

As shown by this extensive tally, a number of actors in the Leaking Landfill paradigm are similar to those of the Irresponsible Corporation paradigm. Governments, industry, and environmental groups continue to play an important role while citizen health groups are still absent.

There is one change, however, which is dramatic and major. This is the growth in influence and power of the hazardous waste treatment industry and the related increase

in importance of technical research and consulting on treatment and recycling methods.

Obviously, waste treatment and recycling companies would have great interest in the Leaking Landfill paradigm because they stand to benefit financially from it. If landfills are allowed--even encouraged--as in the Irresponsible Corporation paradigm, there is little reason for companies to invest in expensive treatment technology. On the other hand, if hazardous waste landfills are banned and any alternative technology for waste disposal is an acceptable solution politically, then treatment and recycling companies would thrive.

In the Netherlands, for example, passage of the Chemical Waste Act prohibiting dumping "spawned a thriving waste detoxification business: chemical, physical and biological treatment techniques have been employed ever since" (Piasecki, 1984b, p. 101). In the U. S., a representative of Waste Management, Inc. estimates that "if there is only a 1 percent shift toward commercial facilities, that could mean \$300 million to waste service companies" (Naber, 1986, p. 41) while an IT corporation official estimates that treatment, transportation, and disposal will grow from about \$1 billion in 1983 to between \$4 and \$8 billion in 1995 (p. 44).

As we have already seen, treatment and reclamation/reuse are the preferred solutions in the Leaking Landfill

paradigm. Therefore, treatment companies have both benefitted from this choice of solutions and have encouraged it.

The emergence and growth of treatment companies and recyclers on the U.S. hazardous waste scene can be taken as an indicator of the gradual shift to the Leaking Landfill paradigm. This growth is certainly related to the 1984 RCRA Amendments, but has been limited by prior regulations and lack of working regulations implementing the Amendments. The formation of the Hazardous Waste Treatment Council (HWTC) increased the ability of these companies to lobby effectively for stricter land disposal regulations. HWTC membership includes ENSCO, SCA Services and CECOS, three of the top seven American firms handling 70 percent of the toxic waste treatment market (Piasecki, 1984c, p. 140).

This consolidation of economic power has resulted in considerable political influence. Piasecki (1984c) cites two instances in which the HWTC has affected policy: the ban against dumping toxic liquids into landfills and the lack of regulation for burning of hazardous waste in industrial boilers (pp.139-143).

These two political controversies are of particular interest because in both cases treatment companies and environmental groups lobbied for the same position. When the hazardous waste problem is perceived as Leaking Landfills, environmentalists and treatment/recycling

companies often find themselves on the same "side." Both want stricter landfill bans as well as clear standards for management.

Despite the existence of treatment companies in the public scenario, lack of professional credibility limits their influence. A 1986 release by the Council on Economic Priorities, for example, evaluates eight of the largest commercial hazardous waste management companies and finds many of them lacking in a number of areas (Goldman, 1986, pp. 10-13). In addition, it is important to note that only 5 percent of hazardous waste produced is handled by commercial companies (Fortuna, 1984, p. 201). The rest is disposed on-site by the generator. Joint and several liability encourages continuation of this on-site disposal.

Nonetheless, commercial companies play an important role because over 80 percent of all generators utilize them for wastes that are difficult or uneconomical for the generator to handle (Fortuna, 1984, p. 201). Often, these difficult wastes are the extremely dangerous ones. In addition, commercial companies are also extremely important to small quantity generators (SQGs) which do not have the capacity to manage their own wastes. The 1984 Amendments extended regulations to those generators producing between 220 and 2200 pounds of hazardous waste per month, thereby mandating compliance and increasing the market for treatment.

If the Leaking Landfill paradigm continues--and treatment companies have every reason to see that it does--the treatment market and companies serving that market--will flourish.

Policy Solutions

Changing perceptions result in changed policy; policy changes help to alter perceptions. The process is a reciprocal and gradual one. In the Irresponsible Corporation paradigm, the goal was to enforce responsible containment technology for landfills. As landfills were perceived to be ineffective, the paradigm shifted and the goal became the banning or limiting of certain hazardous wastes from land disposal. In the Irresponsible Corporation paradigm, landfilling is a solution; in the Leaking Landfill paradigm it is the problem.

Because the reduced use of landfills requires the substitution of alternative approaches and technologies, a need exists to utilize and set standards for these alternatives. The solution to the Leaking Landfill paradigm will therefore include a shift away from land disposal as well as setting standards for the alternative technologies. Each will be examined in turn.

The shift from landfilling requires technology, implementation, and policy. These three are, of course, interrelated. As we have already seen, generators, waste

disposal companies, and the federal government are politically responsible for the invention of alternative technologies. In the United States, it is the companies that are traditionally responsible for implementation although this is not always the case nor does it need to be. Federal and state governments are responsible for setting and enforcing policy to shift the country beyond dumping.

The role of the government will be the focus of this discussion. Since technological solutions have already been examined, this section will look at policy approaches and the variety of implementation techniques the government has available. Examples of each approach will be provided. Careful examination of current federal government policy will follow.

Policymakers have two directions from which to influence the market:

Either from the demand side by changing the cost to generators of treatment and disposal, or from the supply side by creating new capacity directly through state ownership or other institutional mechanisms. (McCann, 1984, pp. 116-117)

To implement the approaches, the government can mandate or prohibit certain practices by legislation and regulation, provide positive incentives to encourage certain practices, and/or provide disincentives to discourage certain practices. In addition, the government may utilize the purely supply side approach of undertaking the activity itself (Davis, 1984, p. 72). A list of state policies that

encourage alternatives to landfilling of hazardous wastes is found in Table 4. More detailed examples of each approach are now provided.

In general, regulation is commonly used to implement policy in the United States. Hazardous waste policy is no exception. Outright bans on landfills, or on disposal of particular hazardous wastes into landfills, curtail demand for land disposal and create demand for alternative technologies. Bans also stimulate supply because they assure a market for alternatives. Piasecki (1984a), in fact, believes that "the story behind America's inability to create a reliable treatment market is a classic tale of how regulatory neglect allows market failure" (p. xvii).

As we have already seen, the "centerpiece of California's program is the regulatory stick" which phases out the land disposal of five categories of hazardous wastes. Variances are given only if the disposer can prove that their disposal method would not present risks to the public health or the environment, or if there is no other facility available to recycle, treat, or store the wastes due to unexpected shutdowns (Davis, 1984, pp. 72-73). Illinois uses a slightly different regulatory approach. No generator may dispose of hazardous waste unless they demonstrate that, "considering technological feasibility and economic reasonableness, the hazardous waste cannot be recycled for reuse; incinerated; or chemically, physically,

TABLE 4. States with Policies Encouraging Alternatives
to Landfilling of Hazardous Waste

	AL	AZ	CA	CT	FL	GA	IL	IN	IA	KS	KY	ME	MD	MA	MI	MN	MS	MO	NH	NJ	NY	NC	OH	OK	OR	RI	SC	TN	WV	WI
Fee Structure	x		x		x		x	x	x	x	x	x			x			x	x		x	x					x	x		x
Tax Incentives															x	x					x	x			x			x		x
Bonds					x	x	x										x					x	x							
Definitional Exclusions				x											x															
Fast-Track Permitting								x		x	x					x		x		x						x				
Land Burial Restrictions			x				x						x					x					x							
Waste Exchanges														x				x			x	x		x					x	x
Research and Development Programs							x							x							x									
Other	x		x		x	x					x		x	x		x	x				x									

Note. From Hazardous Waste Management: A Survey of State Legislation 1982 (p. IV-3) by National Conference of State Legislatures, 1982, Denver: National Conference of State Legislatures.

or biologically treated and rendered nonhazardous" (National Conference of State Legislatures (NCSL), 1982, p. IV-11). Nationally, the 1982 ban on landfilling drummed liquids and the 1984 RCRA Amendments began the process of implementing land ban regulations.

Regulations other than land bans can also encourage treatment and reduction. Examples are:

Excluding certain materials or facilities from the regulatory program; excluding certain facilities from permit requirements; and expediting the permitting of alternative technology facilities. (NCSL, 1982, p. IV-1)

In Kansas, treatment facilities do not need to go through the siting process that is required of disposal facilities (NCSL, 1982, p. IV-14). In California, the Governor's Office of Planning and Research assists projects by coordinating permit requirements. This can cut the time required to obtain permits and reduce the uncertainty of dealing with numerous agencies (Davis, 1984, p. 74). In Minnesota, the planning process for land disposal sites takes three years while planning for processing, incineration, and storage takes only one year (NCSL, 1982, p. IV-20).

Incentives used to increase demand include tax credits and deductions for generators utilizing alternatives to landfills. Disincentives to affect demand, however, have been more commonly used by states. Fee systems attempt to charge generators the long term costs of

landfilling, including the cleanup costs that are often shifted to governments and taxpayers. Fees "help narrow the cost differential that exists between the current price of land disposal and the costs of most treatment methods" (Davis, 1984, p. 74). California's program utilizes two fees levied on hazardous wastes that are land disposed. California's first fee was \$4.00 per ton with a \$10,000 annual cap in 1982-1983. The second fee was \$11.45 per ton for hazardous wastes that would eventually be restricted, and \$4.05 for all others (p. 74). Fees similar to these are also utilized by New York and Minnesota.

It has been noted that there are two problems with these fee systems. First, they are often too low to affect management decisions. Even if this is the case, they serve another important function which is to provide funds for state hazardous waste programs. Joel Hirschhorn, project director for the Office of Technology Assessment, recommends a national fee system which would provide funds for the national Superfund. By switching the funding mechanism "from feedstocks to wastes, CERCLA and RCRA can become better integrated into one federal program" (Hirschhorn, 1984, p. 132). In addition to its practical value as a funding mechanism, this clearly reflects a Leaking Landfill perception of the problem because it recognizes that if new superfund sites are being created by current landfilling, then future costs should be paid for by the generator at

the time that land disposal is utilized.

The second problem with the fee system is that "since pressures within a state can be severe, including the threat of manufacturing operations moving elsewhere and workers facing job loss, these state programs often have been forced into levying relatively low fees" (Hirschhorn, 1984, p. 133). This is a strong argument for a national system. Under Hirschhorn's leadership, the Office of Technology Assessment has proposed such a fee. This will be discussed in more detail in Chapter IV.

One additional cost disincentive to land disposal is legal liability. The strict liability and joint and several liability previously discussed add substantial financial risk to land disposal of hazardous wastes. Unfortunately, this risk also applies to other methods of disposal and therefore does not encourage treatment and reclamation/reuse as it otherwise might. This does not necessarily have to be the case. Statutory law could be written to mandater different liability standards for different technological approaches. Missouri, for instance, established stricter liability for land disposal facilities than for alternative technology facilities (NCSL, 1982, p. IV-22).

On the supply side, disincentives include a graduated fee schedule for hazardous waste permits with disposal facilities paying highest fees. This has been implemented

in Kentucky (NCSL, 1982, p. IV-15).

Supply side incentives to create treatment/recycling capacity also exist. In California, for example, the Pollution Control Financing Authority is authorized to provide low interest loans through the sale of tax-exempt state bonds in order to finance hazardous waste recycling and treatment facilities (Davis, 1984, p. 73). The OTA (1983b) also recognizes the need for a federal loan program which offers low interest rates and long terms for repayment for capital expenditures on existing or new facilities (p. 46). Authorization of the issuance of bonds for construction of certain facilities is another option. Tax law which exempts treatment facilities from taxation to the extent of any increase in value due to construction and which allows for a rapid writeoff for construction of treatment facilities is also a viable incentive. Such tax law is in effect in New York (NCSL, 1982, pp. IV-25-IV-26).

A second supply side incentive is assistance for research and development needed to make technologies commercially feasible. Loan guarantees might be one method of government backing. Direct loans to be repaid upon successful commercialization of the technology is another (OTA, 1983b, p. 46). If a fee system were in place, funds could possibly be obtained from it. Illinois, for example, uses fees to establish a hazardous waste research fund administered by a

quasi-state agency research group. This group can enter into contracts with experts to assist in research and development for recycling, separation, detoxification, or reducing hazardous properties of hazardous waste (NCSL, 1982, p. IV-11).

The federal government or state governments could also directly invest in treatment and recycling facilities. This has not occurred federally, but it has occasionally occurred at the state level and is a significant part of hazardous waste programs for numerous European countries. In Denmark, for example, a central treatment facility--the Kommunekemi facility--is owned by a consortium of municipalities. The West German Bavarian government funds 50 percent of most recycling and treatment facilities, but only contributes about 20 percent for less desirable landfills (Piasecki, 1984b, pp. 102-104). Such investment certainly influences choice of technology.

In the United States, state governments have occasionally moved toward investment. In Oregon, Chem-Security Systems, Inc. owns and operates the only licensed commercial facility in the state. The site of the Arlington facility, however, is owned by the state (Baldwin, 1985, p. 198). In Georgia, a 1981 Act empowers a Hazardous Waste Management Authority to use proceeds of state general obligation bonds to plan, construct, and manage a hazardous waste facility (NCSL, 1982, p. IV-10). In Kentucky, state

funds are to be used for the planning and development of a model facility emphasizing recycling, incineration, and energy recovery (NCSL, 1982, p. IV-15). In addition, some states have set up or financially supported waste exchanges. These are informational clearinghouses which facilitate the reuse of one industry's byproducts by other industries.

All of these implementation approaches have as their intent the shift away from landfilling. Also inherent in the shift is the realization that if other alternatives are to be used, they must be controlled. Standards must be set. These standards might look very much like the standards for landfills or for other media such as air pollution and water pollution.

The Office of Technology Assessment (1983b) clearly recognized this need for standards:

Greater use of waste treatment alternatives is, therefore, a major issue, although they too, if not regulated effectively, can release hazardous constituents to the environment. (p. 12)

The 1976 RCRA and the regulations promulgated in 1979/1980 focused on landfill standards but also included standards for incinerators and permit requirements for treatment, storage, and disposal facilities. Since that time, additional standards have been added and a number of loopholes closed. For example, hazardous wastes burned as fuel for the purpose of recovering usable energy had been exempted from RCRA regulations. Although some exemptions

still exist, work to close this loophole continues. In addition, a complicated definition for recycled materials has been developed which carefully draws the line between regulated and unregulated materials. As already discussed, the purpose of this definition is to decrease "sham" recycling which places hazardous wastes directly back into the land.

As in the Irresponsible Corporation paradigm, it is federal and state governments that are setting these standards for proper management. It should be noted that non-government and government non-regulatory approaches are possible. In his book Alternatives to Regulation, Michael Baram (1982) points to private, voluntary self-regulation of industry through setting of industrial standards and through licensure and certification (chap. 3). He also describes government influence through procurement policies and dissemination of information and publicity (chap. 5).

U. S. solutions to the hazardous waste problem have not seriously included these implementation tools. Potential, however, does exist for their use. Government procurement policies certainly have an affect on hazardous waste management standards, often in a negative way. For example, a recent Council on Economic Priorities (CEP) study has determined that:

EPA has not always selected the best facilities to receive wastes removed from Superfund sites. Other facilities were found to be better managed,

better located, and better at using more advanced technologies than those selected by EPA. Of the facilities CEP evaluated in detail, EPA chose the one that performed worst--CECOS International in Williamsburg, Ohio--to receive Superfund wastes in a majority of instances. (Goldman, 1986, p. 11)

In this case, the federal government is rewarding low standards.

In addition, it was found that for commercial wastes being sent off-site, "generators . . . often do not know which facilities are the best" (Goldman, 1986, p. 11) and performance at these facilities varies greatly. The CEP report indicated that of ten land disposal facilities studied, overall performance ranged from a B+ to an F. These grades were based on 22 criteria concerning financial viability, compliance with environmental and occupational safety regulations, groundwater monitoring, potential liabilities, technology, and corporate public relations (pp. 10-11). Certainly, the government has the ability to compile and disseminate information such as this to encourage improved industry performance. Unfortunately, this ability is rarely utilized.

Paradigm Status

It is, of course, impossible to quantitatively determine or describe the level of belief in the Leaking Landfill definition of the hazardous waste problem. Three generalizations, however, can be made. First, the growth of

the Leaking Landfill paradigm has affected but not completely replaced belief in the Irresponsible Corporation paradigm. Second, there has been a shift of perception in the United States towards the Leaking Landfill paradigm but that shift is still controversial and incomplete. Third, the Leaking Landfill paradigm foreshadows and prepares the transition into the Dangerous and Inefficient Waste paradigm. Each of these will be discussed briefly.

Irresponsible corporate action continues to be of great concern. This is reflected in the 1984 RCRA Amendments which stiffened criminal penalties and increased EPA's law enforcement powers. It is also reflected in the cases that continue to be litigated on claims of negligence. Enforcement continues to be directed toward "irresponsible" dumping, but the definition of dumping has changed. Since all land disposal is bad, companies are irresponsible if they dispose of hazardous wastes in the ground. The rules of the game have changed. These changing rules encourage corporations to be wary of disclosing information. Even if their waste management is appropriate today, it could be illegal tomorrow. The secrecy contributes to the perception that corporations are irresponsible. Thus, many aspects of the Irresponsible Corporation paradigm continue to flourish simultaneously with the Leaking Landfill definition.

The fact that the Leaking Landfill perception of the problem exists should require no further evidence. The

extent and degree of its acceptance, however, is mixed and an engineering mentality towards landfilling persists. The transition is not complete. In 1981 under President Reagan, for example, the EPA stated that "landfill may be the most acceptable management option and that 'environmentally acceptable releases' would be allowed" (Epstein et al., 1982, p. 250). New designs and stricter standards for landfills continue to be developed. One such design--the aboveground landfill--has been lauded as "an idea whose time has come." Advantages include continually operating leachate collection systems run by gravity, less dependence on site geology for containment, and easy observation of problems (K. Brown, 1984, pp. 191-197). Another suggested engineering approach is a remedial pumping program which cleans up water contaminated by failed landfills. This consists of drilling wells into the groundwater, pumping it to the surface, removing contaminants, and returning it to the ground (Montague, 1984, p. 9). The irony of this particular EPA regulation is twofold. The unpredictability and complicated nature of groundwater makes it impossible to guarantee such cleanup. And the very existence of such a regulation indicates that the regulatory program is "premised on the certainty that, sooner or later, all landfills will leak" (Montague, 1984, p. 9). These approaches--right or wrong--do exist and counter the Leaking Landfill paradigm.

The 1984 Amendments to RCRA do, however, show that the Leaking Landfill perception is beginning to prevail. As we have already seen, these Amendments represent a clear shift in policy away from land disposal. They have yet to be implemented in full, and therefore the curtailment of landfilling has yet to happen nationally. The 80 percent landfilled figure for hazardous wastes is still commonly quoted.

It is possible that the RCRA Regulations have a negative affect on the utilization of recycling. Garelick (1985) believes that "it serves not only to catch the "sham" operators, but also to possibly discourage legitimate operations" (p. 32). Some legitimate operators might be hesitant to handle wastes that are designated as hazardous. A generator might be reluctant to ship hazardous waste offsite because "manifesting the waste is akin to putting its name on it" (p. 32).

National policy can also be criticized in its almost complete reliance on regulations. The economic incentives and disincentives discussed earlier and utilized by numerous states are absent. These would not necessarily replace regulations, but could be used to complement the regulations, to strengthen the policy, and close regulatory gaps. Economic policy in conjunction with regulations should strongly affect management decisions. Richard Fortuna (1984), Executive Director of the Hazardous Waste

Treatment Council, confirms that:

First, and foremost, the bottom line of treatment and disposal is the bottom line. Hazardous wastes are like water running down hill; they will always be disposed of along the path of least regulatory control and least cost. (p. 202)

An additional yet related factor influencing management decisions is liability. Although statutory liability is set nationally in RCRA and CERCLA, it could be utilized to reflect this paradigm more effectively by providing different liability standards for landfilling and alternative management methods.

Some states have made much more progress than the federal government in accepting the Leaking Landfill paradigm and curtailing land disposal. Illinois, for example, land disposed 81.7 percent of hazardous wastes generated in the state in 1980 but only 42.6 percent in 1983 (U. S. EPA Region V, 1985, p. 13). In 1984, this figure was down to 25.9 percent (Illinois Environmental Protection Agency (EPA), 1985). In interpreting this information, it must be pointed out that the data includes a category for shipment out of state that is not broken down by management method. In 1984, this "shipped out of state" figure was 30.5 percent (Illinois EPA, 1985). It is possible that landfilled wastes are hidden in this figure. Nonetheless, the decreases in landfilling appear significant and can be attributed to Illinois' strict regulatory program banning landfilling of materials unless it can be shown that they

cannot be reasonably recycled for reuse, incinerated, or treated. In Illinois, the Leaking Landfill paradigm is prevalent.

As we have already seen, numerous other states are also on their way to an acceptance of this paradigm in that they are enacting policies to decrease their dependence on landfills and encourage other management methods. Acceptance of the Leaking Landfill paradigm is mixed. In some circles it is prevalent and the national trend appears to be in its direction.

Because policy implementation is incomplete, it is impossible to evaluate results. Complete implementation should eliminate dependence on land disposal of hazardous wastes that would enter the biophysical environment. In the Leaking Landfill paradigm, it should also eliminate the dangers to human health and the environment.

Instead of perceiving land disposal as the one cause of contamination, however, it is instead possible to perceive it as one of many causes of contamination. The shift from one perception to the next is a small one. Yet the result is a very different definition of the problem. This new, paradigm, yet in embryonic form, is the subject of Chapter IV.

CHAPTER IV

DANGEROUS AND INEFFICIENT WASTE

Problem Description

The Dangerous and Inefficient Waste paradigm is new and not yet widely accepted. Nonetheless, it evolved directly out of the Leaking Landfill definition and expanded upon it. In the new definition, the failure of land disposal technology is understood as being only one of many ways in which contamination from hazardous waste can occur. Other control technologies such as incineration, treatment, recycling, and storage can contaminate land, air, and water and leave hazardous residues requiring further treatment or disposal. Transportation and handling accidents commonly result in contamination. In addition, contamination is only one of the environmental and human health consequences of hazardous wastes. Another undesirable consequence is the misuse of scarce resources in production and disposal.

When all of the inadequacies of hazardous waste throughout its lifecycle are considered, it is evident that the problem is caused by the mere existence of the waste rather than by the irresponsible actions of corporations or the failure of one type of technology. There is no risk-free way to control wastes once they are generated.

Nor is waste generation efficient. Rather, it is an indication of inefficient technologies and misuse of resources.

The inadequacies of other technologies that control wastes after they are produced now need to be described. The major concern about incineration is air emissions of particulate matter, combustion products, and uncombusted or partially combusted organic materials. Particulates can be lung irritants and can carry dangerous uncombusted organics with them. Scrubbers, filters, and electrostatic precipitators may be installed to minimize particulate emissions. Combustion products are water, carbon dioxide, and--depending on the material incinerated--various gases which form acids when contacting water. One possible product, hydrochloric acid, is harmful to plants. Another, sulphur dioxide, contributes to acid precipitation. Alkaline scrubber systems are often used to remove these products. If the incinerator is not hot enough or if heat is not applied for a long enough period of time, partially combusted organic wastes might also be emitted (Jackson et al., 1982, p. 96). A 99.99 percent destruction rate for incinerated hazardous wastes is mandated by the 1984 Amendments to RCRA. However, this destruction rate does not eliminate all products, and some may be harmful to human health and the environment.

In addition, non-organic ash will be left after

combustion. This residue usually contains inorganic salts and hazardous heavy metal particles that require further disposal. Ash can comprise as much as half of the original waste material. Hazardous wastes collected from the scrubbers, filters, and precipitators must also be dealt with (Jackson et al., 1982, p. 97).

Clearly, thermal treatment will reduce the volume and toxicity of many organic wastes, but hazardous emissions and residues will certainly occur. These may cause negative health and environmental consequences and are therefore part of the hazardous waste problem.

Chemical, physical, and biological treatment may also leave hazardous residues requiring additional management. A recent article in Environment highlights this concern:

Some solutions themselves cause more problems. There have been recent reports, for example, about a new Philadelphia waste treatment plant that cannot remove all of the toxic chemicals from the sewage it processes. Those that are left go into the air from the plant's incinerator. (Popkin, 1986, p. 5)

Chemical treatment also often requires the addition of a chemical agent to decrease toxicity. In some cases, another waste stream can be used but in others a virgin chemical is required. The production of these chemicals generates waste and their transportation adds to the total risk. Thus, chemical treatment contributes to the hazardous waste problem in one way even as it alleviates it in another.

Reclamation of materials often requires treatment, and

therefore leaves residues and utilizes chemicals which are themselves dangerous. In addition, reclaimed and reused materials can only be reconstituted or reused a limited number of times. Eventually, they will lose their inherent qualities and will require disposal (Metropolitan Service District, 1985, pp. 13-14). To summarize:

There is no easy solution to the problem of disposal once hazardous wastes are generated . . . the most widely-used methods for dealing with them--recycling, treatment and disposal--have major drawbacks. (Sarokin et al., 1985, pp. 3,5)

No matter what the method, off-site disposal is more dangerous than comparable on-site disposal because of the added risks of transportation. Transportation accidents, of course, can result in spills that contaminate the environment and endanger human health. But they also can result in sudden accidents such as fires and explosions. One former firefighter in Oregon thus defined hazardous waste as "anything that reaches out and grabs you" (R. Stroud, personal communication, December 10, 1985).

Misuse of scarce resources occurs when hazardous wastes and residuals are discarded or "destroyed" rather than being recovered or reused. Misuse results from landfilling, of course, but also from incineration when energy is not recovered and with treatment followed by landfilling of the detoxified materials. In addition, land disposal is a poor use of scarce land.

These two major environmental concerns--contamination

and conservation of scarce resources--are interrelated. It is the perception of hazardous waste as useless that encourages its generation and disposal. Paul Palmer (1982), a strong advocate of recycling who founded Zero Waste Systems, describes the alternate approach:

We refuse to think of excess chemicals as "hazardous waste." That's what the dumpers call it, emphasizing the threat, rather than the opportunity, and emphasizing uselessness rather than usefulness. (p. 74)

The evolving paradigm thus perceives the hazardous waste problem as being both a result of the waste of valuable resources as well as of the hazardous characteristics of the materials when treated as wastes rather than resources.

Industrial Hazardous Waste

In this Dangerous and Inefficient Waste paradigm, hazardous industrial chemical wastes are again the materials of concern. Unlike the prior paradigm, however, all hazardous wastes are considered dangerous no matter how they are managed and no matter which medium they pass through. This results in two important changes to the previous paradigm as it relates to industrial processes.

First, since the problem is the hazardous waste and not the technology, the emphasis on controlling wastes at the "end of the pipe" is replaced by reduction and recycling prior to generation of the waste. Although this preventative approach will be discussed at much greater

length in the following section, it is mentioned here because it expands the paradigm to include the production process itself. The locus of both the problem and the solution is at the point of generation. Focus is shifted from the pipe at the end of the production process to production itself. This is reflected in the Materials Balance Model reproduced in Figure 6.

In the Leaking Landfill paradigm, the problem/solution included the feeding of reusable, sometimes reclaimed, materials back into the production process. But this feedback did not actually affect the design of production. In the Dangerous and Inefficient Waste paradigm, the problem is the production process itself and the solution must therefore involve its alteration.

Because the production process is actually changed, the resources going into the process and the products coming out of it also might be changed. For example, a chemical substitution, product reformulation, or end product substitution might be required to decrease the amount of waste produced. This recognizes the fact that the "hazardous waste intensiveness" of products can vary. Thus, resources and products are also brought into the paradigm as solutions. This, too, is indicated in Figure 6.

The entire "products cycle" of the Materials Balance Model has not been included in the paradigm because although

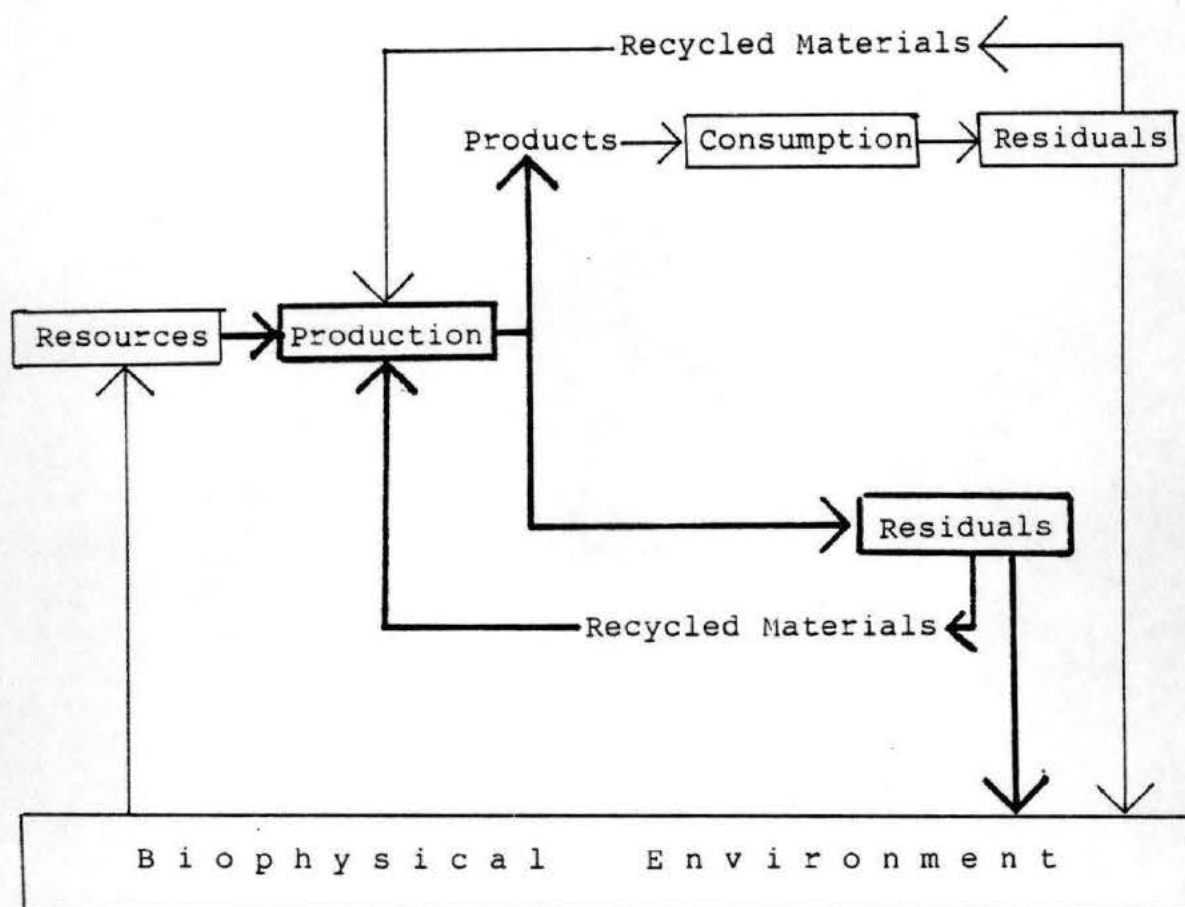


FIGURE 6. Materials Balance Model for the Dangerous and Inefficient Waste definition. Darker lines indicate the scope of the definition.

Note. From Environmental Planning and Management (p. 19) by J. H. Baldwin, 1985, Boulder: Westview Press. Modified by S. M. Mele.

products might be altered to reduce hazardous waste generation, the products themselves are not yet considered to be a problem. Hazardous substances are also not yet defined as being part of the hazardous materials problem.

Medium of Contamination

The second major change is related to the medium of contamination. When all forms of management and all the dangers of hazardous waste are examined, it is seen that wastewater from treatment plants, air emissions from incinerators, etc., can contaminate the environment as easily as land disposal. In this paradigm, all three media are included.

The importance of including all media becomes obvious when it is realized that hazardous waste is not found primarily in solid form. A recent analysis of eight key chemicals in six New Jersey plants found that:

Despite the common assumption that solid waste generation far exceeds discharges to the air and water, hazardous chemical wastes were found to be generated in roughly equal amounts as air emissions, wastewater discharges, and as solid wastes. . . . Wastewater discharges accounted for 42 percent; solid wastes, 35 percent; and air emissions, 23 percent. (Sarokin et al., 1985, p. 27)

This statistic is of particular importance because the three media are not equally regulated. Of the liquids generated by industry, nearly 75 percent are discharged into sewage treatment plants and the chemicals released into the

air go almost totally unregulated by current laws (Culver, 1986, p. III-2). RCRA lists and regulates over 350 chemicals as "hazardous constituents" and also regulates those wastes defined as "characteristic" wastes. On the other hand, the Clean Water Act only regulates 126 toxic chemicals as "priority pollutants" and section 112 of the Clean Air Act only lists six chemicals as hazardous air pollutants (Sarokin et al., 1985, pp. 508-513). Chemicals regulated by RCRA but not by the other Acts can nonetheless seriously contaminate the environment:

While the relatively few pollutants regulated by these laws (Clean Air Act and Clean Water Act) account for most of the tonnage of air and water pollution, thousands of other agents in industrial use have the potential to contaminate the environment. And, of these agents, many are so toxic that even trace quantities are very dangerous. (Epstein et al., 1982, pp. 184-185)

The unbalanced regulation of air, water, and land pollution in federal legislation will of course result in less effective control of air and water pollutants. Equally important, however, is the fact that it will result in less effective regulation of solid waste. Matter can not be destroyed; it can only change form. Application of control technology in one medium will increase the amount of pollution put into the other media.

The initial enactment of the Air and Water Acts caused an increase in the amount of solid wastes requiring management. The reverse can also occur. If solid wastes

are regulated more stringently than air and water pollutants, companies will allow those chemicals not regulated by the Air and Water Acts to escape into the air and water during production rather than gathering them up at the end of the production process and managing them as solid wastes. The "many loopholes in these regulations will simply shift waste into other disposal systems rather than encouraging real reductions in waste generation" (Culver, 1986, p. III-1).

In the emerging paradigm, any waste stream would be considered hazardous if it contains a substance listed as hazardous by either the Clean Air Act, Clean Water Act, or RCRA. For example, the emission into the air of a chemical regulated under RCRA but not under the Clean Air Act would be included. No matter how the wastes are discharged and no matter what media receives the discharge, these wastes are perceived as dangerous.

This perception of air, water, and land as pathways of contamination has grown. For example, the 3M Corporation's program to reduce pollution has included all three media. Since that program's inception in 1975:

The company worldwide has eliminated hundreds of thousands of tons of gaseous effluents, millions of tons of solid wastes and hundreds of millions of gallons of waste waters. (Royston, 1982a, p. 3).

The 23 companies participating in a 1985 Waste Reduction Conference at Woods Hole also describe examples of reduction

efforts in air, water, and land (League of Women Voters of Massachusetts, 1985). This cross media concern reflects the growth of the Dangerous and Inefficient Waste definition of the hazardous waste problem.

Technological Solutions: Prevention
and a Hierarchy of Approaches

All waste management techniques can be evaluated based on their ability to protect the environment and human health. Although it is beyond the scope of this study to perform the detailed and quantitative risk analysis that would be required for careful evaluation, it is both possible and useful to make explicit the values inherent in each management alternative and to build a hierarchy of alternatives based on those values.

Environmental and human health criteria have already been discussed in the introductory section of this chapter. To summarize, they include:

- Protection of land from contamination by wastes
- Protection of ground and surface water from contamination by wastes
- Protection of air from contamination by wastes
- Protection of air, water, and land from contamination by residues
- Protection from dangers of chemicals used to treat wastes
- Protection from releases and sudden accidents during generation, storage or disposal
- Protection from releases and sudden accidents during transportation
- Conservation/recovery of material resources
- Conservation/recovery of energy resources
- Conservation of land

Each hazardous waste management alternative can be evaluated based on its capacity to meet these criteria.

Conversely, each alternative has an inherent degree of danger or wastefulness based on its propensity to contaminate the environment or misuse resources. A summary of the dangers inherent in each alternative is provided in Table 5. By giving each of the dangers equal weight or importance, alternatives can be ranked and a hierarchy of preferred alternatives can be built. This hierarchy, based on Table 5, is presented below with alternatives listed from best to worst:

1. Reduction at source
2. Reuse
3. Reclamation
4. Incineration or physical treatment
5. Chemical or biological treatment
6. Land disposal

As a convenience, transportation has been left out of Table 5. However for each alternative, on-site management is preferred over off-site management because it eliminates transportation dangers.

This or a similar hierarchy has long been recognized. In 1975, the EPA published the following hierarchy in the Federal Register, suggesting that company waste management strategies be guided by the sequence:

- (1) Minimize the quantity of waste generated by modifying the industrial process involved.
- (2) Concentrate the waste at the source (using evaporation, precipitation, etc.) to reduce handling and transport costs.

TABLE 5. Environmental Consequences of Hazardous Waste Management Alternatives

Environmental Consequence	Reduction	Reuse	Reclamation	Physical Treatment	Chemical Treatment	Incineration	Land Disposal
Land Contamination							X
Water Contamination							X
Air Contamination						X	X
Generation of Residue			X	X	X	X	
Potential Accidents during Management		X	X	X	X	X	X
Use of Waste-Producing Chemicals during Management			?		X		
Misuse of Material Resources				X	X	X	X
Misuse of Energy Resources			X	X	X	?	
Misuse of Land Resources				X	X	X	X
Total Number of Potential Consequences	0	1	3 or 4	5	6	5 or 6	7

- (3) If possible, transfer the waste "as is," without reprocessing, to another facility that can use it as a feedstock.
- (4) When a transfer "as is" is not possible, reprocess the waste for material recovery.
- (5) When the material recovery is not possible,
 - (a) Incinerate the waste for energy recovery and for destruction of hazardous components, or,
 - (b) If the waste cannot be incinerated, detoxify and neutralize it through chemical treatment.
- (6) Use carefully controlled land disposal only for what remains. (U. S. EPA, 1977, p. 1)

This hierarchy has been widely quoted. As will be shown in a later part of this chapter, some states have actively worked to implement this hierarchy and the federal government has recently taken a first step towards its application. Nonetheless, we will see that the hierarchy has been more widely quoted than followed.

Although each of the technologies in this hierarchy has been previously described, the word "reduction" requires clarification because it has different meanings in different contexts. In its broadest sense, reduction refers to a decrease in the amount or toxicity of hazardous waste put into the ground. This meaning corresponds to the solutions acceptable in the Leaking Landfill paradigm. In a narrower sense, reduction refers to a decrease in the amount of waste requiring treatment, destruction, or disposal. In this sense, reduction includes recycling or elimination but not treatment or incineration.

In its strictest sense, reduction refers to a decrease

in generation of waste at source, attainable through chemical substitutions, process and equipment changes, product reformulation, and changes in operations. In this category, wastes are never produced although hazardous by-products might be. Reclamation is not considered to be a form of reduction because wastes are initially produced even though they might eventually be turned in part back to products.

Of the various definitions of reduction, only waste reduction at source emphasizes prevention rather than control; only reduction at source alleviates all the dangers and inefficiencies of hazardous waste. As such, it is the preferred solution for this paradigm.

Table 5 and the resulting hierarchy are of course gross simplifications and generalizations:

Individual generators face widely different options depending on the type of waste generated, state regulatory requirements, geographic location, and their ability to use waste by-products in the production operation.
(McCann, 1984, p. 117)

Each alternative is appropriate only for certain hazardous wastes, as shown earlier in Figure 5. For example, incineration only works for organic wastes with high heating values (Jackson et al., 1982, p. 97).

In addition, each of the technologies utilized entails a different degree of risk depending on the chemical involved, the particular technological process utilized, and the distance transported. In other words, in reality the

dangers listed in Table 5 are weighted differently in the analysis depending on the specifics of the situation. For instance, Table 5 indicates that reuse is generally preferred over treatment. However, the risk of transporting an extremely flammable or explosive material over a treacherous road for reuse off-site might be far greater than the risk of landfilling a small amount of minimally toxic residue when that same material is treated on-site. Optimally, a risk analysis for each hazardous waste management decision made by a corporation would be carried out.

Despite its generality, the management hierarchy demonstrates three important principles. First, prevention is always environmentally preferable to control. Control of hazardous waste always involves some risk. On the other hand, if waste is not generated it can't be dangerous. Although reduction "technology" is a part of the solution, an engineering mentality does not prevail in this paradigm. It is better to avoid the problem than to try to fix it after it occurs.

Second, the choice of management approach reflects certain values and degrees of risk. It is not entirely a technical or economic choice. When conservation and preservation values are the criteria upon which decisions are based, not all control technologies are equivalent. This is a change from the Leaking Landfill paradigm in which any technology other than land disposal was equally

acceptable.

A final point concerns technological standards. Standards can insure that some acceptable level of performance is achieved. They do not, however, make all technological approaches equivalent in their effect on the environment. Even the strictest standards, for example, cannot change the fact that incinerators destroy rather than conserve material resources. Emphasis on standards obscures the fact that the choices are based on social and environmental criteria rather than technological ones. The important decision is not which type of liner to use in a landfill but whether or not to landfill at all; not whether a particular scrubber will alleviate emissions but whether it would be better to recycle or reduce the waste in the first place.

The confusion between standards and alternatives stem from a confusion between facts and values. It is this confusion that often results in misunderstandings at public hearings where government and industry representatives are debating one type of scrubber versus another while citizens are debating the appropriateness of incinerators and scrubbers in general:

Specialized scientific knowledge and impenetrable technical jargon are barriers to meaningful participation by a public that is frequently placed at risk by the decisions. (Petersen, 1984, p. 7)

In the Dangerous and Inefficient Waste paradigm, the

questions about choice of alternatives would be asked. And they would be answered using environmental and health criteria.

Technological Feasibility

Although the technological feasibility of incineration and treatment has been demonstrated in the previous chapter, the feasibility of hazardous waste reduction at source has yet to be shown. Two separate questions need to be addressed. First, has reduction been successfully utilized? And second, are reduction technologies universally applicable or transferable to other industries and firms?

To answer the first question it is sufficient to provide individual examples and projections. We have already seen that many European countries utilize treatment, incineration, and recycling to a much greater extent than the United States. For example, almost 85 percent of West Germany's hazardous waste is sent to treatment plants for destruction or reuse. Of even greater relevance is the fact that Americans generate three times more toxic waste per citizen than do the West Germans (Piasecki, 1984b, p. 103). West Germany, a highly industrialized country, has successfully employed reduction strategies and technologies. "Tenacious strategies of waste reduction and exchange are standard operating procedures in at least half a dozen European countries" (p. 102).

Corporate examples of successful reduction also abound. The 3M program has already been mentioned and will be discussed in greater detail later. An important 1985 study of chemical plants performed by INFORM, a non-profit research group, is also encouraging:

INFORM found reports of 44 interesting and innovative waste reduction practices. They involved a variety of process, product, equipment and operational changes that substantially reduced or eliminated individual chemicals in wastestreams at the plants. To the extent that INFORM was able to document the actual impact of the practices, it was found they prevented the generation of at least seven million pounds of hazardous chemical wastes and saved companies at least \$800,000 in reduced raw material and waste disposal costs. These 44 practices taken together suggest the range of possibilities that exist for the more than 1,000 U.S. organic chemical plants to reduce wastes at the sources. (Sarokin et al., 1985, p. 75)

In addition, comparisons between companies utilizing similar quantities of chemical inputs demonstrate the potential of reduction techniques. One German company, for example, found that its Swiss subsidiary was utilizing the same production process but producing only 10 percent of the hazardous waste (Royston, 1982b, p. 42). The INFORM study similarly found that plants using comparable quantities of hazardous chemicals as feedstock generated greatly differing quantities of wastes. Alternative processes and uses of chemicals at those plants accounted for at least part of these differences (Sarokin et al., 1985, p. 28).

Finally, overall projections of the future potential for hazardous waste reduction range from 30 to 80 percent, with process changes being more difficult to make in existing plants than in new ones (OTA, 1983b, p. 19). Although there is a great deal of uncertainty in these projections, a tremendous potential is apparent.

Clearly, waste reduction technology has been successfully applied. To best answer the question of universal applicability it is necessary to understand the nature of reduction itself. The INFORM report identified five major categories of waste reduction practices. These are process changes, product reformulations, chemical substitutions, equipment changes, and operational changes. The striking thing about this list is that most of the practices are strategy changes and material substitutions rather than technology changes. Operational changes, for example, are:

Changes in the way hazardous materials are handled at a plant and can include careful observation and control of material and process conditions and employees' habits so as to minimize spills, process upsets, the use of excessive chemicals or other problems that can generate waste. (Sarokin et al., 1985, p. 97)

These management strategies are available to all companies that choose to implement them.

Another important characteristic of these reduction practices is that many are housekeeping measures. Housekeeping includes tightening valves and replacing

gaskets, altering rinse systems, upgrading filtration systems, improved monitoring such as computerization of resource and energy flow, placing floating roofs on tanks to eliminate hazardous vapors, separating waste streams for enhanced handling and recycling, etc. A comparison of treatment, recycling, and reduction technology is provided in Figure 7 to demonstrate the simplicity and effectiveness of housekeeping practices.

To date, housekeeping has been "the most rewarding waste minimization activity" (Purcell, 1986, p. I-4) and "can accomplish about half of the total waste minimization possible through efficiency increases and process changes" (p. I-5). Housekeeping measures correspond to the first phase for implementing source reduction strategies identified by the Institute for Local Self-Reliance. This stage is called "Commitment & Maintenance" and has "low cost and no risk." It is primarily a change in attitude followed by simple and inexpensive process or operational adjustments (Martin, 1986a, p. 35). The housekeeping nature of many reduction practices supports the contention that these practices are transferable to all corporations.

Even if half of all possible reduction can occur from housekeeping, another half remains which is related to process changes and larger, more difficult, equipment changes and product reformulations. This half is the "Technology Intensive" phase of reduction (Martin, 1986a,

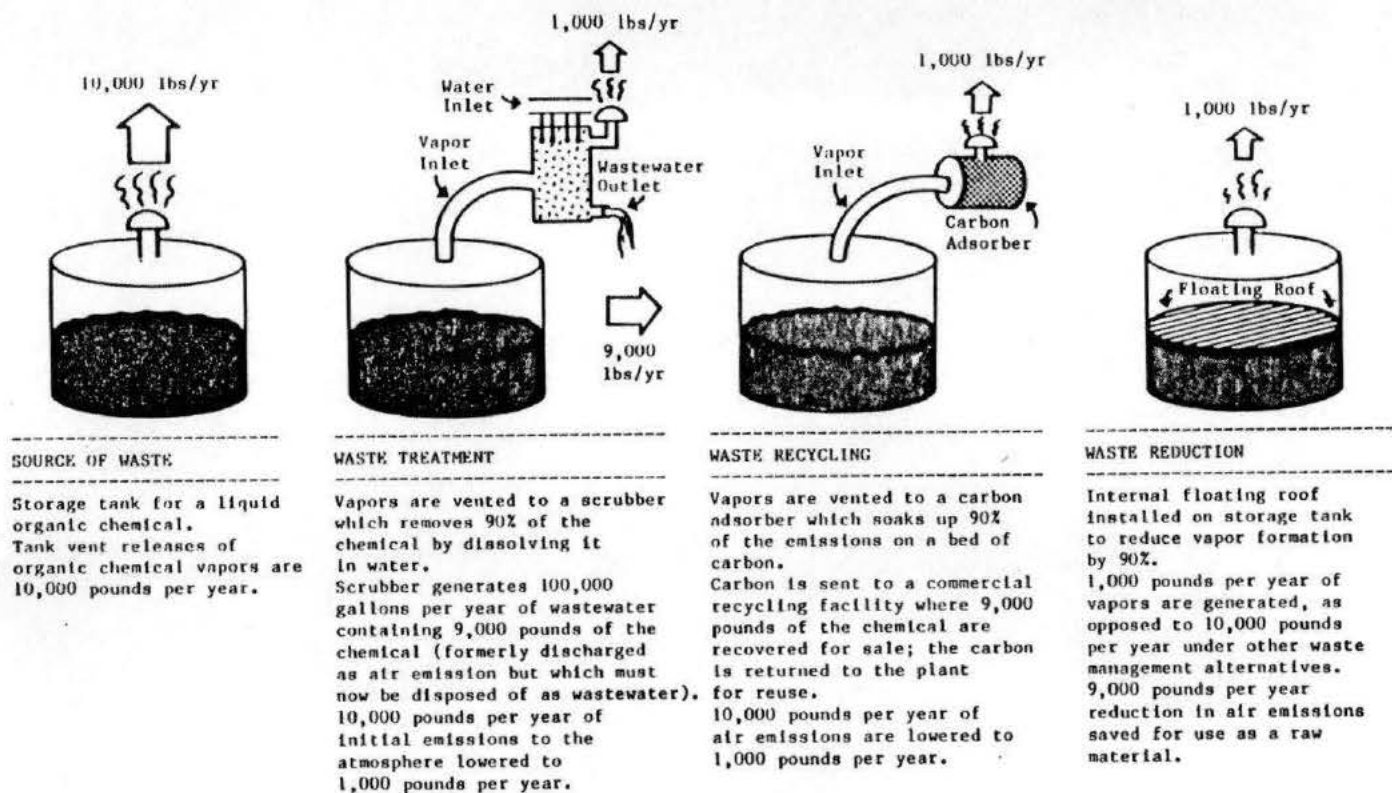


FIGURE 7. Comparison of waste treatment, recycling, and reduction: A hypothetical example for air emissions from a storage tank.

Note. From Cutting Chemical Wastes (p. 24) by D. J. Sarokin, W. R. Muir, C. G. Miller, and S. R. Sperber, 1985, New York: INFORM, Inc.

p. 35). The applicability and transferability of these technologies are still to be demonstrated.

To show that most processes are indeed transferable and generally available, Martin (1986b) classifies thirteen basic strategies or technologies for waste reduction from 118 modifications identified in 86 case studies. The studies include diverse industries from different Standard Industrial Codes (SICs). Martin finds that 90 percent of the reduction techniques currently utilized are "well understood technologies, or entail a waste minimization strategy that needs only to be learned and understood to be implemented in suitable applications" (p. IX-7). These include, for example, evaporation, ion exchange, distillation, filtration, and common sense management initiatives. Only 10 percent of the modifications could be classified as "innovative technology and patent pending processes." Therefore, Martin concludes that 90 percent of the waste reduction strategies currently used are transferable to other industries and companies (p. IX-9).

Martin (1986b), however, also points out that the real problem of transfer lies in the translation of the technology to particular processes. "Because facilities and processes are often uniquely configured, the application of waste reduction modifications must usually be custom designed" (p. IX-3). It is the job of engineers to do this

custom designing, to be the translators. Translation does require process engineering knowledge and corporate commitment. The technologies themselves, however, are both available and easily transferable. They are mostly typical chemical and physical processes already used by industry and are not a mystery to anyone.

An Economic Paradigm

Economic growth and environmental quality. Is it possible, you ask, to have both at the same time? (Huisinigh & Bailey, 1982, p. ix)

The pollution debate traditionally sets the economics of corporate profits and growth in opposition to environmental protection. Pollution control technology and regulations are expensive for corporations to implement and result in a decrease of their profits and/or an increase in cost passed on to consumers. It has been expensive for "Irresponsible Corporations" to comply with standards and for industries to utilize alternatives to "Leaking Landfills":

Building big black boxes at the back of the factory to control pollutants is costly. Hundreds of thousands or even millions of dollars for a single facility is not unusual. (Susag, 1982, p. 18)

Although these costs represent the internalization of real externalities, they intensify the opposition between profits and environmental protection.

It is therefore a mild surprise as well as a major change to find that the transition from control to

prevention in the Dangerous and Inadequate Waste paradigm can result in solutions that simultaneously increase corporate profit and environmental protection. A French survey, for example, showed that of 100 companies using "clean technology," 70 made investments costing less than if they would have implemented end of pipe control technology and 69 had lower running costs (Royston, 1982a, p. 2).

And if it is surprising to see environmental protection and growth resulting from the same action, it is astonishing to find strong corporate support of the "pollution prevention pays" philosophy. This support reflects a shift from environmental to economic philosophies, ramifications, and rhetoric. This economic perspective runs parallel to the environmental one. Its complementary nature is discernable in the economic description of the problem which is now presented.

Waste is an indicator of inefficiency because it is a "misused and misplaced resource" (Martin, 1986a, p. 35). "Pollution is a symptom of using inefficient technologies that waste resources, degrade the environment and are unprofitable" (Huisingh & Bailey, 1982, p. ix). Therefore, utilization of efficient technologies will conserve resources, preserve the environment, and create profits. Efficient corporations will be able to compete and survive in a competitive market while inefficient companies will not. The efficient utilization of resources, measured

by the amount of waste generated per unit of production, should in fact be the fundamental criterion by which to evaluate industry's performance (J. Hirschhorn, conference address, May 8, 1986).

This philosophy is embodied in the 3M Corporation's Pollution Prevention Pays (3P) Program. Begun in 1975, the program has achieved significant--even outstanding--results. "Pollution Prevention Pays" has marked 3M as a leader in hazardous waste reduction and has become the "buzzword" for excellence in the field. The 3M Program "applies the pollution prevention concept on a comprehensive company-wide basis throughout the world" (Susag, 1982, p. 19). It encourages innovations which prevents pollution, conserves natural resources or energy, results in a cost saving for the company, and demonstrates technical achievement.

The first two of these program requirements are the environmental values that spawn the criteria which we have seen to be the heart of the new paradigm. Thus, the preferred solutions of the 3P Program are reduction at source, reuse, and reclamation. Developing non-polluting products, reformulating existing products by substituting ingredients, process changes, equipment modifications, and reuse or resale of by-products are all encouraged. Treatment at the end of the pipe is avoided as costly and polluting, and landfilling is utilized only as a method of

last resort (Susag, 1982, pp. 17-21).

Thus, in its ten years of operation, the 3P program has achieved a 50 percent decrease in potential hazardous waste generation. The corporate goal is an additional 50 percent decrease over the next 5 years (League of Women Voters of Massachusetts, 1985, sec."3M" p. 8). Waste water emissions, for example, have been cut by 1.4 billion gallons per year (Purcell, 1986, p. I-3). As of 1982, 600 projects (both for hazardous and non-hazardous materials) resulted in eliminating 125,000 tons of air pollutants, 4,000 tons of water pollutants, and 12,000 tons of sludge, and saved 228,000 barrels of oil (Susag, 1982, p. 20).

For a 3M project to be implemented, the criteria of cost reduction and technological innovation must also be met. To date, 3M has saved over \$200 million through waste reduction projects (Purcell, 1986, p. I-3). These savings come from pollution control facilities that did not have to be built, from reduced pollution control operating costs, and from retained sales of products that might have been taken off the market as environmentally unacceptable (Susag, 1982, p. 20). Profits reflect efficiency while high costs of production (and lowered profits) reflect waste of valuable resources. Efficiency is connected to pollution prevention. Economic and environmental philosophies are thus joined.

In case studies of corporations and of individual

reduction efforts, this theme of profits from pollution prevention recurs again and again. Comparison of clean with old processes are related to cost savings and decreases in waste generated (League of Women Voters of Massachusetts, 1985; D. Meyer, 1982, pp. 25-26; Royston, 1982b, pp. 46-66; Sarokin et al., 1985, pp. 149-497).

This paradigm recognizes that a sound economy is based on environmental protection:

Human well being--the goal of development--is grounded in Man living in a high quality environment. When the environment is damaged, the development process itself is damaged. (Royston, 1982a, p. 16)

Resource stewardship and profits are interrelated goals. Ecology--the "study of the house"--can be used to optimize our economy--the "management of the house."

This philosophy, of course, suits both corporations and the federal government. Businesses are primarily concerned with the bottom line. To them, the problem is "that production of many toxic materials is not cost effective" (Epstein et al., 1984, p. 255).

The role of the U. S. government, on the other hand, is to assure that "policies are consistent and complementary" (Rydell, 1984, p. 185). In the Irresponsible Corporation and the Leaking Landfill paradigms, government integration of environmental and economic policies involved a precarious balancing act because the two policies were seen as being mutually exclusive. Since the implementation of RCRA would

require corporations to act in ways which would decrease their profit, we are left wondering if "all of this (can) really work" (Epstein et al., 1984, p. 245). In the Dangerous and Inefficient Waste paradigm, however, the two policies are in harmony. If the paradigm were operating and prevalent, economic goals would result in environmental protection.

Causal and Political Responsibility

In the Dangerous and Inefficient Waste paradigm, the causal sequence which leads to environmental and health consequences is initiated by the generation of the hazardous waste. The material itself is inherently dangerous and inherently wasteful of resources. No matter how carefully the material is handled by corporations and no matter how well engineered the disposal technology, a risk is imposed when the waste is created. The more hazardous waste generated, the greater the risk.

This focus on the material itself is a significant shift from the previous foci on individuals and disposal techniques because it directs our thoughts from disposal to generation and from management to prevention. It requires that we examine the production technology rather than control technology and production strategies rather than disposal strategies.

Since corporations choose their own production

strategies and technologies and therefore choose whether or not to generate hazardous waste, they are implicated by the causal sequence. They are also held legally/politically responsible for the consequences in this paradigm. The strict liability previously discussed strengthens the perception that generators are responsible not only because the act of disposal is "abnormally dangerous" but because the act of generation and the hazardous waste itself are dangerous. For instance in a 1985 New Jersey case, the judge held that:

A company (i.e., a hazardous waste generator) which creates the Frankenstein monster of abnormally dangerous waste should not be expected to be relieved of accountability for the depredations of its creature merely because the company entrusts the monster's care to another, even an independent contractor. (G. A. Meyer, 1986, p. 73)

The danger of the material and the liability of the generator are also indicated by the drying up of the insurance market for non-sudden releases of toxic chemicals (Davis, 1986, p. II-9).

As in the previous paradigms, both generators and the government are politically responsible in that they are obligated to do something about the problem. Generators are responsible for eliminating or decreasing the quantity and toxicity of hazardous waste generated. One way of doing this is to decrease production. This, of course, is not a viable alternative and the companies have turned to altering

strategies and technologies to decrease hazardous waste generation. Within the companies, therefore, process engineers play an important role. The 3M Program, for example, is directed toward:

The company's 5,000 technical employees-- laboratory, engineering and manufacturing personnel . . . who are responsible for product formulation, process equipment, manufacturing operations and recycling. (Susag, 1982, p. 19)

Unlike the Leaking Landfill paradigm, the federal government is not responsible for technological and strategy innovations for reducing generation of hazardous waste. In fact, technical control of the production process (and therefore the reduction technology) is outside of RCRA's jurisdiction. This is appropriate because proprietary information is involved. Government is, however, responsible for encouraging maximum prevention and the implementation of the management hierarchy.

Actors and Ownership

Because this paradigm is in embryonic form, actors are only beginning to emerge. It is therefore only possible to provide indications of which actors might play an important role in this scenario.

At present, the primary groups encouraging reduction are those companies who have made it work for them. This is a reversal of the position previously taken by corporations and puts environmental groups and businesses on the same

side of the issue.

We will see in the next section that the solutions to the economic paradigm of Dangerous and Inefficient Waste will only match the environmental paradigm if all external costs are internalized and if the values of each technological solution are made clear. The actor most consistently capable of clarifying values is the citizen group. In past paradigms, citizens have been active in preventing the siting of treatment and disposal facilities in their own backyards but have not necessarily questioned the overall production of waste or judged the appropriateness of alternative approaches to solving the problem. "The public has been frequently excluded from such decision making by leaders who generally define decisions as technical questions" (Petersen, 1984, p. 3).

In this new paradigm, citizen groups will need to clearly express the values inherent in each of the technological approaches in order to support the belief that hazardous waste generation and disposal should occur in no one's backyard. They must "assure that the right questions are being asked about the fundamental problem definitions" (Rydell, 1984, p. 194) and must be part of the:

Forum where alternate frames of reference can be introduced, where the boundaries of the debate can be extended, and where it is possible to force recognition of alternative positions. (Kronick, 1984, p. 200)

Citizen groups will play a critical role in the transition

to the Dangerous and Inefficient Waste paradigm.

Because reduction, reuse, and reclamation are given priority in this paradigm, technical assistance consultants, process engineers, waste exchange personnel, and recycling experts will play a greater role. Waste management companies that treat and incinerate waste will continue to be active but less so than in the Leaking Landfill definition. Control technology will be utilized only when reduction and recycling are unviable. Every incinerator, waste treatment facility, and storage facility will be a "monument to the failure of prevention" (Mavretic, 1982, p. 151).

Reduction and recycling experts have indeed begun to emerge. The private sector has spawned consultants who will make plant visits to examine production processes, perform audits, and make strategy recommendations for reducing or recycling waste. The Institute for Local Self Reliance maintains a list of these consultants as well as equipment suppliers and research agencies involved with the development and application of waste reduction technologies and strategies (Martin, 1986b, pp. IX-11-IX-12).

Public Technical Assistance Programs (TAPs) and Waste Exchanges have also appeared. The Minnesota Technical Assistance Program (MnTAP), for example, is a nonregulatory agency that provides free technical assistance to companies that wish to decrease waste generation. The program began

in 1984 and offers on-site visits and consultation, engineer interns who will work on specific projects, and seminars on waste reduction opportunities (Minnesota Technical Assistance Program and Minnesota Waste Management Board, 1986).

Currently, there are 12 operating non-profit Waste Exchanges in the United States. They publish listings of "wastes" produced and wanted, with the intent of matching companies so that materials can be reused rather than disposed (Banning, Herndon, & Jones, 1986, pp. 105,112). Although exchanges have functioned for 10 years, they have gradually regionalized and increased in viability. The proposed organization of a National Association for Waste Exchange and Resource Reuse would significantly increase their political influence and ownership in the hazardous waste paradigm by creating a mechanism for lobbying at both state and federal levels ("Need for," 1983, pp. 71-75).

As in the earlier paradigms, the federal government will continue to play the critical role in policy formation. Despite the economic perspective of the new paradigm, it will be necessary for the government to insure that the market is not distorted in the signals it gives to businesses. This is subject of the remainder of this chapter.

Policy Solutions

Pollution prevention pays only when the long term, external costs of pollution are incorporated into the cost of production:

Externalities are costs of production or consumption that are borne by society and not by the producers or consumers of the products. The true cost of a good or service is its market price plus the external costs of production or consumption (i.e. for ecological, health, or property damage). (Baldwin, 1985, p. 129)

For the most part hazardous waste management costs have been set by the market and do not reflect the costs of ecological and health damage, materials lost, or energy lost. One estimate of these costs is displayed in Table 6.

When these costs are excluded from the market price, as they are in the Irresponsible Corporation and Leaking Landfill paradigms, management decisions are distorted. Numerous current laws exacerbate the distortion by encouraging the use of virgin materials over the use of recycled materials. Thus, alternatives in the lower part of the hierarchy are less costly than alternatives higher in the hierarchy and environmentally detrimental hazardous waste management decisions are made.

Gradually, this has begun to change as external costs are internalized. Costs imposed by regulations, e.g. manifesting wastes and becoming permitted as a TSDF, increase overall management costs. Liability for cleanup

TABLE 6. Estimated Damage Costs of Uncontrolled Pollution
(Millions of Dollars)

	Per capita cost, US dollars			
	USA	Canada	United Kingdom	Italy
Health	60	2.5	35	2.5
Agriculture	.5	.5	10	.5
Services, amenities, tourism	20	10	10	5
Materials	24	49	14	5
Total	104.5	62	69	13
As a percentage of GNP	2%	1%	3%	1%

Note. From Making Pollution Prevention Pay by M. G. Royston, 1982, in D. Huisingh and V. Bailey (Eds.), Making Pollution Prevention Pay: Ecology with Economy as Policy (p. 14), New York: Pergamon Press.

and damage can also significantly affect the bottom line of a corporation. Legal suits are common enough and costly enough that corporations must seriously consider them as they make management decisions. Costs of remedial action at leaking landfills have, for example, been estimated to be between \$17 and \$30 million per site (Davis, 1986, p. II-1).

The land ban on liquids and the upcoming EPA decisions on banning waste mandated by the 1984 RCRA Amendments will also drastically affect management decisions. In the economic context bans are a method of setting the price of land disposal at infinity, i.e. of saying that the

externalities are too costly to allow. Transportation costs also encourage firms to follow the environmental hierarchy by managing wastes on-site. As we have seen, some corporations such as 3M have begun to respond to these increased costs of liability, management, and resources. They also have realized that future changes in policy will further require that external costs be internalized.

If the costs of all externalities and the value of all resources are considered, hazardous waste management decisions will be made which follow the environmental hierarchy described earlier. In the evolving paradigm, it is the purpose and responsibility of national policy to remove market distortions so that corporations making sound economic decisions will simultaneously be making sound environmental decisions. In other words, policy must translate the environmental values inherent in each hazardous waste management and prevention option into economic values.

For any policy integrating environment and economics to be effective, it will first be necessary to define the problem as a multi-media one and to plug the existing gaps which allow numerous hazardous air and water pollutants to go unregulated. Only when cross-media regulations are in place will reduction at source and adequate protection of the environment occur. At the national level, policy responding to the paradigm must therefore link the land

pollution Act, RCRA, to the policies regulating air and water pollution. This has yet to occur.

At the state level, however, some instances of stringent cross media regulations exist. In North Carolina, for example, stricter air and water laws have "put significant pressure on industry . . . to reduce and potentially eliminate their effluent streams" (Easson, 1982, p. 96).

Once the media gaps have been plugged, policy can be more effectively utilized to integrate environmental and economic values. The individual tools used to implement policy have already been described in the Leaking Landfill Chapter. To review, the approach can be either supply side or demand side and can utilize regulations, incentives, or disincentives. The character of the Dangerous and Inefficient Waste paradigm, however, indicates that certain criteria should be considered in choosing the tools to be utilized. The criteria fall in three general categories.

First, if the goal of policy is to make pollution prevention pay then it is imperative to use economic tools. Regulations might be included but incentives and disincentives are critical if costs are to be directly affected. In addition, economic tools are useful because of their capacity to produce gradations or tiers of incentives that reflect and encourage the gradations or tiers of solutions.

Second, the purpose of policy in this paradigm will be to force companies to consider the solutions at the top of the hierarchy before they consider solutions lower in the hierarchy. This is dramatically different from the two prior paradigms where the bottom solutions were considered first. Policy in the Leaking Landfill paradigm, for instance, cut out the lowest rung of the hierarchy thereby pushing the management decision up one rung to treatment and incineration. Instead of pushing up from the bottom, the new paradigm requires that we start at the top.

In addition, because a hierarchy of solutions exist it is necessary that policy encourages a hierarchy of management decisions. In the Leaking Landfill paradigm the decision was only two tiered: to landfill or not to landfill. In the newer paradigm, each tool must instead be utilized to create the numerous layers of the economic hierarchy. A fee system, for example, would impose graduated fees with the highest ones for the land disposal at the bottom of the hierarchy and no fees (or positive incentives) on reduction and reuse at the top of the hierarchy. Obviously, policy in this paradigm must also insure that all levels of the hierarchy are available to all companies.

The third criteria is similar to the second. In the Dangerous and Inefficient Waste paradigm, policy must encourage companies to implement the activities that are

prerequisites to reduction and reuse before deciding on a management alternative lower in the hierarchy. Such activities require skills and strategies that are significantly different from those traditionally associated with incineration or treatment. These activities are described in detail below.

For reduction to occur, it is generally recognized that companies must first identify the chemical constituents within the wastes that are hazardous and determine their origin in the production process. This is accomplished with a waste audit and materials balance survey as well as by comprehensive training of employees who might recognize waste minimization opportunities (Purcell, 1986, p. I-8). The audit and materials balancing includes a comprehensive plant site inventory of all potential hazardous chemicals:

Processes would need to be listed and characterized. Characterizations would require identification of function, equipment, human interaction (and type of exposure), through put and yield, rate and efficiency, emissions, by-products and down time, cleaning and maintenance conditions. (Geiser, 1986, p. IV-11)

Only when such information is available can choices about appropriate reduction techniques be compiled and analyzed, and choices made. As we have already seen, reduction techniques are technologically available and transferable but process engineering skills will be required to translate them to each individual plant and process.

Successful reuse and recycling utilize these process

engineering skills. In addition, off-site reuse requires a strong marketing capability. Many by-products simply cannot be utilized within the factory at which they are produced, but can be reused or recycled for resale outside of the parent factory. To accomplish such transactions, a company must know enough about other processes and industries to locate potential buyers.

Waste audits and market analysis, then, are the prerequisites and precursors of reduction and reuse. For large corporations, these activities can be accomplished with in-house studies or the hiring of consultants and/or brokers. Small and middle sized companies, however, often "do not have the engineering resources in-house to evaluate and implement waste reduction alternatives" (Brower, 1982, p. 110) or the marketing skills to effectively sell by-products or reconstituted materials to other corporations. The in-house studies conducted by larger corporations are beyond the capabilities of these smaller firms. Small companies also often lack the capital to implement programs requiring large up front capital investments (Purcell, 1986, pp. I-7-I-8). Thus, for small and medium sized corporations to have access to the reduction and reuse alternatives, they must somehow overcome their lack of skills and capital in order to participate in the activities of auditing and marketing. Technical Assistance Programs (TAPs) which provide auditing expertise

and Waste Exchanges which act as marketing agents are required. Some small companies might also hire for-profit consultants and brokers.

For many corporations, reduction and reuse will remain unconsidered until the audits and market studies are required. Only then will companies realize that reduction and reuse are not only feasible but profitable. For policy to be effective in this emerging paradigm, it must mandate or encourage in-house studies, waste exchanges, and technical assistance programs. Supply side tools that increase availability of these programs are important and necessary.

Certain States and European countries have begun implementing policy which responds to the Dangerous and Inefficient Waste paradigm by meeting these three criteria. Economic tools are used and the hierarchy and activities associated with the hierarchy are encouraged from the top down. The remainder of this section provides examples of such policies.

Perhaps the most direct way of regulating industry into compliance with the environmental hierarchy is to require proof that alternatives above the chosen management option on the hierarchy have been explored and that the wastes are not amenable to those options. West Germany, for instance, requires "waste generators to first show whether recycling methods have been explored before other methods can be

permitted." As a result, West Germany boasts a 36 percent success rate of exchange for wastes listed on the exchange (Piasecki, 1984b, p. 104). Optimally, these regulations would require that generators explain why preferred alternatives are not suitable whenever any of the alternatives below reduction on the hierarchy are utilized.

California has a similar law by which the Waste Exchange is authorized to review the hazardous waste manifests for all shipments to find those wastes that could potentially be recycled. Generators must then justify why the wastes were not recycled (Davis, 1984, p. 73). A list of wastes that are economically and technically feasible to recycle facilitates this activity. No comparable law currently exists regarding reduction.

The Illinois Industrial Material Exchange Service recently experimented with similar action. It reviewed permits encompassing 1,439 landfilled items and found that 24 percent of them were potentially recyclable. Each generator of these potentially recyclable materials was contacted and provided with information. A follow-up survey found that 60 percent of those generators then contacted recyclers and half of those had their material recycled or were still negotiating with the recycler or would use the information in the future (Banning et al., 1986, p. 115). Direct bans are also useful in encouraging companies to follow the hierarchy. The land bans on hazardous wastes,

already discussed in some detail, are one such example.

Finally, permitting exemptions can encourage management decisions to utilize the options higher in the hierarchy. The New Jersey Facilities Siting Act, for instance, exempts recycling facilities from being defined as a "major hazardous waste facility" and therefore exempts them from strict siting standards (National Conference of State Legislatures (NCSL), 1982, p. IV-24). Michigan takes this a step further by excluding material "sold for recycling or treatment and is stored for one year or less" from the definition of hazardous waste, thus excluding it from regulation (NCSL, 1982, p. IV-19).

A second type of regulation would require that activities which are prerequisites to reduction and recycling be mandated. A recent Maine law, for example, requires that a corporation perform a waste minimization audit prior to the facility receiving a permit for discharges. Waste audits could be "conducted by internal auditors with a highly rigorous protocol modeled upon the firm's internal financial audit" (Geiser, 1986, p. IV-11). Policy could also require that companies market their "waste", e.g. by listing with a waste exchange.

Audits or reduction plans are important for a number of reasons. First, they would provide information not only on the aggregate quantities of waste produced but on each individual waste stream in the factory. This is obviously

the information required for reduction. Second, if the reports had to be signed by upper management they would assist in moving policy decisions about hazardous waste into the boardrooms. Finally, audits provide information that is needed to document cost savings. This also is critical to management support, overall success, and the integration of environmental and economic values.

Transportation regulations are a type of regulation which can be used to encourage in-house solutions over off-site options. In Denmark, for example, the community generating the waste is responsible for disposal. Only difficult wastes are transported to a central treatment facility. There are 20 major collection substations and no generator is more than 20 miles from one of them. Hazardous wastes are shipped to the central treatment plant by rail in special cars (Piasecki, 1984b, p. 103). This system minimizes transportation distances and accidents.

Another type of regulation encouraging on-site management is exemption from permit requirements. In Indiana, for instance, permits for in-house treatment of hazardous waste are exempt if that waste is recycled, recovered, or reused at the same site by the generator (NCSL, 1982, p. IV-12). This also encourages recycling and reuse over management alternatives lower on the hierarchy.

Finally, it should be recognized that although not yet implemented in the United States, directly mandating a

certain percentage reduction in the generation of hazardous waste or the implementation of state of the art reduction technology, e.g. Best Available Technology (BAT) are regulatory options.

Demand side disincentives are important in this paradigm because they are economic tools capable of integrating environmental and economic values. Fee systems, liability laws, and direct taxes have all been utilized. The national fee system recommended by Joel Hirschhorn (1982) of the U.S. Office of Technology Assessment is an excellent example because of its simplicity and direct connection to the hierarchy. It is quoted extensively below:

1. Fees should be much higher for most hazardous wastes currently disposed of on or into the land.
2. Fees should be lower for wastes that are chemically, thermally, biologically, or physically treated.
3. Fees should be lower for high volume-low hazard wastes, such as those deemed hazardous because of characteristics other than toxicity.
4. There should be no fees for wastes that are recovered or recycled on site for their energy or material value.
5. There should be higher fees, or a supplemental fee, on wastes transported to off-site or commercial facilities because of the potential for accidents and spills during transportation.
6. There probably should be higher fees on wastes disposed of in old land disposal facilities, since they are regulated less stringently than new ones. (pp. 132-133)

The 1983 OTA report also suggests that wastes recycled for material or energy would not be taxed, but that recycling needs to be carefully defined to avoid "inappropriate removal of wastes from the system" (1983b, p. 43).

Although this has not been implemented nationally, similar fee systems are operating in numerous states. In Minnesota and Kentucky, for example, a graduated fee schedule promotes the use of recycling and treatment as well as on-site management rather than off-site (OTA, 1983, p. 44; NCSL, 1982, p. IV-15). A proposed Minnesota fee system is summarized in Table 7.

Legal liability is also a cost disincentive to all alternatives other than reduction and reuse. Liability, then, is an incentive for corporations to use these alternatives. Unfortunately, as currently used it is a two tiered tool that equally discourages land disposal, treatment, and incineration. This does not need to be the case. Statutory law can be written to enforce different degrees of liability on different alternatives.

Another potential demand side disincentive is taxation of virgin materials to discourage their use. A comparable incentive is tax credits on recycled materials to encourage their use. Indirectly, taxation on transporting virgin materials or credits for transporting recycled materials can also be used. At present, the reverse of this is occurring.

TABLE 7. Illustration of a Hazardous Waste Generator Tax Structure

Waste Management Category	Tax on Solid Waste (\$1/tonne)	Tax on Liquid Waste (\$1/tonne)
Land Disposal	42	85
Offsite:		
Land Disposal after Treatment	21	42
Treatment	11	21
Onsite:		
Land Disposal after Treatment	11	21
Treatment	5	11
Recycling/Reuse:		
Used Crankcase Oil	0	0

Note. From Technologies and Management Strategies for Hazardous Waste Control: Summary (p. 44) by Office of Technology Assessment, 1983, Washington, D.C.: U. S. Government Printing Office.

"Virgin material is, in effect, subsidized in relation to secondary material" (Metropolitan Service District, 1985, p. 38).

Supply and demand side incentives can be used to encourage the activities that are precursors of reduction and reuse, i.e. TAPS and Waste Exchanges. "Currently, there are at least 24 states that offer informational programs that support some aspect of waste exchange or resource reuse" and at least 15 states offer TAPS or support exchanges (Stough, 1986, p. 18). Three of the strongest programs--Minnesota, New York, and North Carolina--are

described below.

In 1984, the Minnesota Legislature provided \$110,000 for setting up a Technical Assistance Program (MnTAP) to respond to phone inquiries, conduct on-site visits and consulting, conduct seminars, provide engineering interns to individual companies to address the waste reduction problem at that company, and to offer research grant money on reduction problems facing small quantity generators. An annual "Governor's Achievement Award" recognizes companies for creative, responsible solutions to hazardous waste problems. In addition, the Legislature approved \$150,000 for waste reduction grants and \$350,000 for processing grants which include recovery and recycling projects as well as treatment projects (Peterson, 1986, pp. 21-23).

The North Carolina Pollution Prevention Pays Program was established in 1983 to help industries and communities reduce waste generation through on-site technical assistance, research and education, and financial assistance. Research grants are for application of pollution prevention techniques for air, water, and land pollutants in which technical and economic feasibility are documented. Challenge grants are for matching funds for the costs of materials, personnel, or consultants needed to undertake a prevention project. Projects range from simple audits to pilot scale demonstrations in diverse industries. In addition, program staff can refer firms to other

potential sources of financial assistance (Schechter, 1986, pp. 24-29).

New York State's Industrial Materials Recycling Program is administered by the Environmental Facilities Corporation (EFC) and provides technical assistance similar to that provided by North Carolina and Minnesota. In addition, EFC assists in marketing recycled materials by researching available markets for recycled materials, preparing a list of those materials, and establishing and maintaining a waste exchange (Curran, 1986, pp. 29-31).

Programs such as these increase the supply of information and expertise needed for reduction and recycling. Since many of the services are provided free of charge, they also increase demand.

Other incentives have been implemented by state governments. Minnesota, for example, offers a five percent tax credit for recycling equipment used in treatment of air, water, or land pollution (NCSL, 1982, p. IV-20) and Oregon provides a 100 percent tax credit to industries for pollution control facilities that "produce either a usable source of energy or another item of real economic value from something that would otherwise have been a waste" (NCSL, 1982, p. IV-30). Using a slightly different approach, Michigan established a tax exemption on new property used to minimize or reduce waste generation. The exemption is also applicable to existing plants that change their processes

for the purpose of reduction (NCSL, 1982, p. IV-19). Provision of low interest loans and bonds to finance waste reduction is yet another potential incentive. New York and Massachusetts are investigating this alternative (Martin, 1986a, p. 37).

Finally, the fact that innovative reduction and recycling technology is unproven increases the risk associated with its use. Its failure could interrupt production or leave the corporation without a management option. Commercial disposal companies therefore often appear more dependable than innovative reduction or recycling technology. Government provision of funds to test technology and government support in case of failure would be means of mitigating such risk and encouraging innovation in reduction and recycling.

For the most part, these state incentives, disincentives, and regulations encourage one or a number of management options over other options. They respond to only a portion of the hierarchy rather than providing a comprehensive approach to the prioritization of alternatives. Nonetheless, they are excellent and necessary tools that can be combined carefully to encourage decision-making that prioritizes alternatives closer to the top of the hierarchy.

National Policy and Paradigm Status

Reduction, reuse, and recycling were recognized by the federal government to be preferred management alternatives as early as 1975 when the EPA published its management hierarchy. Nonetheless, the portion of the 1976 Resource Conservation and Recovery Act dealing with hazardous waste (Subtitle C) has little to do with conservation and recovery. As we have already seen, the Act concentrates on control of waste at the end of the pipe and has "been slow in adapting to and encouraging pollution prevention" (Susag, 1982, p. 21). This emphasis has led one recycler to rename this piece of legislation the "Resource Destruction and Disposal Act" (Palmer, 1982, p. 74).

At issue here is not only RCRA's lack of positive encouragement but its deleterious affect on recycling and reduction options. Although RCRA is perceived as solving the problem in previous paradigms, in the context of the Dangerous and Inefficient Waste definition it offers few solutions and perhaps even exacerbates the problem.

These few solutions warrent discussion and are found in the Hazardous and Solid Waste Amendments of 1984. The Amendments encourage reduction and recycling by mandating restrictions to landfilling and by requiring that generators sign waste minimization certifications.

The landfill restrictions have been examined in detail

in the previous Leaking Landfill discussion. Greater restrictions on landfilling will decrease or eliminate the availability of the bottom rung of the hierarchy thereby encouraging alternatives. The more stringent the landfill regulations the greater the incentive to reduce and recycle. Conversely, the greater number of loopholes the less the incentive to reduce and recycle. Thus, deficiencies in the water and air regulations and exemptions for deep well injection and burning of hazardous wastes need to be closed if alternatives are to be encouraged.

Waste minimization certifications are required on manifests and on-site TSDF permits. Generators producing more than 2200 pounds of hazardous waste per month must sign Item 16 of the manifest which certifies that:

- (1) the generator of the hazardous waste has a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable; and
- (2) the proposed method of treatment, storage, or disposal is that practicable method currently available to the generator which minimizes the present and future threat to human health and the environment. (Hazardous and Solid Waste Amendments, 1984, Sec. 224 (a)(2))

Treatment, storage, and disposal companies must also sign such certifications annually as a condition of their permit.

Generators must also submit reports every two years to the EPA Administrator setting out:

(C) the efforts undertaken during the year to reduce the volume and toxicity of waste generated; and

(D) the changes in volume and toxicity of waste actually achieved during the year in question in comparison with previous years. (Hazardous and Solid Waste Amendments, 1984, Sec. 224(a)(2))

In addition, the EPA must submit a report to Congress by October 1, 1986 on the feasibility and desirability of establishing rules related to reducing the volume or quantity and toxicity of hazardous waste generated (Sec. 224(c)).

These regulations will encourage reduction by augmenting information collected in the annual reports, by suggesting to corporations that more stringent requirements might be forthcoming, and by being a potentially useful tool in litigation (Davis, 1986, p. II-9). Nonetheless, the new waste minimization regulations have no teeth. With the exception of the signatory requirement they are meant to encourage voluntary action only. Legislative history makes it clear that the Amendments do not authorize EPA to interfere with the production process by requiring standards for reduction (Berlow, 1986, p. V-3). Choice of processes, degree of compliance, and definition of "economically practical" are left up to the generator. The 1984 Amendments only invites the generator to reduce waste (Geiser, 1986, pp. IV-5,6).

Although this invitation is an environmentally welcomed one, the 1984 Amendments do not meet the criteria described

earlier. They do not encourage corporate decision making to follow the hierarchy nor do they encourage corporations to compile the information or perform the actions that would encourage reduction or recycling. Instead, they contribute to confusion about the definition of "reduction" and do nothing to alleviate the disincentives to reduction and recycling that currently exist. Finally, they do not utilize economic tools. Each of these issues is now discussed to demonstrate the limitations of RCRA and the low level of acceptance of the paradigm.

As we have already seen, the term "reduction" can be used to mean reduction of generation at source, reduction of waste needing treatment, or reduction of waste needing to be landfilled. Since each of these encompass different waste management options on the hierarchy, they represent different levels of environmental and health consequences.

The 1984 Amendments do not clearly define reduction. Other EPA sources, however, indicate that the definition to be utilized is broader than source reduction. In official correspondence, the EPA stated that "generators that either recycle wastes on-site or send their wastes off-site to be recycled" or who participate "in a waste exchange program (which) affects a generator's efforts to reduce the volume or toxicity of hazardous waste" are exercising a form of waste minimization that may be used to satisfy the reduction certification requirement (J. H. Skinner, personal

correspondance to W. Stough & F. Kuhn, 1985). The EPA's definition of reduction, then, includes both reuse and recycling. This was confirmed in an article by an EPA official which summarized the upcoming waste minimization report to Congress (Berlow, 1986, p. V-4). Utilizing this definition, both reduction and recycling are indeed encouraged over other alternatives. However, source reduction is not encouraged over reuse nor reuse over recycling. Thus, the hierarchy is only partially considered.

It is not certain, however, that reduction will be defined even this narrowly. An unreviewed, unreleased draft of EPA's Report to Congress defines waste minimization as any source reduction, recycling, or treatment activity that reduces the volume or toxicity of hazardous waste that is land disposed. This responds to the wording of the RCRA Amendments itself, which could easily be interpreted to include treatment. Although it is not certain what definition the EPA will finally use, it is apparent that confusion exists on the meaning of reduction and that management decisions based on the hierarchy are not being encouraged.

Such confusion is ubiquitous not only in the EPA but among companies and other agencies. Perhaps the most compelling example of this is seen in the reports of 21 of the companies who attended the 1985 "Waste Reduction: The

Untold Story" Conference at Woods Hole, Massachusetts. All of these corporations considered recycling and reuse to be a form of reduction, and eight included incineration and/or treatment projects as part of their reduction program (League of Women Voters of Massachusetts, 1985). In the INFORM report cited earlier, it was also found that:

A compounding factor throughout the study was the lack of understanding of what is meant by the term "waste reduction." A common response to INFORM's request for data on waste reduction was instead information on waste treatment systems. (Sarokin et al., 1985, p. 51)

This indiscriminate lumping together of all management options other than land disposal clearly points to confusion between prevention and control of waste.

This mentality is indicative of the previous Leaking Landfill paradigm and its prevalence demonstrates the lack of awareness of the problem as one of Dangerous and Inefficient Waste. Joel Hirschhorn, Senior Associate at the Office of Technology Assessment, believes that if we continue to confuse prevention and control, we will have a hard time setting policy in this country (Hirschhorn, conference address, May, 1986). The 1984 RCRA Amendments reflect the confusion and the difficulty.

The Amendments also do nothing to alleviate the disincentives to recycling that exist. Currently, recycling is not a preferred alternative. In its 1983 report, even the Office of Technology Assessment admits that this is

indeed the case:

A number of current regulatory policies and practices may actually act as disincentives for waste reduction and treatment activities. In some instances, process intermediates containing recoverable materials or energy are defined as waste even though they are not discarded. This can act as a disincentive to some recycling. (1983b, p. 18)

The Office of Technology Assessment recommends minimal regulations for the recycling of hazardous waste to lessen these disincentives (p. 38). At present, however, recyclers face the same regulatory and permitting costs as disposers, the same legal liability risks, and complicated and changing regulations.

To summarize, the 1984 Amendments do not encourage the activities that might lead to reduction or recycling. They do not require documentation of audits or reduction plans except for the signatory requirement. Nor do they require reporting of the type of information that might encourage such activities. The Amendments do mandate reports that describe the effort undertaken during the year to reduce volume and toxicity and that document the change in volume and toxicity during that year. Information about individual waste streams and costs, however, are not required.

An information requirement could be quite effective in encouraging reduction because "plants tend to collect only such information on their chemical wastes as is required by government forms" (Sarokin et al., 1985, p. 51). It has

been found that:

Regulatory programs . . . are not designed to collect information about the actual sources of waste within a plant--the focus of these programs is to insure that the aggregate wastes from the individual sources within a plant are properly treated and disposed of as they leave the plant site. (Sarokin et al., 1985, pp. 48-49)

If impact of reduction practices cannot be assessed, the government will have no means of assessing the effectiveness of the legislation. In addition, without specific information on individual waste streams, it is impossible for companies to determine where processes are inefficient. It is also impossible for them to determine the cost of such inefficiency. Even if process changes are considered, "justifying waste reduction practices is more difficult if the overall savings in terms of materials and costs is not known" (Sarokin et al., 1985, p. 77). Most likely, however, corporations will remain ignorant of reduction and reuse options.

To summarize, without such information corporations will not necessarily be encouraged to actually reduce and recycle waste. On the other hand, collection of such information could shift the perception of the problem closer to the Dangerous and Inefficient Waste definition.

Finally, RCRA does not mandate any economic incentives or disincentives. None of the fee systems, tax credits, or loan programs implemented by various states are part of the national program. Nor has the federal government provided

significant direct financial support.

Even the OTA acknowledges that "there has been little programmatic support of the concept of a waste management hierarchy" (OTA, 1983b, p. 42). In 1983, for example, only 10 percent (\$4.4 million) of the EPA's research and development activities were concerned with alternatives to land disposal (p. 42) and this was for treatment and incineration rather than reduction and recycling (Palmer, 1982, p. 80).

Other cogent examples of lack of federal support are the waste exchanges and TAP's. The total annual budget for the 12 non-profit exchanges operating in the U.S. in 1985 was estimated to be between \$500,000 and \$600,000 (Banning et al., 1986, p. 107). This in itself is a surprisingly small figure for a management alternative considered to be second only to reduction on the hierarchy. Even more surprising is the fact that the EPA provides financial support to only two of these exchanges. Most funding for the Exchanges comes from state governments, trade associations, corporations, universities, and private foundations (p. 107-110). Much greater financial commitment will be required if reduction and recycling are to become preferred management alternatives. Since there is an overall cap to federal funding of management options, that commitment will only be possible if funding for land disposal is decreased.

To summarize, RCRA does not encourage the use of the hierarchy or activities associated with the hierarchy. It does not mandate the steps necessary to make pollution prevention pay. For the most part, "waste generation rates are still well ahead of waste minimization rates" (Purcell, 1986, p. I-3) and "the emerging picture suggests the continuing overwhelming reliance by chemical plants" on treatment and disposal options rather than reduction practices (Sarokin et al., 1985, p. 53). In 1980, for example, total nonfarm business spent \$6.8 billion on new plant and equipment for end-of-line air and water pollution control methods while only \$1.55 billion was spent on changes in production process methods of pollution abatement (Royston, 1982a, pp. 8-9). In other words, 81 percent of the total was spent on control and 19 percent on prevention. Most corporations either have yet to begin reduction programs or are at early stages of such programs (Martin, 1986b, p. IX-5). Small firms especially are at a disadvantage in implementing prevention programs.

The 1984 Amendments, however, are a beginning--an invitation. This beginning reflects the gradual appearance of the Dangerous and Inefficient Waste definition in the public consciousness. We have seen that individual corporations and some states have been the most progressive in taking the "pollution prevention pays" philosophy to heart. As liability, cost, and regulatory pressure

increase, more businesses and states will do the same and the paradigm will gain in acceptance.

Recommended Policy

Because regulations have such a critical affect on liability and cost and therefore on the growth of this new paradigm, a recommended approach for national policy is now presented. This is primarily a summary of the approaches taken by states and a response to the insufficiencies of the existing RCRA based on the criteria presented earlier.

- 1) Discharge of hazardous waste into all media must be equally controlled so that regulatory gaps for air and water pollutants are closed. This cross media or systems approach should be applied to all new policy.
- 2) The feedstock tax presently utilized to fund Superfund should be replaced with a tax or fee system on hazardous waste generated based on quantity, toxicity, and management method. This would have two purposes. First, it would provide a disincentive to the generation of waste that is not presently provided by the feedstock tax. Second, it would be designed in such a way that alternatives toward the top of the management hierarchy are encouraged.
- 3) Source reduction, reuse, reclamation, and treatment should be carefully defined and distinguished. When reduction and recycling are encouraged by regulation, treatment or incineration must not be considered acceptable substitutes.
- 4) Treatment and incineration of hazardous waste should not be allowed unless the generator can prove that reduction, reuse, and reclamation options are unavailable or unviable. Recycling should not be allowed unless the generator can

prove that reduction is unavailable or unviable.

- 5) Reduction at source should be encouraged with economic incentives such as low interest loans, corporate grants, awards, tax credits, and tax exemptions.
- 6) Expertise in reduction should be encouraged through seminars and workshops and with economic incentives to technical consulting firms.
- 7) Reduction options should be made available to all corporations, including small and medium sized firms, through state-run technical assistance programs.
- 8) Audits and waste reduction plans should be required of all corporations which generate hazardous waste.
- 9) Sale of "waste" to other corporations for reuse should be made available to all corporations, including small and medium sized firms, through waste exchanges. These should be supported through federal as well as state funds. All hazardous waste must be listed on exchanges prior to incineration or treatment.
- 10) Recycling where materials are to be used on the land or burned should be strictly regulated. Regulations on other reclaimed materials should be decreased.
- 11) Recycling should be encouraged through tax credits on equipment, long-term low-interest loans, decreased RCRA permit fees, etc. No tax fee should be collected on recycled materials. All subsidies on virgin materials must be removed.
- 12) Liability laws should be altered to encourage reuse and recycling. Sale of hazardous materials for reuse or reclamation should automatically result in the transfer of liability to the new corporation or recycler. To protect the recycler and the public, a liability fund should be established from fees collected. The intent is to strike a balance between protection from sham recycling and encouragement of legitimate recycling.

- 13) Government agencies should research and provide information on markets for reusable and reclaimed materials.
- 14) In-house management should be encouraged through lower fees and decreased permit requirements.
- 15) A detailed analysis of the applicability of tools utilized in the solid waste sections of RCRA to hazardous waste conservation and recovery should be performed. Subtitle C should be integrated into the rest of RCRA.
- 16) The landfill ban should be vigorously implemented and enforced.

Although some of these approaches will require major alterations to RCRA, most are complementary and could be implemented without significant changes.

Working toward the establishment of this policy would contribute to the perception that hazardous waste is both dangerous and inefficient. Implementing and enforcing the policy would contribute greatly to solving the problem as defined in this chapter.

CHAPTER V

THE META-PROBLEM OF HAZARDOUS MATERIALS

Introduction

The three paradigms already discussed constitute existing perceptions of the hazardous waste problem. The Irresponsible Corporation definition is the foundation from which the others have sprung while the Leaking Landfill definition is the current dominant mode of thought. The definition of the problem as one of Dangerous and Inefficient Waste is the "state-of-the-art" paradigm and not yet commonly accepted.

In the evolution of these three paradigms, it is seen that public problems have a history. Therefore, it can also be safely supposed that they have a future.

The uncovering of the ephemeral character of the dominant perspective provides the occasion for the creation of a newer and better one.
(Gusfield, 1981, p. 193)

This imagining of a new paradigm is not an act of fantasy. Rather, the first three paradigms contain patterns that can be projected forward. Although it is not certain that reality will follow this projected path, the new paradigm is nonetheless extrapolated from reality and has some likelihood of occurring. In fact, the definition can be

found in current thought but it is not common.

Projection of Trends: Materials,
Media of Contamination, and
Causal Responsibility

Three factors employed by this paper as paradigm descriptors form trends that can be projected forward. These factors are materials of concern, pathways of contamination, and causal responsibility. In addition, trends are confirmed through examination of new information produced by the preceeding paradigm.

The three existing paradigms are concerned solely with industrial hazardous chemical waste. However, the transition from one paradigm to the next indicates a gradual expansion into additional areas of industrial activity and materials flow. The Irresponsible Corporation definition only included residuals directly dumped into the environment. The Leaking Landfill definition began to include recycling while the Dangerous and Inefficient Waste definition included the production process itself, thereby completing the industrial waste loop of the Materials Balance Model.

The Materials Balance Model used throughout this paper shows us the areas not yet included by the currently operating paradigms. As indicated in Figure 8, these areas include consumer products and waste, and resources put into the production process.

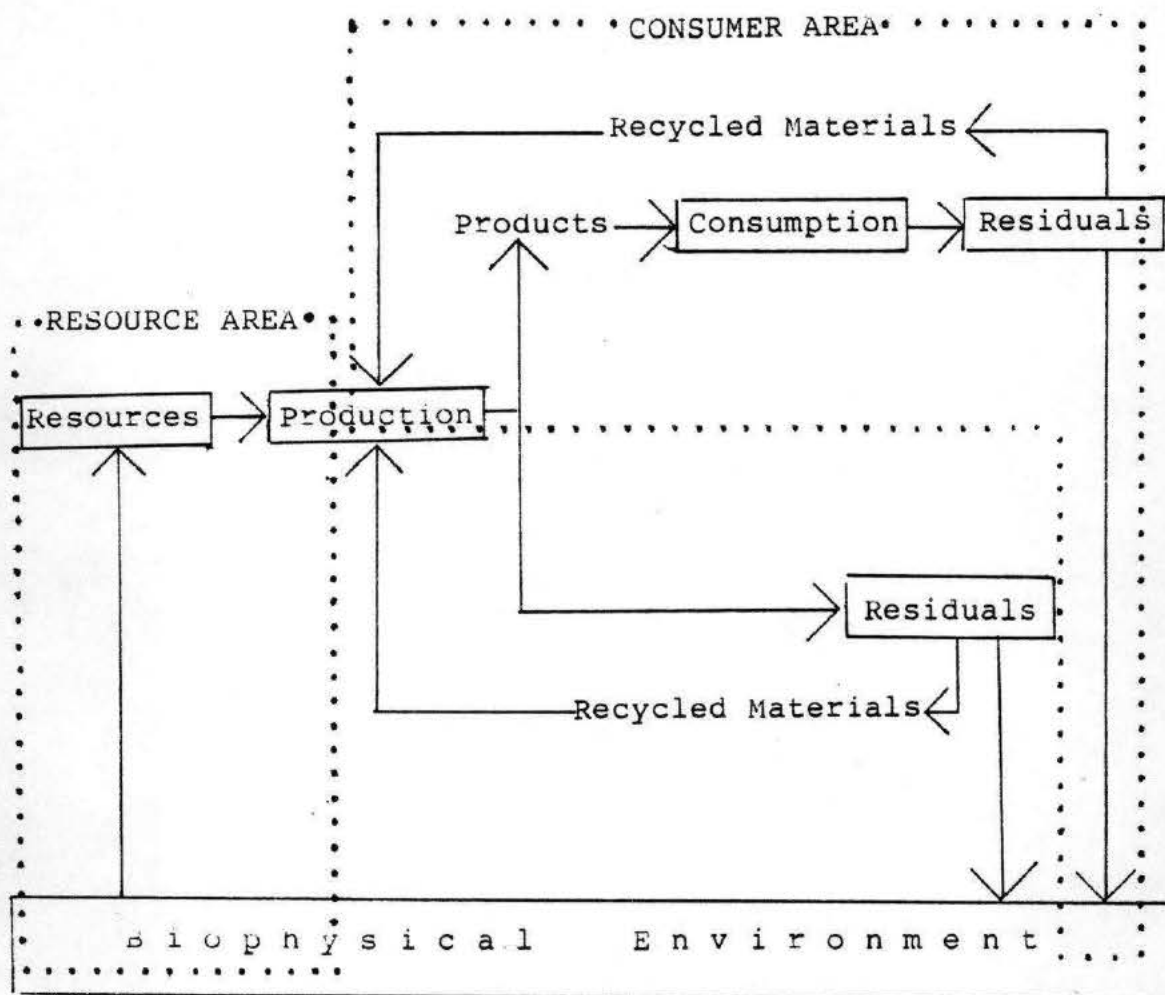


FIGURE 8. Materials Balance Model for the Meta-Problem definition. The resource and consumer problem areas are included in the definition and circumscribed by the dotted lines.

Note. From Environmental Planning and Management (p. 19) by J. H. Baldwin, 1985, Boulder: Westview Press.
Modified by S. M. Mele.

Preliminary connections to these two areas have already been perceived in the Dangerous and Inefficient Waste paradigm. Once production is included in the problem definition, the links between the industrial waste loop, the consumer loop, and resources are suddenly apparent. We have seen that chemical substitution of inputs can be used as a technique for altering the amount and toxicity of hazardous waste produced at the end of the pipe. Product reformulation can do the same. Reduction and recycling techniques not only decrease the amount of waste generated but also decrease the amount of hazardous substances used as feedstock.

This leads to the realization that is quite simple yet radical in the context of the earlier paradigms: hazardous chemicals progress through a lifecycle and industrial wastes are only one part of that cycle. The opportunity for both human and environmental exposure exists at each stage of the lifecycle.

The lifecycle of a chemical begins when it is produced from natural resources by a chemical company. Some chemicals are completely or partially degradable in use. Their lifecycle ends when degradation occurs. Others may last a long time or are immortal (Epstein et al., 1984, pp. 13-14) and therefore have very long or immortal lifecycles.

The pathways that chemicals may follow during their lifetime correspond to the pathways indicated by the

Materials Balance Model. Chemicals can follow either of two alternate pathways out of the plant. If discarded they become a waste. If used as ingredients they become a product. In other words, chemical substances do not disappear but rather are renamed as product or consumer waste or industrial waste. They continue through the economy, often remaining hazardous, and eventually return to the biophysical environment.

Any change in the quantity or toxicity of chemicals initially produced will affect the quantity and toxicity of the chemicals later in their lifecycle. The magnitude of the hazardous waste problem is therefore reflected in the magnitude of chemicals produced, as dramatically shown in Figure 9. It is important to note that true reduction and recycling waste management options are effective in decreasing the waste generated because they decrease the amount of chemical feedstock generated.

In addition, any action that affects the quantity and toxicity of chemicals at any point in their lifecycle will affect the rest of their lifecycle. The boundaries between problem areas are not solid walls, but rather permeable membranes through which the effects of decisions--the chemicals themselves--pass. The chemical that contaminates workers can go on to become a product that contaminates consumers or an industrial waste that gets into a drinking water supply to contaminate citizens.

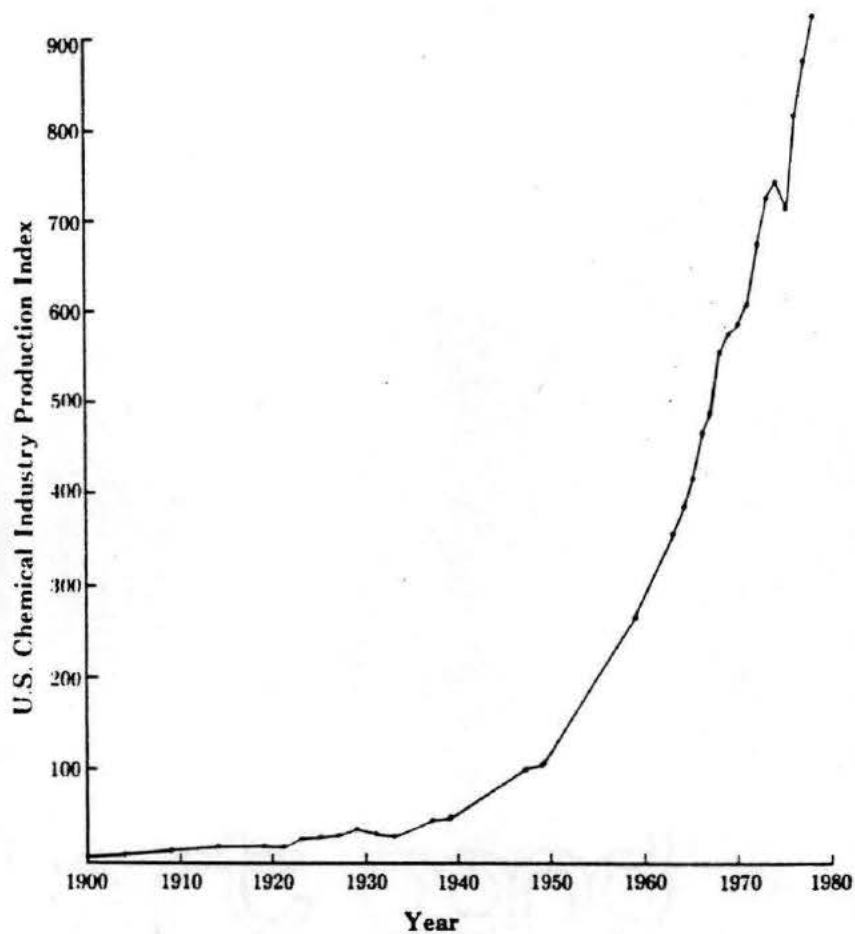


FIGURE 9. Growth in U. S. chemical production between 1900 and 1978.

Note. From The Corporate Alchemists (p. 247) by L. Niedringhaus Davis, 1984, New York: William Morrow and Company, Inc.

The medium of contamination is the second descriptor which establishes a trend useful in projecting a new paradigm. The Irresponsible Corporation and Leaking Landfill paradigms were primarily concerned with contamination through the pathway of land. The Dangerous and Inefficient Waste paradigm extended the problem to contamination through air and water. There is, however, another pathway which has yet to be considered. Contamination can occur by direct human contact with the hazardous materials either through handling or ingesting toxic products, occupational exposure, or accidents in the workplace.

When direct human contact is included as a pathway of contamination, the workplace and marketplace are included as locations of danger. This reinforces the perception that danger is inherent in all hazardous materials no matter where they are in their lifecycle.

Third, causal responsibility follows a trend that can be extrapolated forward. In prior definitions, the perceived cause of the problem shifted from irresponsible actions of corporations to the failure of land disposal technology to the inherent dangers of the waste. Although these appear to be unrelated, a trend is uncovered in which each perceived cause is a step back along a sequence of industry actions.

In the economy, feedstocks are produced which are

turned into wastes (sometimes via products) which are then disposed. In the Irresponsible Corporation and Leaking Landfill paradigms, the cause of the problem was found to be at the point of disposal. In the Dangerous and Inefficient Waste paradigm, it was at the point of waste generation. It seems logical that another shift could be made to the point of generation of the hazardous substance. The cause of the problem is perceived to be the inherent dangerous qualities of the hazardous material itself, i.e. of the chemical. Again, this projection coincides with the others already made.

Overall, the trends show a gradual integration of facets of the problem that had previously been considered separate. Air pollution, water pollution, abandoned sites, workplace disasters, and transportation accidents are now seen to be related to hazardous solid waste issues. This trend toward integration is the heart of the imagined paradigm.

Problem Description

These trends are now condensed into a problem description and the discovered paradigm is named.

The central problem of chemicals today is not a toxic-waste dump here or a polluting factory there; it is not a dangerous solvent here or a pesticide there. The problem is the total cumulative effect of all chemicals on all of us all the time: on our bodies, on our environment, on our unborn children. (Niedringhaus Davis, 1984, p. 277)

Toxic chemicals are ubiquitous in this country today. PCBs have been found in fish, EDB in grain, dioxins in schoolyards and front lawns (Sarokin et al., 1985, p. 3).

Mother's milk has in some cases become so contaminated with banned chemicals that "it would be illegal to sell in supermarkets"; . . . Virtually every adult now contains traces of a "witches' brew" of dangerous substances. (Niedringhaus Davis, 1984, p. 17)

Industrial waste is only one of many sources of these chemicals.

Chemicals also come from consumer wastes that contain hazardous substances and receive improper disposal or are dispersed into the environment during use. They come from the marketplace, i.e. from the consumer products that themselves contain hazardous substances. They come from direct exposure to chemical substances in the workplace and from occupational accidents.

Examples are numerous. Paint thinners and waste oils are thrown by households into municipal dumps. Fragments of automobile tires and asbestos from brake linings are dispersed onto roadways. Pesticides are used in homes and in agriculture.

We use products of the chemical industry to stuff furniture, tile floors, paint walls, clean laundry, build TV sets and computers, print newspapers, and diaper babies. (Niedringhaus Davis, 1984, p. 15)

Some of these chemicals have been found not only to be toxic but also flammable. Industrial accidents are common,

with the Bhopal tragedy being perhaps the most recent and dramatic case but certainly not an isolated one. In 1976, for example, an accident at the ICM-ESA chemical plant in Seveso, Italy, "sent a great cloud laced with dioxin over a wide area, turning a thriving community into an uninhabitable wasteland" (Niedringhaus Davis, 1984, p. 15). Regarding workplace exposure, it has been found that cancer, respiratory ailments, sterility, and cases of skin, gastrointestinal, blood, kidney, and liver diseases are common (Horwitz, 1983, p. 21).

There is nothing new or surprising about these sources of danger from hazardous materials. In the public arena, each of these sources is defined as a separate problem and is regulated as such. Each has a history of changing public perceptions which could be analyzed according to the framework presented in this paper.

What is new about this discovered paradigm is that it is based on the realization that each source of danger is caused by the same hazardous chemicals at different points in their lifecycles. Action taken regarding chemicals in one area affects the chemicals in other areas.

Eric Trist (1983), a professor of Environmental Studies at York University in Canada, contributes terminology that is useful for describing this relatedness. He points out that "complex societies in fast changing environments give rise to sets or systems of problems (meta-problems)

rather than discrete problems" (p. 269). Meta-problems are complex and many-sided. The prefix "meta", which means "among" or "with" as well as "after" and "change", implies a comprehensive connection among many areas as well as a transcending of that which came before. Therefore, the discovered paradigm can appropriately be called the Meta-Problem of Hazardous Materials.

In the context of hazardous materials, the Meta-Problem is the entire system of problems described above, i.e. industrial accidents, workplace contamination, consumer waste, hazardous products, etc. Industrial hazardous waste is only one problem area within the Meta-Problem. This supports the fact that cumulative contamination is the central issue and that, as a problem area, hazardous waste is not a discrete problem but related to the whole. "Each of these seemingly disparate problems has direct links to the others" (Jackson et al., 1982, p. 14). One anecdote is useful:

A scout team in equatorial Africa came upon the territory of an enraged gorilla--the team leader pondered the solution to getting past the gorilla--the leader had been taught to break complex problems into manageable parts: The head--"no way" said his assistant--slashing teeth; the upper body--"no way", arms that can crush steel drums; the lower body--"out of the question"--legs that can kick like a horse; but wait--gorillas are ticklish around their belly button. So, the team leader called forward a private and said, "There is a small patch of leather-like material, about a foot square, covered with coarse hair that has an indentation about one inch in diameter and about a half-inch deep--go

out and tickle around that depression so we can pass. About ten minutes later, the private came back, chewed and torn to pieces, and said, "There's a whole gorilla out there!" (Mavretic, 1982, pp. 150-151)

So, too, is there a whole Meta-Problem of Hazardous Materials out there. Like the gorilla, the problem areas are both cumulative and interactive.

Interaction among Problem Areas

Despite current lack of acceptance of the Meta-Problem paradigm, instances of the connection between problem areas are easy to find. A number of examples are now provided. These are not comprehensive, nor are they meant to be a detailed description of each individual problem area. Such description is, unfortunately, beyond the scope of this paper. The examples are, however, illustrative of the fact that industrial hazardous waste management choices will affect other areas.

The connection between consumer waste and industrial waste is simple. At the end of production, chemicals not discarded as waste will be put into products which eventually are also discarded. Awareness of the hazardous waste dangers of consumer product wastes has recently grown. Municipal solid waste streams include hazardous materials from households and smaller unregulated companies which have caused problems at local city dumps, waste treatment plants, and recycling facilities:

Solid waste handlers were suffering horrible accidents resulting from toxic wastes disposed of with regular trash; hundreds of unexpected explosions in shipping and worker burns were known to have resulted. . . . Sixty-five of the first 115 contaminated sites identified by EPA for emergency cleanup were solid waste facilities and municipal dumps. (Piasecki, 1984c, pp. 142-143)

Response has ranged from "amnesty days" which provide opportunities for households and small generators to bring their hazardous materials to collection points free of charge to stricter regulation of materials deposited in city landfills. Thus, hazardous materials not federally regulated have become a responsibility of government at the municipal and county level and the private solid waste management industry.

The growth in concern over consumer waste can be seen as a progression from awareness of point source pollution (industrial waste) to pollution that comes from so many small points that it is categorized as non-point (i.e. households and very small quantity corporate generators). It has not been uncommon, however, for larger corporate generators to attempt to avoid their legal responsibilities by disposing of materials in municipal dumps.

In addition, corporations do not always consider "impacts of various contaminants on the recycling of metallic scrap" from consumer products such as automobiles, and appliances (Institute of Scrap Iron and Steel (ISIS), 1986b, p. 6). Many steel products contain heavy metals and

chemicals that jeopardize their recovery and recycling:

The increasing regulatory requirements for disposal of small quantities of hazardous waste coupled with additives from manufacturing processes have resulted in more undesirable materials appearing among scrap to be processed. (ISIS, 1986b, p. 6)

Scrap steel recoverers may thus be forced into taking responsibility as hazardous waste generators. This provides a disincentive to their operation.

If recycling of household wastes is discouraged, they will instead be disposed of in the land. Thus, corporate production decisions affect not only the amount of hazardous industrial waste generated, but also the amount of consumer waste and the safety of consumer products.

From this discussion, a number of interconnections are obvious. First, stricter RCRA regulations affect consumer waste disposal by creating disincentives to recycling. Second, stricter hazardous waste regulations can encourage companies to "solve" their hazardous waste problems (and to decrease their costs) by increasing the use of hazardous ingredients in products. Finally, waste reduction and recycling decisions made at the corporate level will also affect product design and chemicals used. Currently, incentives are emerging to encourage corporations to make these decisions in such a way as to minimize hazardous waste generated by the corporation but not to minimize hazardous waste from consumer products.

The dangers of worker contamination and accidents during transport or production are also well known. The Toxic Substance Control Act (TSCA) was enacted in 1976 to prevent the production and spread of toxic chemicals which are hazardous to human health or the environment. It requires manufacturers to present information on the nature, use, and toxicity of a chemical to the EPA before its manufacture or importation. The EPA may prevent its manufacture if there is evidence of risk to health or the environment. Unfortunately, implementation has been extremely slow. "As of July 1980 only five classes of chemicals--PCBs, chlorofluorocarbons, phthalate esters, chlorinated benzenes, and chloromethane--have been subject to any regulatory actions at all" (Baldwin, 1985, p. 189). Aggravating the problem is the fact that there are currently between 60,000 and 70,000 chemicals in use with approximately 1,200 new organic chemical products created in laboratories each year (Sarokin et al., 1985, p. 1).

Despite these huge numbers, information about non-hazardous substitutes is scarce. Little is known about:

why they (hazardous materials) continue to be used despite the known hazardous effects and whether there are economic and viable substitutes not being used either for lack of information or other reasons. (ISIS, 1986a, p. 8)

Lack of information and continued production of hazardous rather than non-hazardous substances makes substitution virtually impossible. As more hazardous substances are

produced, more hazardous waste and products also come into existence.

Implications for Political Responsibility
and Ownership

If accepted as the dominant definition, the Meta-Problem paradigm would create a very different political scenario. The change in causal responsibility has particularly critical implications for political responsibility and ownership. We have seen that when the risks of the chemical throughout its entire lifecycle are considered, causal responsibility falls on the generator of the chemical rather than the generator of the waste. This could implicate chemical companies as politically responsible not only for their own wastes but for their products, i.e. the chemicals themselves.

At present such responsibility is minimal. Chemical companies have not been held legally responsible for the inadequate management of other companies' hazardous wastes. TSCA does hold chemical companies responsible for testing new chemicals prior to manufacture in order to assess potential hazards. We have already seen, however, that implementation of TSCA has been slow. In addition, required testing does not include proof that environmentally sound disposal techniques exist for each new chemical.

Certainly, it is to the advantage of the chemical

companies that they avoid political irresponsibility. That they have been able to do so can be attributed to their power as an actor in the political arena:

The (chemical) companies, to begin with, provide a variety of services on both the local and national level. They are a prime source of jobs, they form an important tax base, and they serve as a magnet for other industries. . . . Nationally, they contribute to overall economic strength and the balance of payments. (Niedringhaus Davis, 1984, p. 248)

This economic strength translates into political power. Chemical companies contribute to political campaigns, procure expensive legal council, lobby individually and collectively, and put "pressure on bureaucrats to look the other way" (Niedringhaus Davis, 1984, p. 248). We have already seen that although the Chemical Manufacturers Association did not initially lobby on RCRA, it lobbied extensively on the Toxic Substance Control Act.

In addition, chemical companies' power stems from the number of industries and products dependant on chemicals. Corporations providing alternatives to these hazardous chemicals are few and not readily accepted. Users of chemical products add their support of chemicals to the political scenario.

As strong actors with economic and political power, chemical companies are able to disown responsibility for the problem. This disownership of political responsibility weakens the causal theory that substances are the source of

the problem. In fact, it constructs a strong barricade that prevents the Meta-Problem definition of the problem from being accepted, perhaps even from being imagined.

Implications for Solutions

In addition to its implications for political responsibility and ownership, the Meta-Problem of Hazardous Materials also influences the appropriateness of solutions. In the Inefficient and Dangerous Waste paradigm, waste management strategies were evaluated based on the combined environmental and health risks of the waste. In the Meta-Problem paradigm, decisions about any hazardous material must be evaluated based on the combined environmental and health risks of the material throughout its lifecycle.

This requirement translates into three general criteria for solutions. Solutions must encourage (or discourage) certain chemicals, consider the interrelationship between problem areas, and give equal attention to all problem areas. Each criterion is now described.

First, since the source of the problem is hazardous substances themselves, the preferred solution is to halt production of those substances. Non-hazardous materials should be substituted. This is the preventative approach. It is the only solution that eliminates risks at all stages of the lifecycle.

If a hazardous chemical must be produced, its degree of hazard should be minimized. Hazardous chemicals that naturally degrade into non-hazardous materials or that can be broken down easily are preferred to those that last a long time, are immortal, or are difficult to manage. For chemicals with equivalent degrees of hazard, those with shorter lifecycles are preferred.

Second, since problem areas are related, solutions must be evaluated based on their affects on all areas. Just as chemicals pass through the permeable membranes that separate problem areas, so, too, do decisions in one area affect other areas. Consider, for instance, the choice between two technologically suitable chemicals to be used in a production process. If worker safety were the only criteria one chemical might be chosen. If, however, "waste intensiveness" of the chemical and its effect on the toxicity of the product are also taken into account, a different choice might be made. For example, it might be acceptable to use and recycle a highly hazardous chemical within a production process if, at the end of its use, it remains contained and can be successfully managed. It would, however, be extremely unacceptable to use that same chemical as a product ingredient if it becomes dispersed among consumers.

Adding up risks of a chemical throughout its lifecycle is important not only for decisions made at the

beginning but also throughout its lifecycle. The preferred solution, elimination of production of hazardous substances, can be influenced by supply and demand in all problem areas. Consumer demand for goods containing chemical ingredients and goods that generate hazardous waste during their production will affect the amount and toxicity of substances produced. Corporate demand for chemicals used in production will affect the amount and toxicity of substances produced. Simultaneously, the type of feedstock available will limit corporate alternatives and act as a strong barrier to use of substitutes. Solutions to the Meta-Problem must shape supply and demand by shaping corporate and consumer decisions.

It is well beyond the scope of this study to analyze demand and supply in the chemical industry. However since industrial hazardous waste has been the focus of this paper, it is appropriate to examine hazardous waste management decisions in the context of the Meta-Problem. When the additional layers of risk in the Meta-Problem are included, the environmental hierarchy of hazardous waste solutions described in the previous chapter will be both expanded and clarified.

The expansion stems from the fact that when marketplace and workplace risks are considered, some reduction practices become preferable to others. All five reduction practices (process changes, chemical substitution, equipment changes,

operational changes, and product reformulation) will reduce waste and substances produced. Only two, however, will eliminate the use of particular hazardous chemicals in the workplace and market thereby decreasing worker and consumer risk. These preferred practices are substitutions of toxic chemicals by non-toxic chemicals and product reformulations that result in the elimination of the initial need for hazardous chemicals. Since process changes might indirectly have the same result, each practice must be individually analyzed.

To summarize, an additional rung will be added to the top of the environmental hierarchy. That rung is elimination of the hazardous chemical at its source. Some waste reduction practices will qualify. Only practices that eliminate the use of hazardous chemicals will eliminate or decrease workplace and marketplace dangers. Thus, the Meta-Problem perception changes the preferred solution within the hazardous waste problem area.

Clarification of the hierarchy results from the fact that the only way to decrease quantity and toxicity of hazardous wastes is either to increase the quantity and toxicity of chemicals fed into the consumer loop or to decrease the amount of hazardous feedstock fed into production. In the Dangerous and Inefficient Waste paradigm, either method is equally acceptable because industrial hazardous waste is minimized. In the

Meta-Problem paradigm, however, only reduction and recycling practices that decrease the amount of hazardous feedstock required are preferred. Therefore, reduction and recycling practices that result in an increase in the hazardous waste intensiveness of consumer products or the inherent danger of the products themselves will not be acceptable.

It is both interesting and satisfying to discover that these distinctions create an excellent definition of "true" reduction and recycling as opposed to "sham" reduction and recycling. Sham reduction, reuse, or reclamation does decrease the amount of hazardous industrial waste requiring further management. It does so, however, not by lowering the amount of substance produced at the beginning of the lifecycle but by diverting the material to the consumer loop. Conversely, true waste reduction will minimize chemical production. Thus, the Meta-Problem perception of the problem clarifies an issue which is confusing when viewed from the perspective of other paradigms.

Finally, it is important to recognize that for any solution to the Meta-Problem to be effective, all problem areas must be considered part of the overall problem. Once chemicals are produced, they will seek and find the path of least resistance. This path will be in areas not perceived as being part of the problem or perceived as being less important. Gaps in the problem perception will

therefore create gaps in solutions and decrease the effectiveness of existing solutions.

This has already been clearly demonstrated by the movement of wastes from one medium to the other. Movement can also occur, for example, between industrial residues and consumer products and waste, i.e. between the industrial waste loop and the product loop of the Materials Balance model. Focus on discrete problem areas rather than the Meta-Problem could result in solutions that simply shift the chemicals--and therefore the problem--from one problem area to another. Thus, just as the Meta-Problem is a set of interlocking problem areas, the overall solution will be a set of interlocking strategies.

Trist (1983) recommends the formation of "referent organizations" to uncover such gaps and coordinate strategies:

These (meta-problems) are beyond the capacity of single organizations to meet. Inter-organizational collaboration is required by groups of organizations. . . . The required capability at this level is mediated by "referent organizations." (p. 269)

Referent organizations that deal with hazardous materials do exist, usually as government interagency task forces that include representatives from the business community and citizen groups. An excellent Oregon example is the Interagency Hazard Communication Council formed recently to "develop and adopt a plan to coordinate state

agencies' regulatory responsibilities over hazardous material and hazardous substances" (Oregon Laws, Chap. 696 Sec. 4(3)(c)). The Council "represents a forum for impacted agencies to discuss their programs, conflicts, gaps, overlaps, and specific incidents or situations" (Interagency Hazard Communication Council, agency discussion paper, 1986).

Implications For Policy

As with existing paradigms, national policy is a potentially strong tool for implementing the solutions implied by the Meta-Problem. General policy recommendations that meet the criteria set out above are now presented.

Closing regulatory gaps is a prerequisite to successful implementation of policy. We have already seen that all problem areas must be equally considered part of the Meta-Problem if risks are not going to be simply shifted from one area to another. Policy must respond to this need by regulating each problem area equally and by linking them together. Some of these links have already been forged. We have already seen that the shift from the Irresponsible Corporation definition to Leaking Landfills resulted in a linking of CERCLA and RCRA, and that the shift to the Dangerous and Inefficient Waste definition resulted in a linking of air, water, and land pollution regulations.

The transition to the Meta-Problem will continue this trend by linking RCRA with the Toxic Substance Control Act (TSCA) as well as to legislation dealing with occupational safety, product safety, and municipal waste. Currently, this connection does not exist. Federal control over these areas is spread over numerous pieces of legislation and regulation. These include the Consumer Product Safety Act; Federal Food and Drug and Cosmetic Act; Federal Insecticide, Fungicide and Rodenticide Act; Hazardous Material Transportation Act; Marine Protection, Research, and Sanctuaries Act; Occupational Safety and Health Act; Surface Mining Control and Reclamation Act; and Toxic Substances Pollution Victim Compensation Act. Each gives jurisdiction of a piece of the problem to a different agency.

The result is a "piecemeal approach (that) has created a patchwork of laws, difficult for EPA and other agencies to implement." Worse yet, "while many of these statutes overlap, all of them taken together do not provide a comprehensive protection program" (S. Brown, 1982, p. 91). Although the author of these statements was referring specifically to groundwater, the sentiments are obviously applicable to hazardous materials in general. In describing the continuation of illegal dumping of hazardous waste, for example, Epstein (1982) claims that:

Another major jurisdictional problem . . . is fragmentation of waste disposal regulatory responsibilities among several agencies within each state and between state and federal agencies. There is, in many cases, an almost total lack of cross-communication between these groups. (p. 176)

Even the Office of Technology Assessment (1983b) recognizes the problem and suggests a plan for:

Greater integration of environmental protection programs. . . . Policies and programs that lead to inefficient overlapping regulations, gaps in regulatory coverage, and inconsistent regulations would be addressed. (pp. 48-48)

These suggestions apply only to specific areas in the Meta-Problem, i.e. water and hazardous waste. The need is even greater when the entire Meta-Problem is considered.

To accomplish integration, two initial actions are necessary. First, a "referent organization" must be mandated at the federal level. Such an organization would be comprised of representatives from each agency with jurisdiction over hazardous materials. Its task would be to find program gaps and overlaps, and insure that solutions are both comprehensive and mutually reinforcing.

Second, information must be collected that demonstrates the need for strong regulation in each problem area. As we have seen, current perception of the problem focuses on industrial hazardous waste rather than consumer waste or worker safety. Although this is clearly changing, "no good estimates exist for the total of consumer and producer wastes" (Epstein, 1982, p. 13). Data would substantiate

the need and thus shift perceptions closer to the Meta-Problem definition.

Once gaps are closed, policy will still be required to discourage the production and use of hazardous substances. As with policy in the previous paradigms, it can be oriented either to demand or supply side approaches. Policy affecting demand will be primarily aimed at corporations utilizing chemicals in either the production process or in their products. These corporations purchase hazardous substances from the chemical companies. Policy affecting supply will be primarily aimed at the chemical corporations that produce the hazardous substance.

The demand side approach will decrease the quantity and/or degree of hazardous chemicals used by corporations. It should be clear by now that waste management decisions leading to reduction, reuse, or reclamation of hazardous waste will decrease the demand for hazardous chemicals by decreasing the amount of virgin materials needed. All the economic and regulatory tools recommended for this purpose in the previous chapter are therefore applicable with one alteration. In the Meta-Problem paradigm, some reduction practices are preferred over others and an additional tier is added to the top of the hierarchy. The preferred solution is elimination of substance at source. The economic tools are easily adaptable to this additional tier.

Before incentives can be provided, it will first be

necessary to better understand current barriers to the substitution of non-hazardous for hazardous substances so that they can be removed. These barriers can be both subtle and insidious. One farmer who farmed without chemicals, for example, found that a later insurance claim for crop losses "had been denied on the grounds that he had utilized 'poor farming practices'" (Neidringhaus Davis, 1984, pp. 250-251).

One additional innovative policy tool is the requirement that corporations prepare pre-production plans:

In these plans, the company should be forced to take into account the potential impacts of its actions upon all sectors of society and the environment. These plans should include waste disposal programmes, worker protection plans and effluent control measures. . . . The government should then insist on changes in the company's production proposals in order to protect the public and the environment. (Jackson et al., 1982, pp. 104-5)

Implementation of such a requirement would be fraught with difficulties. The U. S. Government has consistently avoided direct intervention. In many cases, proprietary information would be involved. In addition, enforcement would be extremely difficult and expensive, and would require a complicated scheme for grandfathering in (or out) product lines already being produced. Nonetheless, the idea is intriguing particularly because of its emphasis on prevention rather than control. It might be feasible to require pre-production plans in conjunction with reduction plans and waste audits.

The requirement of such plans or, at the least, waste audits would have the additional benefit of providing information to the government and the public about the chemicals utilized in the plant. This would be extremely valuable in the implementation of community and worker right-to-know programs which are aimed at worker safety and improved emergency response to workplace and transportation accidents. This also demonstrates the value of cooperation between jurisdictions dealing with separate problem areas. Sharing of knowledge between areas would decrease the costs accrued when each jurisdiction collects information separately.

Policy can also influence demand for chemicals by requiring or encouraging changes in the goods produced. The Netherland's Chemical Waste Act, for example, prohibits:

the manufacture of Dutch goods that generate wastes "impossible or very difficult to dispose of" or that are "not properly stored, treated, processed or destroyed." (Piasecki, 1984b, p. 102)

This encourages product substitution and waste reduction which in turn reduces production of hazardous substances. Similar requirements for goods that are difficult to recycle or reuse will also decrease the demand for hazardous ingredients, as would economic incentives to produce non-toxic products and more durable goods.

In this country, individual corporations have sometime internalized these goals in their corporate policy. Dow

Corning, for example, implements a "product stewardship program" that evaluates their "product as a potential waste in a customer's plant" and aims at providing products having "minimal waste control problems and acceptable environmental risks" (D. Meyer, 1982, p. 24).

Finally, demand can be affected by consumer purchases. However, because the problem areas of consumer products and waste have only been considered in relationship to the entire Meta-Problem, it is beyond the scope of this paper to discuss appropriate policy. Nonetheless, policy affecting consumer choice is critical if the Meta-Problem is to be solved.

Supply side policy approaches will be directed at the chemical companies themselves. The Toxic Substance Control Act (TSCA) requires premanufacture notification of all new commercial chemicals and gives EPA authority to prevent manufacture if there is evidence of risk to health or the environment. We have already seen, however, that TSCA has been infrequently used to limit production. Enforcement has been minimal and companies have been lax in providing information (Baldwin, 1984, pp. 189-190). In addition, testing is expensive and not comprehensive:

It is extremely difficult to determine the long-term impacts of a substance and to know what effects it will have, particularly when it is combined with other substances. (Jackson et al., 1982, pp. 21-22)

This does not imply that testing and banning chemicals

is impossible or undesirable. Rather it indicates that much greater enforcement and funding of the program is needed. Incentives to encourage testing by corporations might also be used. For example, one reason that so many new chemicals are produced annually is because patents run out on the products and companies lose their competitive edge. One incentive, therefore, could be an extension of patents on a new product "by a period equal to the number of years required to make the necessary tests" (Niedringhaus Davis, 1984, p. 289).

Testing could also be made less difficult by the creation of a computerized system to compile and organize the "information on the dangers of chemical substances, from the research labs of industry, government, and academia" (Niedringhaus Davis, 1984, p. 292). Such a "Hazards Data Bank" would be available to companies which could "save time and trouble by checking current research into the known hazards of the substance and related substances before proceeding" with the production of new chemicals (p. 292).

In addition to present TSCA requirements, chemical companies should be required to provide confirmed methods for a chemical's disposal as a prerequisite to its production.

Supply side policy should also strongly encourage the substitution of non-hazardous substances or quickly

degradable materials for the hazardous substances currently used. Incentives can be similar to the tools suggested by the past two paradigms. They include tax credits and deductions, accelerated write-offs, bonuses, property tax reductions, etc. Grants for research on non-toxic materials or direct government research should also be made available. For highly toxic synthetic substances that are immortal or very long lasting, prohibitions are perhaps appropriate.

Finally, corporations producing hazardous chemicals should assume at least part of the legal responsibility for their products. This is, of course, a dramatic shift from the current scenario in which the generator of the waste is legally liable rather than the generator of the substance. Such a shift would require widespread legal reform.

Prospects for Transition

Although a valid alternative perception of reality, the Meta-Problem of Hazardous Materials is not widely embraced. Predominant perceptions of the hazardous material problem continue to be focused on the Leaking Landfill definition with the Dangerous and Inefficient Waste definition only slowly emerging.

Given this scenario, it is possible to imagine the implications of the Meta-Problem paradigm but almost impossible to imagine its widespread acceptance in the near future. Similarly, it is difficult to imagine the

implementation of solutions inherent in the Meta-Problem paradigm precisely because of this lack of acceptance. Chemical companies wield too much economic and political power. And unlike the compatibility of economic and environmental philosophies in the Dangerous and Inefficient Waste paradigm, it will be difficult to make the Meta-Problem paradigm economically attractive to chemical companies whose entire purpose is to produce chemicals.

Perhaps even more discouraging are the institutional barriers that exist. There has been a "broad willingness on the part of both the government and the public to accept chemicals as 'innocent until proven guilty'" (Niedringhaus Davis, 1984, p. 263). This is linked to the commonly accepted belief that all chemicals are necessary to maintain the economy and society. The perception exists that substitutes are not viable and that our way of life is dependent on chemicals.

Given such strong barriers, it is not surprising to find a lack of hope reflected in writings on the subject. In an Environment article, Roy Popkin (1986) states that "the toxic waste problem is not amenable to a quick fix" (p. 3). And Lee Niedringhaus Davis (1984), using the tale of the sorcerer's apprentice, grippingly compares chemical corporations to the bewitched broom that brings the torrent of water threatening to drown the apprentice. Current policy attempts to control hazardous materials by attacking

the symptoms just as the apprentice attempts to stop the flooding by attacking the broom rather than changing the magical spell. Niedringhaus Davis concludes:

In the parable of the sorcerer's apprentice, the master finally appears at the end to say the magic words and make the frantic brooms stop. The chemical industry, too, is out of control. But where is the master? And who will say the magic words? (1984, p. 296)

The magic words and their implementation are indeed difficult and elusive.

This does not mean, however, that the situation is entirely devoid of hope. The political framework used throughout this paper is helpful in providing at least a direction for action. First of all, in demonstrating the shifts from one dominant paradigm to the next the analysis suggests that the perceptions inherent in the Inefficient and Dangerous Waste definition must be more widely accepted before the Meta-Problem definition can begin to emerge. Each paradigm is a bridge between the preceeding and emerging paradigms. For example, the transition to perceiving hazardous substance as the cause of the problem will occur more easily if hazardous waste is already considered to be the root of the problem than if failed technology is blamed. Similarly, the jump from waste control to substance prevention is much larger than the shift from waste prevention to substance prevention. In other words, the Dangerous and Inefficient Waste paradigm is

a stepping stone between what came before and what will emerge in the future. The middle step is a necessary one. As such, political support of policies responding to the Dangerous and Inefficient Waste definition will support the eventual emergence of the Meta-Problem paradigm.

Second, if the Meta-Problem is believed to be a preferred interpretation of reality, its discovery suggests new directions for political action, i.e. it offers some indication of where resources should be focused. Political action that excludes numerous problem areas will not be effective in solving the problem. For example, the air and water acts and TSCA require as much attention as RCRA if the hazardous waste problem is to be solved.

Finally, the discovery of the Meta-Problem allows us to look at the scenario from a different angle and through different lenses. The altered perspective allows us to see economic and institutional barriers and uncover informational gaps previously unnoticed. We need to learn precisely how dependent we are on hazardous chemicals, i.e. what viable substitutes exist or might be created. We need to learn just how serious the problem of consumer wastes in municipal landfills has been. We need to have a complete and available information system about the hazards of chemicals in order to evaluate the necessity and desirability of chemicals entering the market.

Studies, data bases, and the referent organizations

already described in the policy section of this chapter can be instrumental in filling these gaps. Although it might not yet be feasible to implement all the policies suggested in this chapter, it is certainly feasible to compile the data and create the organizations that are the prerequisites to such policy. Once the Dangerous and Inefficient Waste paradigm is more strongly developed, such information and organizations will then be readily available to expedite the move to the Meta-Problem definition.

Perhaps most important, awareness of the Meta-Problem teaches us the correct questions to ask. The asking of the questions broadens the public debate so that shimmers of the previously untried paradigm begin to appear. Once answers to the questions begin to emerge, the shimmers will grow and the new paradigm will take shape.

REFERENCES

- Baldwin, J. H. (1985). Environmental Planning and Management. Boulder: Westview Press.
- Banks, J. (1984). Dumping into surface waters: The making and demise of toxic discharge regulations. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 37-52). Westport, CT: Quorum Books.
- Banning, W., Herndon, R. C., & Jones, E. B. (1986, March). North American waste exchanges: A history of change and evolution. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange (pp. 104-118). Sponsored by Arizona State University, Center for Environmental Studies.
- Baram, M. S. (1982). Alternatives to Regulation. Lexington, MA: Lexington Books-D. C. Heath and Company.
- Berlow, J. R. (1986, May). Current status of the waste minimization report to Congress and supporting technical activities. In A. H. Purcell (Chair), Hazardous and solid waste minimization (pp. V-1-V-7). Rockville, MD: Government Institutes.
- Boffey, P. M. (1983, March 16). Experts showing concern on safety of burying toxic waste in landfills. The New York Times, p. A20.
- Brower, A. B. (1982). Waste reduction--concept to reality. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 110-114). New York: Pergamon Press.
- Brown, K. W. (1984). Landfills of the future: Aboveground and aboveboard. In B. Piasecki (Ed.), Beyond dumping: New Strategies for controlling toxic contamination (pp. 191-197). Westport, CT: Quorum Books.
- Brown, M. (1981). Laying waste: The poisoning of America by toxic chemicals (rev. ed.). New York: Washington Square Press.

- Brown, S. (1984). Preventing groundwater contamination: The role of state and federal programs. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 85-99). Westport, CT: Quorum Books.
- Chubin, D. (1984). Research missions and the public: Over-selling and buying the U. S. war on cancer. In J. C. Petersen (Ed.), Citizen participation in science policy (pp. 109-129). Amherst: The University of Massachusetts Press.
- Culver, A. A. (1986, May). The economics of waste management decisions: Deepwell injection as a deterrent to waste reduction. In A. H. Purcell (Chair), Hazardous and solid waste minimization (pp. III-1-III-6). Rockville, MD: Government Institutes.
- Curran, T. P. (1986, March). The industrial materials recycling program. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange (pp. 29-35). Sponsored by Arizona State University, Center for Environmental Studies.
- Davis, G. A. (1984). Discouraging dumping: The California example. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 71-83). Westport, CT: Quorum Books.
- Davis, G. A. (1986, May). The role of liability and regulation in encouraging waste minimization. In A. H. Purcell (Chair), Hazardous and Solid Waste Minimization (pp. II-1-II-10). Rockville, MD: Government Institutes.
- DeKoltz, S. K., (1985, December). Hazardous materials/waste: A complete issue. Idaho Conservation League News, p. 8.
- Department of Health Services. (1984). Alternative technology for recycling and treatment of hazardous wastes: Second biennial report, July 1984. CA: Department of Health Services.
- Dietrich, G. N. (1984). Information burdens and difficulties in conceptualizing the crisis: A reappraisal. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 19-26). Westport, CT: Quorum Books.

- Easson, D. D. (1982). Process design to minimize pollution case studies. In D. Huisinigh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 95-102). New York: Pergamon Press.
- Epstein, S. S., Brown, L. O., & Pope, C. (1982). Hazardous waste in America. San Francisco: Sierra Club Books.
- Florio, J. (1984). Foreward. In B. Piasecki (Ed.), Beyond dumping: new strategies for controlling toxic contamination (pp. vii-x). Westport, CT: Quorum Books.
- Fortuna, R. C. (1984). Same wastes, new solutions: The market for treatment alternatives. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 199-210). Westport, CT: Quorum Books.
- Garelick, B. (1985, December). When is a waste not a waste? The Environmental Forum, pp. 26-32.
- Geiser, K. (1986, May). Critical elements of a waste reduction plan. In A. H. Purcell (Chair), Hazardous and solid waste minimization (pp. IV-5-IV-17). Rockville, MD: Government Institutes.
- Goldman, B. A. (1986). Rating the performance of waste management companies. Environment, 28(3), 10-13.
- Gusfield, J. R. (1981). The culture of public problems. Chicago: The University of Chicago Press.
- Hall, K. L. (1984). Keeping the EPA vigilant: The role of private watchdog agencies. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 27-35). Westport, CT: Quorum Books.
- Hazardous and Solid Waste Amendments of 1984, 42 USC 6901 et seq., Pub. L. No. 98-616.
- Hazardous Waste Disposal: Hearings Before the Subcomm. on Investigations and Oversight of the House Committee on Science and Technology, 98th Cong., 1st Sess. (1983).
- Hazardous Waste Management System, 1980, 40 CFR Sec. 260.
- Hirschhorn, J. S. (1984). Emerging options in waste reduction and treatment: A market incentive approach. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 129-137). Westport, CT: Quorum Books.

- Horwitz, C. (1983). Workers' compensation. In J. Tryens (Ed.), The toxics crisis: What the states should do (pp. 21-26). Washington, DC: Conference on Alternative State and Local Policies.
- Huisingsh, D. & Bailey, V. (1982). Preface. In D. Huisingsh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. ix-x). New York: Pergamon Press.
- Illinois Environmental Protection Agency. (1985, May 21). Waste management method for manifested special wastes in 1984. (LPSWP960).
- Institute of Scrap Iron and Steel, Inc. (1986a, Spring). Design for recycling. Phoenix Quarterly, pp. 8-9.
- Institute of Scrap Iron and Steel, Inc. (1986b, Spring). The monster is vulnerable. Phoenix Quarterly, pp. 6-7.
- Jackson, J., Weller, P., & the Waterloo Public Interest Research Group. (1982). Chemical nightmare. Toronto: Between The Lines.
- Johnson, C. C. (1986, May). Management is the key. Council on Economic Priorities Newsletter, pp. 1-6.
- Kazis, R., & Grossman, R. L. (1982). Fear at work: Job blackmail, labor and the environment. New York: The Pilgrim Press.
- Kronick, J. C. (1984). Public interest group participation in congressional hearings on nuclear power development. In J. C. Petersen (Ed.), Citizen participation in science policy (pp. 196-214). Amherst: The University of Massachusetts Press.
- League of Women Voters of Massachusetts. (1985, June). Waste reduction: The untold story. Proceedings from conference at Woods Hole, MA.
- Martin, L. (1986a). The case for stopping wastes at their source. Environment, 28(3), 35-37.
- Martin, L. (1986b, May). Hazardous waste minimization technology transfer. In A. H. Purcell (Chair), Hazardous and solid waste minimization (pp. IX-1-IX-15). Rockville, MD: Government Institutes.

- Mavretic, J. (1982). Where do we go from here, and how do we get there. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 149-152). New York: Pergamon Press.
- McCann, P. G. (1984). Preparing management: The political economy of stronger controls. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 115-127). Westport, CT: Quorum Books.
- McKillip, P. (1977). Heir of sea and fire. New York: Ballantine Books.
- Metropolitan Service District. (1985, September). Draft report: Solid waste management plan. Portland, OR: Author.
- Meyer, D. (1982). In every dark cloud. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 23-27). New York: Pergamon Press.
- Meyer, G. A. (1986, March). Criminal and civil liability for hazardous waste violators. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange (pp. 73-78). Sponsored by Arizona State University, Center for Environmental Studies.
- Minnesota Technical Assistance Program & Minnesota Waste Management Board. (1986). A year of service: Minnesota Technical Assistance Program 1985 Annual Report.
- Montague, P. (1984). The limitations of landfilling. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 3-17). Westport, CT: Quorum Books.
- Naber, T. (1986, February). Hazarding a guess. Waste Age, pp. 40-42, 44.
- National Conference of State Legislatures. (1982). Hazardous waste management: A survey of state legislation 1982. Denver: National Conference of State Legislatures.
- Need for a national association for waste exchange and resource reuse. (1983, March). In R. C. Herndon (Ed.), Proceedings of the National Conference on Waste Exchange (pp. 71-75). Sponsored by the Florida Chamber of Commerce, Florida State University, and the U. S. Environmental Protection Agency.

- Nelkin, D. (1984). Science and technology policy and the democratic process. In J. C. Petersen (Ed.), Citizen participation in science policy (pp. 18-39). Amherst: The University of Massachusetts Press.
- Niedringhaus Davis, L. (1984). The corporate alchemists. New York: William Morrow.
- Office of Technology Assessment. (1983a). Technologies and management strategies for hazardous waste control (OTA-M-196). Washington, DC: U. S. Government Printing Office.
- Office of Technology Assessment. (1983b). Technologies and management strategies for hazardous waste control: Summary. Washington, DC: U. S. Government Printing Office.
- Oregon Laws. Chap. 696 Sec. 4 (1985).
- Palmer, P. (1982). Chemical recycling: Making it work, making in pay. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 73-85). New York: Pergamon Press.
- Petersen, J. C. (1984). Citizen participation in science policy. In J. C. Petersen (Ed.), Citizen participation in science policy (pp. 1-17). Amherst: The University of Massachusetts Press.
- Peterson, D. & McComas, C. (1986, March). The role of the Minnesota Technical Assistance Program in helping Minnesota businesses improve their hazardous waste management. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange (pp. 19-24). Sponsored by Arizona State University, Environmental Studies Center.
- Piasecki, B. (1984a). Beyond dumping: An overview and introduction. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. xiii-xix). Westport, CT: Quorum Books.
- Piasecki, B. (1984b). Europe's detoxification arsenals: Lessons in waste recovery and exchange. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 101-111). Westport, CT: Quorum Books.

- Piasecki, B. (1984c). Toward a stable treatment market: The role of industrial lobbying. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 139-143). Westport, CT: Quorum Books.
- Piasecki, B. (1984d). Unfouling the nest: New detoxification strategies. In B. Piasecki (Ed.), Beyond dumping: New strategies for controlling toxic contamination (pp. 145-151). Westport, CT: Quorum Books.
- Popkin, R. (1986). Hazardous waste cleanup and disaster management. Environment, 28(3), 2-5.
- Purcell, A. H. (1986, May). Waste minimization/resource recovery. In A. H. Purcell (Chair), Hazardous and solid waste minimization (pp. I-1-I-10). Rockville, MD: Government Institutes.
- Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq., Pub. L. No. 94-580.
- Royston, M. G. (1982a). Making pollution prevention pay. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 1-16). New York: Pergamon Press.
- Royston, M. G. (1982b). Opportunities for clean technology in North Carolina. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 41-67). New York: Pergamon Press.
- Rydell, R. J. (1984). Solving political problems of nuclear technology: The role of public participation. In J. C. Petersen (Ed.), Citizen participation in science policy (pp. 182-195). Amherst: The University of Massachusetts Press.
- Sarokin, D. J., Muir, W. R., Miller, C. G., & Sperber, S. R. (1985). Cutting chemical wastes. New York: INFORM.
- Schechter, R. N. (1986, March). The North Carolina Pollution Prevention Pays Program: 1985 summary and status. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange (pp. 24-29). Sponsored by Arizona State University, Environmental Studies Center.

Stough, W. (1986, March). States can reduce generator liability by providing industry with technical assistance. In N. R. Hild (Chair), Proceedings of the Third National Conference on Waste Exchange. (pp. 15-19). Sponsored by Arizona State University, Environmental Studies Center.

Susag, R. H. (1982). Pollution prevention pays: The 3M corporate experience. In D. Huisingh & V. Bailey (Eds.), Making pollution prevention pay: Ecology with economy as policy (pp. 17-22). New York: Pergamon Press.

Transcript: Regional public meetings on the Resource Conservation and Recovery Act of 1976 (EPA SW-20p), (1977), Seattle, WA: Environmental Protection Agency Region X.

Trist, E., (1983). Referent organizations and the development of inter-organizational domains. Human Relations, 36, 269-284.

U. S. Environmental Protection Agency. (1977). Waste clearinghouses and exchanges: A summary (SW-130c.1). Washington, DC: Environmental Protection Agency. (NTIS No. PB-261 287)

U. S. Environmental Protection Agency. (1985, October). The new RCRA: A fact book. Washington DC: Office of Solid Waste and Emergency Response.

U. S. Environmental Protection Agency Region V. (1985, Summer). Alternative treatments for hazardous waste. Hazardous waste and toxic substances, p. 13.