DOCKET REPORT

SUPPORTING DOCUMENTS FOR THE REGULATORY ANALYSIS OF THE PART 264 LAND DISPOSAL REGULATIONS

Volume I

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OF THE PART 264 LAND DISPOSAL REGULATIONS

TABLE OF CONTENTS

Volume I

Chapter I -- Introduction

Chapter II -- Profile of Land Disposal Units and Facilities Costed in the Analysis

Chapter III -- Assumptions/Costs Included in the Baseline

Chapter IV -- Summary of Part 264 Regulatory Requirements

Chapter V -- Ground-Water Protection and Corrective Action Costs

Chapter VI -- Assumptions and Methodology Used to Calculate Annual Revenue Requirements

Chapter VII -- Results of Cost Analysis

Chapter VIII -- Impacts of the Regulations on Selected Industries

Volume II

Appendix A -- Regulatory Analysis (Section IX. of the Preamble to the Part 264 Regulations)

Appendix B -- Unit Costs Used to Develop Baselines

Appendix C -- Part 264 Engineering Costs for Landfills, Surface Impoundments, Waste Piles, and Land Treatment areas

Appendix D -- Cost Estimates for Containment of Contaminated Ground-Water Plumes

Volume III

Appendix E -- Printouts of Annual Revenue Requirements and First Year Cash Requirements for Landfills, Surface Impoundments, Waste Piles, and Land Treatment areas by Size.

CHAPTER I

INTRODUCTION

This report provides complete background information on the underlying data and assumptions used to estimate compliance costs for the Part 264 land disposal regulations. The report systematically describes the various steps that were taken to develop the costs shown in Section IX of the Preamble to the regulations. It is organized into 8 chapters (one for each major component of the analysis) and 5 appendices.[1] Each of these is summarized below.

- Chapter II defines the population of land disposal units and facilities based on information contained in the Hazardous Waste Data Management System (HWDMS). Separate size distributions were developed for landfills, surface impoundments, land treatment facilities, and waste piles so that design and operating (D&O) and corrective action costs could be estimated for a range of unit sizes for each type of process. The total number of units for each type of process was estimated to provide a basis for calculating total D&O costs.

  In order to calculate total corrective action costs on a facility instead of a unit basis, the individual processes were combined to develop a distribution of land disposal facilities. This distribution depicts land disposal facilities on the basis of their size and the particular combination of land disposal units at the facility. For example, a facility might consist of three disposal processes -- a landfill, a surface impoundment and a waste pile.

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[1] To aid in understanding this report, definitions of several key terms are provided here.

(1) Land disposal process refers to a method of disposal or a disposal technique. The disposal media focussed on in this report include landfills, surface impoundments, land treatment and waste piles.

(2) Land disposal unit refers to single landfill, surface impoundment, land treatment area or waste pile. The analysis examines both D&O and corrective action costs on a per unit basis for various sizes of each process.

(3) Land disposal facilities are combinations of individual land disposal units. For example, a "facility" may consist of two surface impoundments, one waste pile and one land treatment area. Total corrective action costs were estimated on a facility basis using average facility sizes.

- Chapter III explains the methodology used to derive baseline D&O costs for all land disposal processes. Baseline costs reflect both normal capital and operating expenses incurred whether or not any regulatory system exists, in addition to costs incurred as a result of the Interim Status Standards (ISS). Estimating baseline costs was a necessary prerequisite to determining the incremental cost burden imposed by the Part 264 requirements.

- Chapter IV describes the Part 264 D&O requirements that apply to each land disposal process and how unit costs for these requirements were developed using engineering models. It also reviews the treatment of these costs in the analysis.

- Chapter V reviews the assumptions and models used to develop corrective action costs for individual units and facilities (combinations of units). It also discusses the sensitivity of the corrective action costs to changes in some of the key technical assumptions.

- Chapter VI describes the economic assumptions and methodology used to derive estimates of the annual revenue required to offset the incremental costs of the Part 264 regulations for each land disposal process. Estimates of total D&O costs were obtained by multiplying the costs estimated for each unit size by the number of units in that size category and summing across all processes. Total corrective action costs were derived by multiplying corrective action costs estimated for each facility configuration by the number of facilities with that configuration and summing across all facilities. Total D&O costs were merged with total corrective action costs to calculate total compliance costs.

- Chapter VII reviews the results of the analysis and shows costs estimated by unit size for all processes, total costs estimated for each process, and total costs for all processes.

- Chapter VIII reviews the methodology used to estimate the economic impacts of the Part 264 regulations on industries that generate significant quantities of hazardous waste.

- Appendix A contains Section XI (Regulatory Analysis) of the Preamble to the Part 264 regulations.

- Appendix B contains the unit costs used to develop the baseline D&O estimates for all land disposal processes.

- Appendix C contains the detailed engineering cost estimates for the Part 264 D&O requirements for all landfill, surface impoundment, land treatment and waste pile unit sizes considered in the analysis.

- Appendix D contains a copy of the technical working papers: Cost Estimates for Containment of Plumes of Contaminated Ground Water prepared by Geraghty and Miller, Inc. The report explains in detail the assumptions and models used to estimate all corrective action costs used in the analysis.

- Appendix E contains tables showing the baseline and Part 264 incremental annual revenue requirements and first year cash requirements for all landfill, surface impoundment, land treatment and waste pile unit sizes used in the analysis.

It is EPA's intent that this report be complete enough so that any interested party can use the information it contains to reconstruct any of the costs/results contained in Section IX (The Regulatory Analysis) of the Preamble to the Part 264 regulations.

A team of consulting firms assisted EPA with this Regulatory Analysis. Each firm contributed to different aspects of the analysis. The firms and their areas of responsibility are listed below.

- Development Planning and Research Associates (DPRA) developed the initial distributions of land disposal units and facilities by size from the Part A data in the Hazardous Waste Data Management System.

- Pope-Reid Associates, Inc.(PRA) developed detailed engineering models used to derive unit costs for landfills, surface impoundments and waste piles.

  K.W. Brown provided technical and cost information on land treatment.

- SCS Engineers reviewed PRA's models and data inputs to those models and contributed technical expertise on all land disposal processes for the analysis. They also estimated some of the planning and demonstration costs that firms could incur as a result of the Part 264 regulations.

- Geraghty and Miller (G&M) developed detailed technical models used to estimate corrective action costs under a range of hydrogeologic conditions.

- Industrial Economics, Inc. (IEc) performed the industry impact analysis described in Chapter VIII. They also assisted in developing the population distributions for the various land disposal processes, provided estimates of post-closure costs for landfills and surface impoundments, and closure and post-closure financial assurance costs for a range of financial instruments.

- Sobotka and Company, Inc. (SCI) developed the economic models used to calculate the incremental costs of the Part 264 regulations for individual land disposal units and for all facilities as a whole. In this capacity, SCI was responsible for coordinating the work of the other team members and synthesizing all the separate efforts into a single product for the Preamble and this Docket Report.

CHAPTER II

PROFILE OF LAND DISPOSAL UNITS AND FACILITIES COSTED IN THE ANALYSIS

Four types of land disposal processes are affected by the Part 264 regulations: landfills, surface impoundments, land treatment areas and waste piles. This chapter summarizes the methodology used to estimate, for each process, the total number of process units and their size distributions. It also describes the methodology used to combine the different types of units to develop a distribution of land disposal facilities.

First, individual landfill, surface impoundment, land treatment and waste pile populations were defined. These populations provided the basis for costing the design and operating (D&O) requirements specified in the Part 264 regulationa. Second, the distribution of land disposal facilities (combinations of individual process units) according to the types of processes located at each facility was estimated. This distribution was used to estimate total corrective action costs that could result from the regulations.

The methods used to obtain these distributions and their purposes in the analysis are described in greater detail below.

A. Distribution of Land Disposal Units By Size

The number and sizes of existing landfills, surface impoundments, land treatment areas and waste piles were derived from the Part A data contained in the Hazardous Waste Data Management System (HWDMS). Adjustments were made to all data obtained from the HWDMS to account for missing data.

1. Landfills. The number of landfills reported in the Part A data was increased by 23 percent to account for facilities that did not report on their landfilling activities for reasons of confidentiality. Landfills were separated into off-site and on-site on the basis of SIC code. Facilities with a SIC code

of 4953 (refuse systems) were classified as off-site landfills. All other facilities were classified as on-site.

Based on the Part A data, Development, Planning and Research Associates (DPRA) tabulated 24 size categories of landfills measured in acrefeet. Pope-Reid Associates, Inc. (PRA) then used these categories to obtain a range of eight landfill sizes measured in terms of annual operating capacities. This simplified the analysis by limiting the number of sizes to be costed, and resulted in a distribution (shown in Table II-1) that was more appropriate for costing the D&O component of the regulations than was the distribution based on acre-feet. The Pope-Reid distribution was then used to estimate the landfill D&O and corrective action unit costs reported in Section IX.D of the Preamble to the Part 264 regulations and Section A.1 of Chapter VII of this report. It was also used to estimate the total D&O costs for landfills reported in Section IX.F of the Preamble and Section C of Chapter III of this report.

TABLE II-1
Distribution of Landfills By Size

Unit Size (MT/Year)	Number of Units		
	Offsite	Onsite	Total
500	9	246	253
2000	10	60	70
5000	4	30	34
7000	7	36	43
15000	11	42	53
35000	9	13	22
60000	13	15	28
123000	39	29	68
TOTAL	102	471	573

Estimated Average Annual Capacity = 21,549 MT/yr.

2. Surface Impoundments. The HWDMS provides information on the total capacity of surface impoundments at each site by type of impoundment: storage, treatment, or disposal. However, there is no data on the number of surface impoundments at each site.

To estimate the total number of surface impoundments, the following steps were taken.

- o If the part A information indicated ownership of both storage and disposal impoundments, they were counted separately, unless their capacities were the same.
- o Where the total capacity of a disposal or storage impoundment was less than or equal to 100,000 gallons, the facility was counted as a 1/4 acre impoundment.
- o For treatment impoundments, where the total capacity was less than or equal to 10,000 gallons, the facility was counted as a 1/4 acre impoundment.
- o Where a disposal or treatment impoundment was larger than 100,000 gallons or where a treatment impoundment was larger than 10,000 gallons, but where the total size was less than 40 acres,[1] the facility was counted as two surface impoundments, each with half the total capacity.
- o Where a size greater than 40 acres was indicated, the number of surface impoundments was determined by dividing the total acreage by 20 acres and rounding up.
- o The total number of impoundments derived from this process was multiplied by a factor of 1.11 to account for firms that did not submit Part A's for reasons of confidentiality.

This process resulted in an average of 2.45 surface impoundments per site.

The Surface Impoundment Assessment (SIA) data base was used to establish size categories and their means, which were used to derive point estimates appropriate for use in the analysis. The data base indicated that about 45 percent of all hazardous waste impoundments were smaller than 1/4 acre. The analysis treated these facilities as 1/4 acre impoundments.

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[1] Forty acres is roughly equivalent to 120 million gallons for disposal and storage surface impoundments or 8 million gallons per day for treatment surface impoundments.

Sizes in the SIA data base reported as greater than 15 acres were collapsed into the 7 to 15 acre category (11 acres is the midpoint) because of uncertainty regarding the feasibility of the larger surface impoundment sizes. For the purposes of estimating the total D&O costs of the Part 264 regulations, all surface impoundments were assumed to be on-site facilities. However, for purposes of estimating industry impacts, impoundments were separated into on-site and off-site categories. (See Chapter VIII.) Table II-2 shows the distribution that was used to estimate the D&O costs for surface impoundments in Sections IX.D and IX.F of the Preamble and in Section A.2 of Chapter VII of this report.

TABLE II-2
Distribution of Surface Impoundments By Size

Unit Size (Acres)	Number of Units
1/4	1904
1/2	460
1	393
2	513
5	271
11	699
Total	4240

Estimated Average Size = 2.63 acres

3. Land Treatment Units. The total number and size distribution of land treatment facilities are based on Part A data contained in the HWDMS. The total number of land treatment facilities was multiplied by a factor of 1.2 to account for firms that did not report for reasons of confidentiality. Table II-3 shows the distribution of land treatment units used in the analysis.

TABLE II-3
Size Distribution of Land Treatment Facilities

Unit Size (Acres)	Number of Units
1.7	70
6.5	56
20.1	55
74.3	25
247.1	35
Total	241

Estimated Average Size = 50.2 acres

4. Waste Piles. Numbers and sizes of waste piles were based on Part A data. The total number of waste piles was multiplied by a factor of 1.2 to account for nonreporting firms. The frequency distribution of waste pile sizes obtained from the Part A data was adjusted by EPA to develop a size distribution appropriate for this analysis. The distribution used is shown in Table II-4.

TABLE II-4
Size Distribution of Waste Piles

Unit Size (000 Cubic Feet)	Number of Units
2	306
10	53
25	45
100	107
500	45
1000	52
Total	608

Estimated Average Size = 143,000 cubic feet

B. Distribution of Land Disposal Facilities

To calculate total corrective action costs, EPA used the Part A data to group individual units into facilities and to estimate the average acreage required for different combinations of land disposal units. This was done because land area was used as a surrogate for plume size, and corrective action costs were estimated on the basis of plume size. Total corrective action costs provided in Section IX.F of the Preamble assumed that plume sizes were equivalent to the acreage of the total waste management area at land disposal facilities.[1] The distribution of land disposal facilities is shown in Table II-5.

TABLE II-5
Distribution of Land Disposal Facilities by
Size and Type of Disposal Activities

Type of Facility	Total Number of Facilities	Average Acreage[1]
Landfill only	267	34
Surface Impoundment only	1292	9
Land Treatment only	72	103
Waste Pile only	376	1/2
Land Treatment/Waste Pile	77	309
Landfill/Waste Pile	24	44
Landfill/Land Treatment	14	243
Surface Impoundment/Waste Pile	113	8
Surface Impoundment/Land Treatment	74	76
Surface Impoundment/Land Treatment/ Waste Pile	12	80
Surface Impoundment/Landfill	155	45
Surface Impoundment/Landfill/Waste Pile	38	65
Surface Impoundment/Landfill/Land Treatment	35	162
Surface Impoundment/Landfill/Land Treatment/ Waste Pile	5	138
Total Number of Facilities	2484	32 (average acreage)

[1] Acreages derived from the Part A data were adjusted by a factor of 1.5 to account for common areas between the individual land disposal units and between the waste disposal area and the property boundary.

CHAPTER III

ASSUMPTIONS/COSTS INCLUDED IN THE BASELINE

Baseline costs for landfills, surface impoundments, land treatment areas and waste piles were developed before calculating the incremental costs due to the Part 264 regulations. The baseline was composed of costs attributable to the interim status standards (ISS regulations) and basic operating costs that facilities would incur regardless of the existence of federal, state, or local regulatory programs.

Baseline costs for landfills and surface impoundments were broken out between pre-ISS costs (costs prior to a regulatory program) and ISS incremental costs (those incurred as a result of the ISS requirements). Baseline costs for waste piles and land treatment areas consisted entirely of ISS incremental costs. This was because detailed information regarding normal pre-ISS operating practices and costs were not readily available for the latter two processes.

Appendix B provides a complete listing of the unit baseline costs by type of process for all unit sizes used in the analysis. Baseline cost elements and assumptions are summarized below.

A. Pre-ISS Costs and Assumptions for Landfills and Surface Impoundments

1. Landfills. EPA developed detailed costs for several different landfill sizes, attempting to capture all significant elements that would be required for a landfill to operate. A fitted curve (based on a power function) was used to interpolate costs for some intermediate landfill sizes used in the analysis. Pre-ISS costs were the same for on-site and off-site landfills, because the analysis treated all pre-ISS landfills as if they were off-site, grassroots facilities. As with all unit costs used in the analysis, costs were broken out into:

- capital -- depreciable expenses incurred in the zero year (the year before facility operation starts;
- initial -- nondepreciable expenses incurred in the zero year;
- annual -- recurring operating costs and other nondepreciable expenses;
- last year capital -- depreciable expenses occurring in the last year (year 20 of facility operation); and
- other last year -- nondepreciable expenses occurring in year 20.

Table III-1 lists the elements for which pre-ISS costs for landfills were estimated.

TABLE III-1
Pre-ISS Cost Components for Landfills

Capital Costs

o Office space	o Heavy equipment
o Dewatering pumps	o Truck scales
o Road gravel	o Water wells
o Revegetation	o Utilities
	o Site clearing and grading

Initial Costs

- o Land acquisition
- o Cell excavation

Annual Costs Occurring in Years 0 Through 19

- o Cell excavation

Annual Costs Occurring in Years 1 Through 20

o Clerical labor	o Overhead
o Operating labor	o Insurance
o Labor burden	o G&A
o Supervision	o Cell closure
o Fuel	o 5% inspection fee
o Electricity	o 10% engineering fee
o Equipment maintenance labor	o 15% contingency

The analysis assumed that landfills have a remaining operating life of 20 years and that a landfill cell is opened each year starting in year 0 through year 19, and that a cell is closed each year starting in year 1 through year 20. Therefore, cell excavation and closure costs, although they are technically

capital costs, were treated as annual costs (incurred and expensed in each year). Appendix B provides a complete listing of all unit costs shown in Table III-1 by landfill size.

2. Surface Impoundments. Pre-ISS costs estimated for surface impoundments were less comprehensive than those estimated for landfills, and consist primarily of facility construction costs. Surface impoundments are simpler to design and operate than landfills because wastes are piped into instead of physically placed in the facility. Thus, initial capital costs are less than those for landfills and annual O&M costs are negligible. Because all surface impoundments were assumed to be on-site (i.e., they are always associated with other industrial or land disposal processes), there was no need to estimate costs for offices or special personnel. Table III-2 lists the categories for which pre-ISS costs were estimated for surface impoundments.

TABLE III-2
Pre-ISS Cost Components for Surface Impoundments

Capital Costs

- o Site clearing and grading
- o Excavation
- o Access road
- o Revegetation
- o Inlet/outlet valve
- o 5% inspection fee
- o 10% engineering fee
- o 15% contingency

Initial Costs

- o Land acquisition

Depreciable Capital Costs Occurring in Year 20

- o Fill/compact/slope
- o Revegetation

Intermittent Costs

- o Dredge and disposal of accumulated wastes

As Table III-2 shows, surface impoundment excavation is a capital cost, and is therefore depreciable. Unlike landfills, where new cells must be excavated each year, surface impoundments are only excavated once in the zero year, before actual operation begins. However, all surface impoundments must be dredged periodically to maintain their design capacities. The analysis assumed that dredging frequency is a function of surface impoundment size, although in practice, other factors (e.g., production rates, etc.) are likely to affect dredging frequency. Dredging costs reflect both the cost to remove (estimated to be $3 per metric ton) accumulated waste from the impoundment and the cost to dispose of the waste in a 123,000 metric ton/year off-site landfill. Shipping costs were not included because assumptions made regarding hauling distances would be extremely arbitrary. Appendix B provides a complete listing of all pre-ISS unit costs by surface impoundment size.

B. ISS-Incremental Costs and Assumptions For All Processes

For the most part, ISS administrative, monitoring and testing, and record-keeping and reporting costs were taken from the Arthur D. Little Economic Impact Analysis of RCRA Interim Status Standards. Incremental design costs resulting from the ISS regulations were estimated by PRA.

While certain cost elements were fixed (independent of facility size and type), others varied with both size and type of facility. For example, ADL's estimate of the cost to prepare an annual report was the same for all types and sizes of land disposal units. However, the ADL study used different fencing and runoff control formulae (which were dependent on the amount of waste handled) for each type of process.

1. Cost elements that apply to all processes. Basic cost elements that were generally the same for all land disposal processes are outlined below. Exceptions are noted.

Groundwater Monitoring. Capital costs for 4 ground-water wells (3 upgradient and 1 downgradient) were included in the baseline costs for all landfills, surface impoundments, and land treatment facilities, consistent with ISS requirements.

Ground-water sampling and analysis costs assumed quarterly testing in the initial year (year zero) and annual testing thereafter.

Because the ISS regulations do not require waste piles to undertake groundwater monitoring, costs for this activity were not included in the waste pile baselines.

Contingency Equipment. Capital costs for contingency equipment for cleaning up spills, putting out fires, etc. were included in the baseline costs for all land disposal processes.

Fencing. Costs for fencing were included for all processes. For landfills, fencing costs were assumed to be annual (surrounding each cell), while for the other three types of facilities, fencing costs were included as depreciable capital expenses incurred in year zero.

Run-off/run-on Control. The ISS regulations require facilities to collect run-off and divert run-on from active portions of the facility. Collected run-off is to be treated as hazardous. Baseline costs for surface impoundments, land treatment facilities and waste piles included capital costs in year 0 for run-off/run-on control. Run-on/run-off control costs were included as annual costs in the landfill baselines.

Planning Costs. The Part 265 regulations require all facilities to engage in certain planning activities. The following types of activities were costed for all land disposal processes:

- o Contingency plan development
- o Closure/post closure plan development
- o Waste analysis plan
- o Establishment of a reporting system, operating log, etc. (systems design)
- o Training course development

The analysis assumed that all planning costs are nondepreciable expenses that are incurred in the zero year.

Recordkeeping and Reporting Costs. The Part 265 regulations impose a number of reporting costs on land disposal facilities. Costs for the following activities were included in the baselines for all land disposal processes.

o Initial Year Costs Only

- Initial EPA notification
- Part A administration and recordkeeping and reporting
- Regulatory review

o Initial Year and Annual Costs

- Maintenance of detailed disposal records (This was not included in the waste pile cost baseline).
- Annual report
- Ground-water sampling and analysis
- Waste testing
- Regular inspection
- Personnel training

o Last Year Costs

- Decontamination and certification

2. Cost elements that vary by type of process. The ISS costs that were specific to certain processes are described below.

Landfill and Surface Impoundment Cap Costs. The Part 265 regulations require disposal facilities to close so as to minimize the need for further maintenance and to minimize or eliminate the release of contaminants. PRA estimated the cost of an ISS cap for landfill cells and for surface impoundments. (The analysis assumed that surface impoundments close as landfills.)

Post Closure Costs for Landfills and Surface Impoundments. Costs for the following post closure activities were estimated and included in the ISS baselines for landfills and surface impoundments. The post closure period was assumed to be 30 years, consistent with requirements in Part 265.

o Capital costs

- replanting of the facility in the first year of the post closure period.
- replacement of the fence surrounding the facility in year 16 of the post closure period.
- correction of damage to final cover expected to occur once (assumed to be year 15 of post closure period).

o Annual O&M costs

- inspection of the facility
- grass mowing
- repair of routine erosion damage
- fertilization of the groundcover planted at the facility[1]
- ground-water monitoring
- 30% contingency

Special Requirements for Waste Piles. The ISS regulations require facility owner/operators to install sturdy impermeable bases for waste piles or to protect the pile from precipitation and run-on. PRA developed designs and estimated costs for bases that would last for the remaining operating life of the waste pile (20 years).

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[1] Actually this cost occurs annually for the first three years and then five times in the next 27 years. These costs were adjusted to derive an equivalent annual cost to simplify the calculations.

Although the analysis assumed that waste pile bases last for 20 years, it did not assume that the piles themselves would last for 20 years. Rather, it assumed that piles sized at 2,000, 10,000 and 25,000 cubic feet would be completed, removed and disposed of each year; that a 100,000 cubic ft pile would be completed in two years; that a 500,000 cubic ft pile would be completed in 10 years; and that it would take 20 years to complete a 1,000,000 cubic ft pile.

The baseline analysis also assumed that all disposal of piles, bases, contaminated soils, etc., took place in a 123,000 MT/yr off-site landfill that was complying with the ISS regulations.

There were no post closure costs for waste piles.

Special Monitoring Requirements for Land Treatment Facilities. The Part 265 regulations require land treatment facilities to perform soil core and soil pore-liquid monitoring in the unsaturated zone, below the depth to which waste is incorporated. The regulations do not specify the number of test locations or the required frequency of sampling. The analysis assumed an average of 7 samples per year for soil core and soil pore liquid monitoring in the zone of aeration using lysimeters. The analysis also assumed pH analysis of soil samples, and treatment of surface water runon/runoff.

Closure for land treatment facilities consists of revegetation. Post closure costs include costs for soil pore liquid and ground-water monitoring, and wind dispersal control.

CHAPTER IV

SUMMARY OF REGULATORY REQUIREMENTS COSTED

This chapter summarizes the part 264 regulatory requirements the analysis addressed for each land disposal process. It describes the treatment of these requirements in the analysis and the assumptions used to estimate costs. It also indicates which requirements could not be or were not costed in the analysis and provides the rationale for their exclusion. Requirements for each land disposal process are described separately. The reader is cautioned that this summary is intended solely to describe the analysis that was undertaken. It should not be used as a guide to regulatory requirements under Part 264.

A. Landfill Requirements Costed in the Analysis

1. Liners and leachate collection systems. The Part 264 regulations require that all landfills (except for existing portions) have liners and leachate collection systems. The liners are to be designed, constructed, installed and maintained to prevent any migration of wastes out of the landfill to the adjacent subsurface soil, or ground water or surface water at anytime during the active life (including the closure period) of the landfill. In addition, the regulations provide that owner/operators of double-lined landfills are exempt from ground-water monitoring requirements under Subpart F of the regulations, provided that a leak detection system is installed between the liners. (The exemption ends if a leak is detected.) Leachate collection and removal systems are to be located immediately above the liner and are to be designed, constructed, maintained and operated to collect and remove leachate from the landfill.

PRA developed one single liner and two double liner designs intended to satisfy the performance requirements specified in the regulations, and to be consistent with the more detailed design suggestions provided in the draft

guidance document that will support the regulations. The three designs are described below.

- Design #1 was a single synthetic liner design. Its top layer was a leachate collection system which consisted of 30 cm of gravel interspersed with drainage tiles spaced at 15.25 meter intervals, and 15 cm of sand. A 30 mil synthetic membrane was located immediately under the leachate collection system. The membrane was on a 15 cm sand buffer, which completed the design. The design cost included sump pumps, wet wells, and a leachate treatment system.

  This was the lowest cost design used in the analysis. It was believed to be capable of satisfying the performance requirements provided in §264.301(a). Owner/operators using this design would still need to undertake ground-water monitoring. Design costs were the same for both off-site and on-site landfills.

- Design #2 was a double liner system. A second drainage layer of 30 cm of gravel was included below the primary synthetic liner and sand buffer of Design #1. A secondary liner consisting of 60 cm of compacted clay was then situated under the drainage layer.

  The clay liner resulted in higher design costs for on-site landfills than for off-site landfills. This was because the analysis assumed that clay would not be readily available to on-site facilities and would need to be brought in. However, off-site landfills were assumed to locate close to sources of clay, so their clay costs were considerably lower, reflecting the lower shipping expense.

  The analysis assumed that landfills using this design would still be required to undertake ground-water monitoring.

- Design #3 was a double synthetic liner system intended to satisfy the conditions specified in the Guidance Document for avoiding ground-water monitoring. It consisted of all the items outlined above, except that the clay liner under Design #2 was replaced with a second 30 mil synthetic liner sitting on a 15 cm sand buffer. The gravel drainage layer located between the two liners served as a leak detection system. Design costs were the same for off-site and on-site landfills.

  The analysis assumed that landfills using this design would not need to do ground-water monitoring.

Appendix C lists the detailed engineering costs for each of these designs.

The regulations provide that owner/operators that can demonstrate the ability of alternative design and operating practices and/or location characteristics to prevent the migration of any hazardous constituents into the ground water or surface water at any future time can be exempted from some

requirements. However, EPA did not estimate the cost of making such a demonstration, or the potential cost savings from successful demonstrations, or make assumptions about the number of facilities that would attempt to obtain this exemption or succeed in obtaining the exemption.

2. Run-on/run-off control. The Part 264 regulations require landfill owner/operators to design, construct, operate and maintain run-on and run-off control systems. The run-on control system must be capable of preventing flow onto the active portion of the landfill during the peak discharge from at least a 25-year storm. The run-off control system must be capable of collecting and controlling the water volume resulting from a 24-hour, 25-year storm. These systems are to be managed efficiently, with special attention required after storms to maintain design capacity.

In addition to the ISS run-on/run-off control costs included in the baseline, PRA's designs included costs for systems to meet these requirements. As with the liner costs, the analysis assumed that these costs were incurred in year zero and in each year of operation except year 20, because of the assumption that a new cell is opened each year. (No new cells are opened in the last year of operation.)

3. Wind dispersal control. The regulations require owner/operators of landfills containing particulate matter which could be subject to wind dispersal to cover the landfill or use other appropriate means to control wind dispersal. This requirement was not costed in the analysis, but is likely to be very small relative to other compliance costs.

4. Monitoring and inspection. Section 264.303 of the regulations impose additional monitoring requirements on facilities. Liners are to be inspected during and immediately after construction and installation for uniformity, damage, and imperfections. During operation, landfills are to be inspected weekly and after storms to detect problems with the run-on/run-off control

systems, the presence of liquids in the leak detection systems, or malfunction of wind dispersal control measures. The analysis did not cost any of these incremental monitoring and inspection requirements. It assumed that these costs would be about the same under FSS as they were under ISS (i.e., no change from baseline). These costs are expected to be very small compared to other compliance costs.

5. Surveying and recordkeeping. Section 264.309 requires owner/operators to maintain a map showing the exact location and dimensions of each cell with respect to permanently surveyed benchmarks, and records showing the contents of each cell and the general location of each waste type within each cell. Again, costs for these items were not estimated, but are expected to be small.

6. Closure. The regulations require owner/operators to place a cap or final cover on each cell at closure. This cap is to be designed and constructed to minimize the migration of liquids into the landfill. It is also to have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. PRA developed liner costs based on the following design.

- The cap design included 61 cm of vegetated top soil as a top cover; a 30.5 cm drainage layer of sand with perimeter collection tiles for run-off/runon control; and 61 cm of compacted clay to provide the impermeable layer. Costs assumed that the cell would be filled and graded to a 3 percent slope before final cover is applied.

The analysis assumed that cap costs are incurred in each year of operation (yrs 1 through 20), because of the assumption that one cell is opened and closed each year. Cap costs were higher for on-site landfills than for offsite landfills because of the assumption that on-site facilities do not have clay available on site but must ship it in, while off-site facilities are better situated with respect to clay supplies. Engineering costs for caps for different landfill sizes are listed in Appendix C.

7. Post closure care. The regulations require owner/operators to maintain the integrity and effectiveness of the final cover. In addition, they must monitor the leak detection system or the ground-water monitoring system through the end of the post closure period, operate the leachate collection and removal system for at least three years after closure, and protect and maintain surveyed benchmarks. Chapter III lists the activities for which post closure costs were estimated, and Appendix B contains a more detailed breakout of these costs by type and size of unit.

8. Special requirements for landfills that were not costed in the analysis. Sections 264.312 through 264.316 place restrictions or prohibitions on the disposal of certain types of wastes in landfills (e.g., reactive, ignitable, and incompatible wastes and liquids). None of these requirements were costed in the analysis, largely because of the lack of information regarding current industry practices with respect to these activities and the amounts of these types of wastes relative to total wastes handled at a facility.

B. Surface Impoundment Requirements Costed in the Analysis

Existing portions of surface impoundments are permitted to comply with the regulations by undertaking ground-water monitoring and by closing the facility at the end of its useful life according to Part 264. Should no ground-water contamination be detected through the end of the post closure period, these are the only significant costs the facility will incur as a result of these regulations. The low total cost case depicted in Table 15 of Section IX of the Preamble is based on such a scenario. It assumes that at the end of the 20-year remaining operating life, all surface impoundments close as disposal facilities (i.e., wastes remain in the impoundment and it is capped like a landfill) instead of closing as storage/treatment facilities (where all wastes and contaminated soil are removed at closure and no cap or post closure monitoring is required).

While existing portions of surface impoundments do not technically need to comply with the liner requirements specified in §264.221 and §264.222 (only new surface impoundments or lateral expansions of existing impoundments are required to comply), owner/operators of existing surface impoundments may wish to upgrade their facilities to reduce the likelihood that they will leak and contaminate ground water. However, surface impoundments are not like landfills, where Part 264 liners can simply be applied to new cells. The owner/operator of an existing surface impoundment that wants to install a Part 264 liner system, must either close the impoundment as a landfill according to the Part 264 closure requirements under §264.228 and construct a new impoundment, or he can close the facility temporarily and retrofit. Both of these options were costed in the analysis for each of the 3 liner systems described below, in addition to the case where the owner/operator does nothing except ground-water monitoring and closure. As previously discussed, surface impoundment liner and cap costs are treated as capital expenses instead of annual expenses, because it is assumed that surface impoundments have 20-year operating lives, while individual landfill cells only have 1-year lives. The requirements are described below.

1. Liners. The Part 264 regulations require that all surface impoundments (except for existing portions) must have liners that are designed, constructed, installed and maintained to prevent any migration of wastes out of the impoundment to the adjacent subsurface soil or ground water or surface water at anytime during the active life (including the closure period) of the impoundment. The regulations require that liners for disposal surface impoundments (those that close as landfills) be constructed of materials that can prevent wastes from migrating into the liner during the active life of the facility.[1] Storage

[1] This was interpreted to mean that disposal impoundments must be constructed with synthetic liners. Because the analysis assumed that all surface impoundments are disposal, all the surface impoundment designs included at least one synthetic liner.

or treatment impoundment (where wastes are removed at closure) liners can be constructed of materials that allow wastes to migrate into the liner but not into the adjacent subsurface soil. In addition, the draft guidance identified conditions under which single and double liner systems would be appropriate. As for landfills, the regulations provide that owner/operators of certain types of double-lined surface impoundments are exempt from ground-water monitoring requirements under Subpart F of the regulations, provided that a leak detection system is installed between the liners.

PRA developed one single liner and two double liner designs intended to satisfy the performance requirements specified in the regulations, and to be consistent with the more detailed design suggestions provided in the draft Surface Impoundment Guidance Document. Although leachate collection and removal systems are not required for surface impoundments, PRA included these systems in all three surface impoundment designs. The three designs are described below.

- Design #1 was a single synthetic liner design that included 15 cm of protective, compacted soil placed on a 15 cm sand layer interspersed with drainage tiles that serves as the leachate collection and removal system. A 30 mil synthetic liner was under the sand layer and was situated on a buffer of 15 cm of sand. The design costed by PRA included sump pumps and drainage tiles, although these would not be required to satisfy the minimum requirements specified in the regulations and guidance.

  Owner/operators using this design would still need to undertake ground-water monitoring.

- Design #2 was a double liner system. Its top layer consisted of 15 cm of soil, as in Design #1. This covered a 30 mil synthetic liner. PRA's design included 45 cm of sand between the synthetic liner and the bottom layer of 61 cm of compacted clay. The sand between the liners served both as a buffer for the synthetic liner and as a drainage system to collect any leachate that could pass through the synthetic liner. PRA's design includes drainage tiles and sump pumps. Design costs for all surface impoundments assumed that clay is not readily available on-site and must be brought in.

  Technically, Design #2 could enable owner/operators to avoid compliance with the ground-water monitoring requirements, because it is a double-liner design with a 30 cm drainage layer between the two liners, a drainage tile system, and a sump pump to remove liquid. However, the analysis assumed that impoundments using this design would still need to comply with Subpart F.

- Design #3 was a double synthetic liner system intended to satisfy the conditions specified in the regulations for avoiding ground-water monitoring. It consisted of a 15 cm top layer of compacted soil, that covered the first 30 mil synthetic membrane. A 15 cm sand buffer was located immediately under the top liner. A full leachate collection system was located between the two membranes and consisted of 15 cm of gravel with drainage tiles and 15 cm of sand. Design costs included a sump pump. A 15 cm sand buffer was located under the second synthetic liner.

The regulations provide that owner/operators that can demonstrate the ability of alternative design and operating practices and/or location characteristics to prevent the migration of any hazardous constituents into the ground water or surface water at any future time can be exempted from the requirements. However, EPA did not estimate the cost of making such a demonstration, or the potential cost savings from successful demonstrations, or make assumptions about the number of surface impoundments that would attempt to obtain this exemption or succeed in obtaining the exemption.

2. Run-on/run-off control. The Part 264 regulations require that surface impoundments be designed and constructed to prevent overtopping and that impoundment dikes be designed and constructed to prevent massive failure. PRA's design costs include costs for berms, which act to prevent overtopping during storms.

3. Monitoring and inspection. Section 264.226 of the regulations impose additional (above ISS baseline) monitoring requirements on surface impoundments. Liners are to be inspected during and immediately after construction and installation for uniformity, damage, and imperfections. During operation, surface impoundments are to be inspected weekly and after storms to detect sudden drops in the level of the impoundment's contents, evidence of overtopping, or the presence of liquids in the leak detection systems. The analysis did not cost any of these incremental monitoring and inspection requirements. It assumed that these costs would be about the same under Part 264 as they were under ISS

(i.e., no change from baseline). Any incremental costs are expected to be very small compared to other compliance costs.

4. Emergency repairs and contingency plans. Section 264.227 stipulates situations which would require that a surface impoundment be removed from service and that repairs be undertaken. The frequency and costs of these types of situations were not considered in the analysis. No incremental (above ISS baseline) contingency planning or equipment costs were included to meet Part 264 requirements.

5. Closure. Under the regulations surface impoundment owner/operators can either: 1) remove and manage as hazardous all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and any other fixtures or equipment that may be contaminated; or 2) eliminate free liquids by removing liquid wastes or solidifying remaining wastes and waste residues and close the impoundment as a landfill.

The analysis considered only the second closure option, because of the high cost of removing and landfilling contaminated soils. It assumed that all surface impoundments would be capped at closure, just as landfills are capped. The regulations place the same requirements on surface impoundment caps that are placed on landfill caps. They must be designed and constructed to minimize the migration of liquids into the impoundment. They must also to have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. PRA developed costs for the following design.

- The surface impoundment cap included 61 cm of vegetated top soil as a top cover; a 30.5 cm drainage layer of sand with perimeter collection tiles for run-off/runon control; and 61 cm of compacted clay to provide the impermeable layer. Costs assumed that the surface impoundment would be filled and graded to a 3 percent slope before final cover is applied.

The analysis assumed that cap costs are depreciable capital expenses that are incurred in the last year of operation (year 20).

6. Post closure care. Where surface impoundments close with waste residues or contaminated materials in place (i.e., they close as landfills), the owner/operator must comply with all the post-closure requirements that apply to landfills. Where all contaminated materials and soil are removed, there are no post-closure requirements. Because the analysis assumed that all surface impoundments close as disposal facilities, all are subject to post-closure requirements and costs. Chapter III lists the activities for which post closure costs were estimated, and a more detailed breakout of these costs by type and size of unit are presented in Appendix B.

7. Special requirements for surface impoundments that were not costed in the analysis. Sections 264.229 and 264.230 place restrictions or prohibitions on the disposal of certain types of wastes in surface impoundments (e.g., reactive, ignitable, and incompatible wastes). None of these requirements were costed in the analysis, largely because of the lack of information regarding current industry practices with respect to these activities and the amounts of of these types of wastes relative to total wastes handled at a facility.

C. Waste Pile Requirements Costed in the Analysis

The analysis assumed that all waste piles are treatment or storage piles as opposed to disposal piles. Disposal piles would be subject to the same D&O requirements that apply to landfills. The regulations stipulate that piles that are placed inside or under a structure that shelters it from precipitation can obtain exemptions from both Subpart F and the design and operating requirements listed under §264.251. This compliance option was not costed in the analysis.

1. Liner and leachate collection requirements for waste piles. If the pile is not protected from precipitation, the regulations require that the pile have both a liner and a leachate collection and removal system located immediately above the liner. As for landfills and surface impoundments, waste pile

liners must be designed, constructed, installed and maintained to prevent any migration of wastes out of the pile to the adjacent subsurface soil or ground water or surface water at anytime during the active life (including the closure period) of the waste pile. The leachate collection and removal system is to be designed, constructed, maintained and operated to collect and remove leachate from the pile. The regulations provide that owner/operators of certain types of double-lined waste piles can obtain exemptions from ground-water monitoring requirements under Subpart F of the regulations, provided that a leak detection system is installed between the liners.

The draft guidance for waste piles stated that a base of admixed materials such as concrete or asphalt and run-off controls could be used instead of the liner/leachate collection system for above grade piles.

In addition, §264.253 of the regulations allows owner/operators to avoid ground-water monitoring under certain conditions if they remove wastes in the pile periodically and inspect the liner or impermeable base for deterioration, cracks, or other conditions that may result in leaks.

PRA developed costs for each of these three compliance options.

- Liner/Leachate Collection System: Costs for a double synthetic liner system were estimated for waste piles. The system consisted of a primary 30 mil synthetic liner overlaying a leachate collection system that consisted of a 30 cm sand layer with drainage tiles and a wet well and sump pump. Underneath the leachate collection system there was a secondary 30 mil synthetic liner with a 15 cm sand buffer below it.

  Because of the double synthetic liner, ground-water monitoring was not required.

- Sturdy Impermeable Base with Ground-Water Monitoring: Liner costs used here were the same as those used for the ISS baseline. Capital costs for ground-water monitoring wells and initial year and annual costs for ground-water sampling and analysis were included, consistent with the addition of these requirements in Part 264.

- Sturdy Impermeable Base with Periodic Inspection: Liner costs assumed here were the same as those used to develop the ISS baseline. Annual inspection costs to move the pile and check the base were added. Ground-water monitoring was not required.

Costs to install liners or bases were treated as depreciable capital expenses, because the life of the base/liner system was assumed to be 20 years for all waste pile sizes.

The regulations provide that owner/operators that can demonstrate the ability of alternative design and operating practices and/or location characteristics to prevent the migration of any hazardous constituents into the ground water or surface water at any future time can be exempted from the requirements. However, EPA did not estimate the cost of making such a demonstration, or the potential cost savings from successful demonstrations, or make assumptions about the number of waste piles that would attempt to obtain this exemption or succeed in obtaining the exemption.

2. Run-on/run-off control. The Part 264 regulations require waste pile owner/operators to design, construct, operate and maintain run-on and run-off control systems. As for landfills, the run-on control system must be capable of preventing flow onto the active portion of the landfill during the peak discharge from at least a 25-year storm. The run-off control system must be capable of collecting and controlling the water volume resulting from a 24-hour, 25-year storm. These systems are to be managed efficiently, with special attention required after storms to maintain design capacity.

Part 264 run-on/run-off control costs were the same as those estimated for the ISS baseline. However, where owner/operators elected to comply by installing a liner/leachate collection system instead of the hard impermeable base, run-on/run-off control costs were slightly reduced, because of the smaller area required for that containment system. As with the liner and base costs, run-on/run-off control costs are capital expenses incurred in year zero.

3. Wind dispersal control. The regulations require owner/operators of waste piles containing particulate matter which could be subject to wind

dispersal. PRA included costs for a jute mesh placed over the lateral surface area of the pile to minimize wind dispersal.

4. Monitoring and inspection. Under §264.253, owner/operators that move their wastes periodically to inspect the pile base can be exempted from Subpart F requirements. PRA estimated costs for annual inspections that included costs to move the waste, inspect the base and report on the state of the base. Other incremental (above ISS) monitoring and inspection costs, such as liner/base inspection during and immediately after construction and installation, weekly inspection during operation, and inspection after storms to detect problems with the run-on/runoff control systems, the presence of liquids in the leak detection systems, or malfunction of wind dispersal control measures, were not costed. As for the other facilities, these costs are expected to be very small compared to other compliance costs.

5. Closure. The regulations require owner/operators to remove and manage as hazardous all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and contaminated structures and equipment at closure. If this is not feasible, the waste pile is subject to the closure and post closure requirements that apply to landfills. The analysis assumed that all waste pile owner/operators close by removing wastes at closure. PRA estimated the costs to remove the waste and containment system and dispose of them in a 123,000 MT/year off-site landfill with a Part 264 double liner (synthetic/clay) system. Transportation costs were not included.

6. Post Closure Care. Waste piles where all wastes and contaminated soils, etc. are removed at closure are not subject to post closure requirements. Because the analysis assumed that all wastes, residues, contaminated soils, etc. were removed at closure, it was not necessary to estimate post closure costs.

7. Special requirements for waste piles. Section 264.257 prohibits the placement of incompatible wastes in the same pile unless certain conditions apply. Costs were not estimated for this requirement.

D. Part 264 Land Treatment Requirements

Costs estimated for land treatment areas differ from costs estimated for other processes because there are no requirements for a containment system under this process. Rather, the regulations and guidance specify a treatment program which, if followed, will ensure that hazardous constituents placed on or in the treatment zone are degraded, transformed or immobilized.

The types of compliance activities required under the Part 264 regulations and their treatment in the analysis are described below.

1. Treatment demonstration. For each waste to be applied, §264.272 requires owner/operators to demonstrate that hazardous constituents in the waste can be completely degraded, transformed or immobilized in the treatment zone. Field tests or laboratory analysis can be used to make the demonstration. The demonstration must be based on conditions similar to those present in the treatment zone. The analysis assumed that each land treatment area would undertake one initial waste analysis and demonstration. The cost used represented an average of the cost of field testing and the cost of lab analysis.

2. Design and operating requirements. The regulations require owner/operators to maintain land treatment facilities to maximize the degradation, transformation and immobilization of hazardous constituents in the treatment zone. To do this the regulations require that they:

- o control soil pH. The analysis assumed that 10 percent of all land treatment areas would require an initial pH adjustment. The pH adjustment was attained by applying lime to the area.
- o apply wastes at a specified rate. The analysis assumed that wastes are applied at a rate of 206 metric tons per acre per year.
- o fertilize or take other action to enhance microbial or chemical reactions. Annual costs for ground cover planting and fertilization were included for 90 percent of the areas.
- o control moisture content. The analysis assumed that 90 percent of all land treatment areas that are 20 acres or larger would incur capital costs for an irrigation mobile pump and spray nozzle. Smaller areas were assumed to use garden hoses. Annual costs for irrigation that assumed operation of the system for two hours every three days were applied to 90 of all areas (regardless of size).

- o minimize run-off of hazardous constituents from the treatment zone. No incremental costs were assumed for run-off control, because it was assumed (based on Part A information) that most areas are already graded to the desired slope for proper run-off control.

- o design, construct and maintain a run-on control system capable of preventing flow onto the treatment zone during peak discharge from at least a 25-year storm. No incremental (over ISS) costs were assumed for run-on control.

- o control wind dispersal of particulate matter. The analysis assumed that the measures taken to control moisture content of the treatment zone would also satisfy the wind dispersal control requirements.

- o inspect the facility weekly and after storms to detect any malfunction of the run-on/run-off control system or the wind dispersal control system. Incremental costs for these inspection activities were not included in the analysis. ISS inspection costs were assumed to satisfy this requirement.

3. Requirements for growing food-chain crops. Section 264.276 lists requirements for growing food-chain crops at hazardous waste land treatment areas. The whole area of food chain crops was not addressed in the analysis because of insufficient information regarding current practices, costs of complying, etc.

4. Monitoring the unsaturated zone. Section 264.278 requires owner/operators of land treatment areas to establish and carry out an unsaturated zone monitoring program to determine whether hazardous constituents migrate out of the treatment zone. The program is to consist of soil and soil-pore liquid monitoring using soil cores and lysimeters. A sufficient quantity of samples is to be obtained to represent background levels and determine any changes in these levels. Information provided by K.W. Brown indicated that many land treatment facilities already engage in these activities. Therefore, incremental costs for these activities were not applied across all areas. The analysis assumed that 50 percent of all areas would need to add one lysimeter per 8 acres (an initial capital expense) and would incur an annual cost to analyze an additional 5 parameters. The analysis assumed that 25 percent of all areas would need to increase soil sampling by an additional soil core per 4 acres on an annual basis.

In addition, the analysis assumed that 10 percent of all areas would show a statistically significant increase in hazardous constituent levels and would have to take additional measures (short of corrective action) to respond to the increases. Costs assumed for evaluating and responding to these situations were as follows: 1) additional annual pH adjustment costs were applied to 3 percent of all areas; 2) capital and annual costs of expanding the treatment zone were applied to 5 percent of all areas; and 3) annual costs to dispose of overload wastes in an off-site landfill were applied to 2 percent of all areas.

5. Closure. At closure the area owner/operator is to establish a vegetative cover on the portion being closed. The cover must not impede degradation, transformation or immobilization of constituents and must be able to grow without extensive maintenance. No incremental cost (above the ISS vegetative cover) was assumed.

6. Post closure care. The regulations require owner/operators to continue all activities (including pH control) necessary to enhance degradation and transformation and sustain immobilization of hazardous constituents in the treatment zone. Where the owner/operator can demonstrate that the level of hazardous constituents in the treatment zone does not exceed background levels, the site can avoid post-closure requirements. However, this alternative was not taken into account in the cost analysis. All land treatment areas were assumed to close with hazardous constituents in place. The analysis assumed additional post closure costs (over ISS) for pH control.

CHAPTER V

GROUND-WATER PROTECTION AND CORRECTIVE ACTION COSTS

Section A of this chapter reviews the corrective action scenarios that were considered in the analysis. Section B then briefly summarizes the models and major technical assumptions that were used to calculate counterpumping costs for each of the scenarios. Section C examines the sensitivity of corrective action costs to changes in some of the underlying assumptions. Greater detail on the technical aspects of the counterpumping costs is provided in the Geraghty & Miller (G&M) working papers entitled Cost Estimates for Containment of Plumes of Contaminated Ground-Water, which is included as Appendix D to this report.

A. Ground-Water Protection Requirements Considered in the Analysis

The Ground-Water Protection section of the regulations (Subpart F) contains requirements for ground-water monitoring which specify procedures that owner/operators are to follow to determine whether hazardous constituents are leaking into ground water. Subpart F also specifies what actions owner/operators must take if any leakage is detected.

Subpart F requires facilities that are not currently leaking to undertake a detection monitoring program. Detection monitoring requires the owner/operator to monitor for the presence of any hazardous constituents at the compliance point (the waste boundary) through the operating life and post closure period. The requirements of this program are essentially the same as those under the ISS regulations.

The regulations require owner/operators that detect hazardous constituents at the compliance point to undertake a compliance monitoring program. The purpose of the compliance monitoring program is to determine whether concentration limits for specified hazardous constituents established in the permit are exceeded. This program is more expensive than the ISS detection monitoring

program because testing costs are higher and samples must be taken more frequently.[1] Under the regulations, corrective action must be taken if hazardous constituents exceed established concentration limits.

Four corrective action scenarios were developed for the cost analysis. The first assumes detection monitoring only (no corrective action or compliance monitoring necessary) while the last three assume both compliance monitoring and corrective action. A separate scenario specifying compliance monitoring without corrective action was not included because the costs for such a program were expected to be fairly close to the "Detection Monitoring Only" scenario.

The four ground-water protection scenarios used in the analysis are described below.

1. Detection monitoring only. The lowest cost case examined in the analysis assumed that facilities would incur no incremental costs (above ISS) for ground-water monitoring. Part 264 capital costs (to drill 4 wells) and initial and annual sampling and analysis costs were the same as those included in the ISS baseline cost streams. The tables of results contained in Appendix E have columns entitled "No Corrective Action Necessary." The annual revenue requirements listed in that column assume no incremental ground-water monitoring costs over ISS. The lower end of the total cost range estimated in the analysis, $702 million, also assumes no incremental ground-water monitoring costs (over ISS).

2. Corrective action required in the zero year, continuing for 150 years. This scenario was developed to provide a "worst case" estimate of corrective action costs. It covers situations where facilities must pump indefinitely in order to maintain concentrations of hazardous constituents at acceptable levels.

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[1] The annual compliance monitoring cost estimate includes the cost to do a scan of all Section VIII constituents ($3,500 every three years), the cost to take quarterly ground-water samples ($6,000 per year), and the cost to analyze the ground water for the presence of specific hazardous constituents ($2,800 per year for on-site facilities and $12,480 for off-site facilities).

In this scenario, 150 years was used as a surrogate for "forever," as the discounting factor for anything greater than 150 years rapidly approaches zero. Cost streams for this scenario reflect:

- o higher annual costs because of compliance monitoring (instead of detection monitoring) starting in year one and continuing for 150 years;
- o an initial cost of $25,000 in year zero to develop a corrective action plan;
- o capital costs in year zero to drill wells and construct the fluid recovery and treatment systems. The analysis assumed complete replacement of the fluid recovery system every 30 years, so capital costs were repeated in years 30, 60, 90 and 120.
- o annual operating and maintenance costs for the counterpumping program starting in year 1 and continuing for 150 years.

Section IX.F of the Preamble to the regulations lists an estimated range for Part 264 incremental compliance costs. The high estimate -- $1,145 million -- includes $677 million in corrective action costs, which assumes that all facilities must take corrective action immediately and continue for 150 years.

3. Corrective action required in the zero year, continuing for 20 years. This scenario represents a mid-cost case. Facilities are still required to take action immediately but all contamination is effectively removed (concentrations of hazardous constituents drop below specified levels) by the end of year 20. The analysis assumes that the facility continues to operate while it undertakes corrective action. Cost streams under this scenario include:

- o higher annual costs for compliance monitoring in lieu of detection monitoring starting in year one and continuing through year 20. Annual costs for detection monitoring from year 21 through year 50 (the end of the post closure period).
- o an initial cost of $25,000 in year zero to develop a corrective action plan;
- o capital costs in year zero to drill wells for the counterpumping program and to construct the fluid recovery and treatment systems; and
- o annual operating and maintenance costs for the counterpumping program starting in year 1 and continuing for 20 years.

4. Corrective action required in year 49, continuing for 20 years. This scenario assumes that no leakage is detected until the last year of the post

closure period. Only detection monitoring costs are incurred in years 0 through 48. Although contamination is not detected until year 49, the facility must still undertake corrective action. The analysis assumed that counterpumping can effectively remove the contaminant plume in 20 years. Because all costs under this scenario are incurred far in the future, discounting significantly reduces their impact. For example, the present value of a $100 cost that will be incurred 50 years from now is only $22.81 assuming a real rate of return of 3 percent and an inflation rate of 8 percent. Therefore, the annual revenue requirements for this scenario are much lower than those calculated for scenario 3, where the high capital costs were incurred immediately and were not discounted. Cost streams for this scenario assume:

- o higher annual costs for compliance monitoring starting in year 50 and continuing through year 69. Annual costs for detection monitoring from year 0 through year 49.
- o a fixed cost of $25,000 in year 49 to develop a corrective action plan;
- o capital costs in year 49 to drill wells for the counterpumping program and to construct a treatment plant; and
- o annual operating and maintenance costs for the counterpumping program starting in year 50 and continuing for 20 years.

B. Assumptions/Models Used to Develop Corrective Action Cost Estimates

The analytic approach used to estimate corrective action costs is fully described in Appendix D of this report. The analytic approach is summarized below.

G&M used a model plume approach to estimate the costs of corrective action. They developed cost estimation algorithms for a range of simplified plume and hydrogeological conditions for systems designed to remove contaminant plumes (counterpumping) and systems designed to only isolate plumes (slurry walls). The costs used in Section IX of the Preamble were based on earlier versions of the Part 264 regulations that differed from the proposal published in the

July 26, 1982 Federal Register. The earlier versions appeared to preclude the use of slurry walls as a corrective action technique, so slurry walls were not fully analyzed. Therefore, the discussion below focuses only on G&M's methodology for estimating counterpumping costs. Slurry wall costs are discussed in a later section of this chapter (Section D) and in G&M's report.

All of G&M's algorithms estimated costs for containing plumes rather than removing them. (The Preamble used these containment cost estimates as surrogates for removal costs.) The primary variables affecting the costs and the relative effectiveness of containment techniques are:

1) plume dimensions. G&M's report considered a range of plume dimensions. Plume widths ranged from 100 to 2000 feet; lengths ranged from 200 to 10,000 feet. Two width to length ratios were considered -- 1 to 5 and 1 to 2. Plume depth ranged from 25 to 200 feet.

   All cost estimates developed for the Preamble assumed a width to length ratio of 1 to 2, to be consistent with assumptions made regarding facility size and shape. It was assumed that all land disposal units and facilities are rectangular, with the length being two times longer than the width. Plume dimensions were assumed to be equivalent to the dimensions of the facility, because of requirements in the regulations that the plume must be "stopped" at the waste boundary. Dimensions and areas estimated for the different types of units and facilities are provided in Tables V-1 and V-2.

   In estimating costs for the Preamble, depth was held constant at 75 feet. As stated in Section IX.D of the Preamble, this depth is likely to be typical only for well-established plumes. New plumes are expected to be shallower and, therefore, less expensive to control.

   As shown in Table V-1, the smallest plume for which costs were estimated was 108 ft x 217 ft, while the largest plume costed was 2,333 ft x 4,666 ft. Plumes smaller or larger than these fell outside the range of G&M's cost model. For these plume sizes, costs estimated for the extremes were used.

2) hydraulic gradient. Hydraulic gradient measures the change in total head[1] with a change in distance in a given direction. While G&M's report considered a range of .5 to 500 feet per mile for hydraulic gradient, corrective action costs estimated for the Preamble assumed a constant gradient of 5 feet per mile. This was selected as representative of mid-range conditions, while more extreme values were considered in the sensitivity analysis. See Section C below.

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[1] G&M defines total head as the sum of the elevation head, the pressure head and the velocity head at a given point in an aquifer.

3) transmissivity. Transmissivity measures the rate at which water of a specific density and viscosity moves through a unit width of an aquifer under a unit hydraulic gradient. The G&M report used a range of 1,000 to 1,000,000 gal/day/foot for transmissivity to estimate corrective action costs. For the counterpumping costs used in the Preamble, transmissivity was held at 100,000 gal/day/foot, again a mid-range value. The extreme values were treated in the sensitivity analysis.

4) aquifer discharge. Aquifer discharge is defined as the quantity of water moving across a one-mile wide section of an aquifer per day. Both transmissivity and hydraulic gradient affect aquifer discharge. Aquifer discharges used in G&M's study ranged from .05 to 5 million gallons per day across a one-mile wide section of the aquifer. A value of .5 million gallons per day per mile was used to estimate costs for the Preamble. The analysis assumed that the plume discharge was directly proportional to the discharge through a unit width of the aquifer. For counterpumping this is important because the quantity pumped must be at least as great as the plume discharge.

5) treatment required. Both the G&M Report and the Preamble used an average of the costs for three different types of treatment technology as estimates of the costs of treating contaminated ground water pumped through the counterpumping system. The three types of treatment are reverse osmosis, activated carbon filtration, and coagulation/flocculation/sedimentation/filtration. Capital and annual O&M costs for each technology were treated only as functions of total discharge from the fluid removal system. All treatment costs assume low concentrations of contaminants because the level of hazardous constituents in the pumped ground water is expected to be fairly low over the life of a corrective action program. The implications of using an average treatment cost assumption are addressed in the sensitivity analysis (Section C below).

G&M estimated counterpumping costs for both a uni-directional hydraulic gradient (Strategy 1) and a radially-directed gradient (Strategy 2) across plume boundaries.[1] Both were costed for the Preamble, although the total costs presented in Table 15, Section IX.F of the Preamble reflect only Strategy 2 conditions. Strategy 1 was used to represent "simple" ground-water flow conditions, where the plume elongates only in the direction of ground water flow. Strategy 2 is the higher cost case and represents a situation where the plume spreads in all directions and is therefore more difficult to control. For Strategy 1, containment is achieved by using a recovery well (or wells) to create a limiting flowline around the plume. For Strategy 2, containment

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[1] Unlike Strategy 1, plume discharge under Strategy 2 is not directly related to aquifer discharge as defined above.

is achieved by creating a ground-water divide around the plume. Total discharge from the wells must be at least as large as the total discharge through the plume.

Under Strategy 1 conditions, recovery wells are located at the toe of the plume in the traverse direction to ground-water flow. The number of wells increases as hydraulic gradient and plume discharge increase, as plume width increases, as plume depth decreases, and as aquifer transmissivity decreases. The number of recovery wells required is not sensitive to plume length. G&M's report states that decreases in depth or transmissivity or increases in plume discharge influence the number of recovery wells because they increase the pumping rate required. Changes in width or transmissivity affect the number of wells because they limit the effective drawdown at plume boundaries.

Under Strategy 2 conditions, wells are placed along the length of the plume. In general, more wells and higher pumping rates are required to control plumes under Strategy 2 conditions. Under Strategy 2 conditions, the number of recovery wells increases as hydraulic gradient and plume discharge increase, as plume perimeter (a function of width and length) increases, as plume depth decreases, and as aquifer transmissivity decreases.

Capital and annual costs for different plume sizes under each strategy are presented in Tables V-1 and V-2. Table V-1 provides the costs used to calculate the corrective action annual revenue requirements for individual land disposal units provided in Section IX.D of the Preamble. Table V-2 provides the backup costs used to estimate total corrective action costs for land disposal facilities (combinations of units). This distribution was used to derive the total corrective action cost estimate provided in Section IX.F of the Preamble (Table 15).

Capital costs are composed of infrastructure construction costs (roads, electric power, manifold and service piping, and treatment plant), costs for

TABLE V-1
Plume Sizes and Counterpumping Costs
By Type and Size of Land Disposal Unit
($ 000)

Type of Unit	Plume Dimensions	Plume Size (Acres)	Strategy 1		Strategy 2	
			Capital	Annual	Capital	Annual
Landfill (LF)						
500 MT/Yr	236 x 471	2.6	160	43	270	63
2000	372 x 745	6.4	180	47	340	71
5000	577 x 1154	15.3	230	54	380	87
7000	623 x 1246	17.8	240	56	390	90
15000	833 x 1665	31.8	290	60	440	102
35000	1178 x 2355	63.7	350	66	560	118
60000	1442 x 2884	95.5	400	70	660	125
123000	1747 x 3493	140.1	450	76	770	132
Surface Impoundment (SI)¶						
1/4 Acre	74 x 148	.3	130	38	180	53
1/2	118 x 236	.6	130	38	180	53
1	167 x 333	1.3	140	40	225	58
2	225 x 450	2.3	160	43	270	63
5	340 x 680	5.3	180	47	340	71
11	500 x 1000	11.5	225	53	370	85
Land Treatment (LT)						
1.75 Acres	195 x 390	1.7	150	42	240	60
6.63	380 x 760	6.6	180	49	340	76
20.30	665 x 1330	20.3	240	56	400	90
75.25	1280 x 2560	75.2	370	69	600	120
250.00	2333 x 4666	249.9	540	85	1000	140
Waste Piles (WP)†						
2,000 cu. ft.	27 x 54	*	140	40	212	56
10,000	44 x 87	*	140	40	212	56
25,000	59 x 117	.2	140	40	212	56
100,000	90 x 180	.4	140	40	212	56
500,000	152 x 304	1.1	140	40	212	56
1,000,000	189 x 378	1.6	145	41	240	59

* plume size is less than .05 acres.

¶ plumes for 1/4 acre surface impoundments fell below G&M's range. Costs used are those estimated for a 1/2 acre surface impoundment.

† plumes for waste pile sizes smaller than 500,000 cu. ft. fell below G&M's range. Costs used are those estimated for 500,000 cu. ft. [illegible].

TABLE V-2
Plume Sizes and Counterpumping Costs
By Type and Size of Land Disposal Facility
($ 000)

Type of Facility	Plume Dimensions	Plume Size (Acres)	Strategy 1		Strategy 2	
			Capital	Annual	Capital	Annual
Landfill only	861 x 1722	34.1	265	58	435	98
Surface Impoundment only	446 x 892	9.1	200	50	330	76
Land Treatment only	1495 x 2990	102.6	400	69	600	127
Waste Pile only	108 x 217	.5	128	38	170	52
Landfill & Surface Impoundment	987 x 1973	44.7	340	65	520	115
Landfill & Land Treatment*	2303 x 4606	243.5	540	85	1000	140
Landfill & Waste Pile	977 x 1953	43.8	340	65	520	115
Surface Impoundment & Land Treatment	1282 x 2565	75.5	420	70	625	130
Surface Impoundment & Waste Pile	410 x 820	7.7	210	52	350	78
Land Treatment & Waste Pile*	2593 x 5185	308.6	540	85	1000	140
Landfill, Surface Impoundment & Land Treatment	1875 x 3750	161.4	540	85	1000	140
Landfill, Surface Impoundment & Waste Pile	1188 x 2376	64.8	390	68	595	125
Surface Impoundment, Land Treatment & Waste Pile	1321 x 2642	80.1	420	72	660	130
Landfill, Surface Impoundment, Land Treatment & Wast Pile	1736 x 3471	138.3	480	78	860	140

* These sizes were outside the range of G&M's model.
Costs used were those calculated for a 1875 x 3750 ft plume.

plume delineation, design engineering, well construction, and construction engineering. Annual costs include O&M costs for fluid removal, infrastructure, and treatment systems. These costs are detailed in Appendix D.

C. Sensitivity of Corrective Action Costs to Changes in Technical Assumptions

This section summarizes the effects of changing the "base case" assumptions regarding aquifer transmissivity and gradient, and type of treatment technology that were used to develop per unit and total corrective action costs for the Preamble. Appendix D examines the sensitivity of counterpumping costs to changes in these variables in greater detail.

The effects of changing these base case assumptions were examined for two plume sizes to indicate the range of costs for each set of hydrogeologic assumptions. The small plume (100 ft x 200 ft) is approximately the size of the plume used to estimate corrective action costs for a half acre surface impoundment. The large plume (1000 ft x 2000 ft) falls between the plume size estimated for a 15,000 MT/yr landfill and a 35,000 MT/yr landfill.

1. Sensitivity to Changes in Gradient and Transmissivity. Table V-3 shows the effects on costs of changing assumptions regarding transmissivity and gradient under Strategy 1 and Strategy 2 conditions. The annual revenue requirements included in the table assume counterpumping begins in year 0 and continues until year 20. They do not include treatment costs.

As the table indicates, changing gradient or transmissivity assumptions has almost no effect on costs for small plumes under Strategy 1 conditions. However, for large plumes under Strategy 1 conditions, increasing the gradient from the base case level of 5 feet per mile to 50 feet per mile or increasing the transmissivity from 100,000 to 1,000,000 gallons per day per foot increased costs by about 50 percent. Decreasing the gradient or the transmissivity below base case levels had no significant impact on costs.

Under Strategy 2 conditions, increasing transmissivity from base case levels increased costs for small plumes by 42 percent and for large plumes almost 150 percent. Decreasing transmissivity had little impact for small plumes under Strategy 2 conditions, but reduced costs for large plumes by about 30 percent. The greater sensitivity of costs to changes in hydrogeologic assumptions under Strategy 2 conditions is largely due to the higher pumping rates required.

TABLE V-3
Effects of Varying Gradient and Transmissivity
Assumptions on Counterpumping Costs Under Strategy 1 & 2 Conditions

STRATEGY 1	Hydraulic Gradient (ft./mile)	Trans-missivity (gallon/ day/ft)	Aquifer Discharge (10^6 gal/ day/mile)	Ann. Revenue Requirement ($ 000)
Small Plume (100 x 200 ft)				
Low Gradient	0.5	100,000	0.05	21
Base Case	5.0	100,000	0.5	21
High Gradient	50.0	100,000	5.0	22
Low Transmissivity	5.0	10,000	0.05	21
Base Case	5.0	100,000	0.5	21
High Transmissivity	5.0	1,000,000	5.0	22
Large Plume (1000 x 2000 ft)				
Low Gradient	0.5	100,000	0.05	29
Base Case	5.0	100,000	0.5	30
High Gradient	50.0	100,000	5.0	47
Low Transmissivity	5.0	10,000	0.05	29
Base Case	5.0	100,000	0.5	30
High Transmissivity	5.0	1,000,000	5.0	44
STRATEGY 2				
Small Plume (100 x 200 ft)				
Low Transmissivity	5.0	10,000	Varies	21
Base Case	5.0	100,000	Varies	21
High Transmissivity	5.0	1,000,000	Varies	30
Large Plume (1000 x 2000 ft)				
Low Transmissivity	5.0	10,000	Varies	28
Base Case	5.0	100,000	Varies	37
High Transmissivity	5.0	1,000,000	Varies	91

2. Sensitivity to Type of Treatment. Treatment costs are an important factor in determining total counterpumping costs. Under Strategy 1 conditions, about 40 percent of the capital costs and 60 percent of the annual O&M costs estimated for counterpumping are attributable to treatment costs. Under Strategy 2 conditions, the portions attributable to treatment costs increase to about 55-60 percent for capital costs and about 70 percent for annual O&M costs. Because treatment costs play such a significant role in estimating total counterpumping costs, it is important to understand how they were developed.

All corrective action cost estimates in the Preamble assumed a mid-case cost; i.e., a simple average of the costs of three types of treatment: activated carbon; reverse osmosis; and coagulation, flocculation, sedimentation and filtration. Table V-4 compares corrective action costs using each of the three types of treatment separately with corrective action costs using the average of the three. Hydraulic gradient and transmissivity are held at base case levels for all examples. The annual revenue requirements shown in the table assume that counterpumping starts in year 0 and continues for 20 years.

TABLE V-4
Annual Revenue Required For Corrective Action
Using Various Types of Treatment Technologies

	Quantity Treated		Average of 3 Treatment Cases	Type of Treatment ($ 000)		
	Pump Rate*	MT Per Year	(Base Case) ($ 000)	Carbon	Osmosis	Filtration
Strategy 1						
Small Plume (100 x 200 ft)	8	15,828	49	28	49	69
Large Plume (1000 x 2000 ft)	41	81,116	92	61	115	97
Strategy 2						
Small Plume (100 x 200 ft)	80	158,280	67	40	80	79
Large Plume (1000 x 2000 ft)	413	817,099	154	102	232	128

* In gallons per minute.

The table shows significant variation in the treatment costs and indicates that the type of treatment technology used can have a big impact on corrective action costs. Activated carbon systems appear to be the cheapest alternative under all conditions. Reverse osmosis costs appear to be comparable to other types of treatment for small plumes and under simple ground-water flow conditions, but is the most expensive treatment alternative when plumes are large or when flow conditions are complex.

Table V-4 also indicates that the average treatment cost used to develop the corrective action cost estimate for the Preamble appears to be reasonably close to the individual treatment costs. Other potentially less expensive alternatives, such as air stripping or using contract services rather than constructing permanent on-site facilities, were not fully analyzed.

The higher costs under Strategy 2 conditions reflect the higher pumping rates used. All treatment costs assume low concentrations of contaminants and constituents. Complex or highly contaminated plumes could significantly affect treatment costs.

D. Use of Slurry Walls

The Preamble provides a complete analysis of costs for only one type of corrective action technology -- counterpumping. However, owner/operators may find it advantageous to use slurry walls or other techniques to isolate plumes or to control their growth. Slurry walls are composed of bentonite or other admixed materials, and are constructed in the ground to completely surround and contain the plume. Walls can be used under a large range of hydrogeologic conditions and up to depths of 150 feet. However, as with counterpumping, their actual feasibility will depend on site-specific conditions. Capital costs for slurry walls depend primarily on plume perimeter, plume depth, and plume area (where surface sealing is done).

This section compares the costs of slurry walls with the costs for counterpumping on a total cost basis as well as on a site-specific basis. It also

examines the cost effectiveness of adding a small capacity fluid removal system inside the wall to manage water levels and prevent outward leakage of plume fluids. More detailed information on the assumptions and unit costs used to develop cost estimates for slurry walls can be found in Appendix D.

1. Comparison of Slurry Wall and Counterpumping Annual Revenue Requirements. Table 15 in Section IX.F of the Preamble provided an estimate for total corrective action costs of $677 million. This cost estimate assumes that 2,484 facilities will use Strategy 2 counterpumping beginning in year 0 and continuing for 150 years. Effects on total costs of using slurry walls instead of counterpumping were not estimated for the Preamble, although G&M examined this approach in their analysis. Table V-5 compares total corrective action costs assuming the use of slurry walls with total corrective action costs assuming Strategy 2 counterpumping.

Surface seals were included in the slurry wall design to limit fluid buildup inside the wall, thus reducing outward leakage. The surface area sealed equalled the area of the plume (the area of waste management facility) and the slurry wall's dimensions equalled the perimeter of the plume. Slurry wall costs assumed G&M's mid-wall cost of $5 per vertical foot and their high surface seal cost of $.75 per square foot.

TABLE V-5
Comparison of Total Corrective Action Costs
Using Counterpumping and Slurry Walls
($ 000 000)

	Low Estimate: Detect in Year 49 Take Action for 20 Years		High Estimate: Detect in Year 0 Take Action for 150 Years	
	Counterpumping	Slurry Wall	Counterpumping	Slurry Wall
Total Corrective Action Costs for 2,484 Facilities:	51	104	677	473-758†

† The low end of the range assumes that slurry walls are not replaced during the 150 year period. The high end of the range assumes that they must be replaced every 30 years.

The low end of the cost range ($473 million) estimated for slurry walls assumes that the wall does not need to be replaced during the 150-year period. The high end of the range ($758 million) assumes that walls must be replaced every 30 years, and is consistent with the assumption used to estimate counterpumping costs that the fluid removal and treatment system would need to be replaced every 30 years.[1]

For the high cost scenario, if it is assumed that slurry walls do not need replacement during the 150 year period, they appear to be much cheaper than counterpumping. This is largely due to: 1) the lower annual O&M costs estimated for slurry walls ($10,000 per year no matter how big the wall is to check for major leaks or significant plume migration beyond the wall) compared with $50,000 to $150,000 per year for counterpumping, depending on plume size; and 2) the fact that these costs (and the cost differences) occur every year for 150 years. For the low cost scenario, slurry walls appear to be more than twice as expensive as counterpumping. This is because the costs for both strategies occur so far out in the future (50-70 years) that discounting practically eliminates the disparity in the O&M costs between the two. However, the discounting can not fully eliminate the difference between the two sets of capital costs. Slurry wall capital costs are 2 to 7 times more expensive than the capital costs for a counterpumping system, depending on plume size.

Table V-6 indicates how slurry wall and counterpumping costs compare for specific plume sizes. The low ends of the ranges indicate the low cost corrective action scenario (beginning in year 49 and continuing for 20 years) while the high estimates assume action for 150 years beginning in year 0.

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[1] Although slurry wall capital costs are incurred five times in the high cost case and only once in the low cost case, the annual revenue requirement for the high estimate is less than twice that for the low estimate because of discounting far into the future and because of additional depreciation tax shields.

TABLE V-6
Comparison of Slurry Wall and Counterpumping Annual Revenue Requirements
For Small and Large Plumes
($ 000)

	Small Plume (100 ft.x 200 ft.)	Large Plume (1,000 ft. x 2,000 ft)
Slurry Wall		
- Wall is not Replaced	7 - 44	69 - 305
- Wall Replaced Every 30 Years	7 - 58	69 - 497
Counterpumping		
- Strategy 1	11 - 102	21 - 187
- Strategy 2	16 - 141	36 - 314

The table shows that walls tend to be cheaper for smaller plumes but are much more expensive for larger plumes. For a small plume under the 0/150 year scenario, Strategy 2 counterpumping is about 2.5 times more expensive than a slurry wall (even assuming wall replacement every 30 years). However, for a large plume, the slurry wall is more than 1.5 times more expensive than counterpumping (where it is assumed that both must be replaced every 30 years). This is because slurry wall costs are more dependent on plume size than are counterpumping costs. As plume sizes increase the ratio of slurry wall costs to counterpumping costs will also increase.

2. Combining a Small Capacity Fluid Removal System With a Slurry Wall

Under certain conditions, it may be attractive for facilities to install a small capacity fluid removal system inside the wall to prevent outward leakage of plume fluids. Owner/operators may find this approach financially attractive where the alternative is to pump at a high rate (due to high aquifer discharge rates) for a long period of time. It is also likely to be more attractive for small plumes than for large plumes. Permit writers may find the approach attractive because it provides containment while minimizing impacts on surrounding ground-water systems.

Table V-7 compares the cost of the slurry wall and small fluid removal system to the cost of a full-scale fluid removal (counterpumping) system.

TABLE V-7
Cost of Counterpumping Compared to Slurry Wall Cost
Where Low Pumping Rate is used to Limit Fluid Migration Through the Wall
($ 000)

	Small Plume (100x200)	
	Strategy 2 Counterpumping	Slurry Wall + Pumping at Low Rate
1. Amount of Contaminated Ground Water Requiring Treatment (MT/Year)*	189	<.5
2. Annualized Corrective Action Cost†	140	83
3. Annualized Funds Available For Shipping/Treatment	-	57
4. Annual Funds Available For Shipping/Treatment§	-	26
5. Distance Pumped Water Could Be Shipped with Available Funds**	-	517

* These quantities reflect pumping rates of 22 million gallons per year (counterpumping only) and 50,000 gallons per year (slurry wall + pumping).

† Annualized costs based on corrective action beginning in Year Zero and continuing 150 years.

§ Assumes 150 years of annual shipping and treatment costs at 3 percent real discount rate.

** Assumes $.15 per ton-mile shipping cost and $60 per MT treatment cost.

The table assumes that for a small plume (100 ft x 200 ft) with a slurry wall in place, pumping rates of about 50,000 gallons per year[1] (<.5 metric tons per year) would be sufficient to control any leakage of plume fluids through the wall. This pumping rate compares to an annual rate of 22 million gallons (189 metric tons) per year, which would be required where counterpumping is the only corrective action measure used. Line 2 of the table compares the costs of the two options and line 3 indicates the cost savings to the owner/operator of selecting the "slurry wall plus pumping" option. Because the

1 Based on information provided by Geraghty & Miller.

quantity of liquid requiring treatment would be so small under the slurry wall plus pumping option, on-site treatment would probably not be cost-effective. Therefore, it was assumed that the site owner/operator would ship the water off-site for treatment. Line 4 shows the annual funds that would be available (savings) each year over the 150-year corrective action period that could be used to offset costs to ship the contaminated ground water off-site for treatment. Line 5 indicates that the owner/operator could afford to ship the ground water 517 miles (assuming a shipping cost of $.15 per mile and treatment cost of $60 per metric ton) with the money saved by selecting the slurry wall option in lieu of counterpumping.

Reducing the pumping rates even more would enable contaminated liquids to be shipped even further. For example, if pumping rates could be reduced to 10,000 gallons per day, an owner/operator could afford to ship contaminated ground water up to 4,126 miles before the wall/pumping combination would become less attractive than counterpumping alone. The costs of the slurry wall/pumping option would be even more attractive under more pessimistic assumptions regarding gradient and transmissivity because these changes would not affect the costs of the combination approach. However, the slurry wall/pumping combination would be much less attractive with deeper plumes, and infeasible at depths greater than 150 feet.

CHAPTER VI

ASSUMPTIONS AND METHODOLOGY USED TO CALCULATE ANNUAL REVENUE REQUIREMENTS

This chapter describes the methodology and economic assumptions SCI used to convert the ISS baseline cost streams, the Part 264 D&O cost streams, and the Part 264 corrective action cost streams (described in Chapters III, IV, and V) into annual revenue requirements. Annual revenue requirements measure the incremental revenues that an individual landfill, surface impoundment, land treatment areas, or waste piles would need to obtain -- through increased prices for its products or for its waste management services -- in each year of operation to offset the costs of the regulations. SCI developed models to calculate annual revenue requirements for the baseline cost streams and for the baseline plus Part 264 cost streams. The difference between the two was determined to be the incremental annual revenue requirement resulting from the Part 264 regulations.

The models also calculated first year cash requirements as a measure of what the maximum impact of the regulations could be for an individual land disposal unit or a facility in any single year. Both the annual revenue requirements and the first year cash requirements were used to determine the impacts of the regulations on specific industries, as will be described in Chapter VIII.

The economic assumptions and the discounted cash flow methodology used in the models are summarized below. An example of how the annual revenue requirements was calculated for a 35,000 metric ton/year on-site landfill is also presented. The example includes only costs incurred during the operating lives of each facility. Post closure cash flows, and any cash flows that would result from corrective action are excluded from the simplified example.

A. Economic Assumptions Used In Calculating Annual Revenue Requirements

1. Remaining operating life. All units and facilities were assumed to have 20-year remaining operating lives. Baseline and Part 264 initial capital costs were always incurred in Year 0, and plant O&M costs were incurred in years 1 through 20. Closure of the unit always occurred in year 20. All baseline costs and costs resulting from the Part 264 requirements were annualized over the 20-year remaining operating life.

2. Types of costs considered. Costs were broken out into several categories for purposes of calculating net present values and annual revenue requirements. Categories used were as follows:

Capital:	Costs such as infrastructure construction or surface impoundment capping that are depreciable. Most capital costs occurred in year 0, although for some facilities capital costs also occurred in year 20, at closure.
Initial Year:	Costs such as initial reporting requirements that occur in year zero and cannot be depreciated.
Annual:	Costs that occur in each operating year such as groundwater sampling and analysis.
Last Year:	Costs such as decontamination and closure certification that occur in year 20 and that cannot be depreciated.
Intermittent:	Costs such as dredging that occur periodically throughout the operating life or post closure period of the facility.

3. Depreciation Method Used. Using the straight-line depreciation method, capital costs were depreciated over five years.

4. Tax Rate. An effective tax rate of 50 percent was assumed. No investment tax credits were applied.

5. Inflation Rate. All costs incurred after the zero (base) year were inflated at a rate of 8 percent per year.

6. Discount Rate (Rate of Return). A real rate of return of 3 percent was used. Adjusting for inflation, the discount rate was 11.24 percent.

7. Capital Recovery Factor (annuity factor for repaying a present value). The equation used to calculate the Capital Recovery Factor (CRF) is:

$$CRF = \frac{i*(1+i)^n}{(1+i)^{n-1}}$$

where i = 3 percent; and
n = the remaining operating life of the facility (20 years).

This results in a capital recovery factor (CRF) of 0.0672.

B. Methodology for Annual Revenue Requirement Calculations

The models performed the following calculations to derive the annual revenue requirements for the baseline costs and Part 264 costs for all unit sizes and types of processes included in the analysis. The results are summarized in Chapter VII, and are presented in greater detail in Appendix D.

1. All costs were categorized as capital, initial, annual, etc., as shown in Appendix B. Costs incurred after the zero (base) year were inflated, using the 8 percent inflation rate.

2. All capital costs were depreciated using a 5-year straight line depreciation schedule.

3. Aftertax cash flows for each year were calculated as follows:

(Tax Rate * Depreciation) - Capital Costs - [(1 - Tax Rate) * (Initial Costs + Annual + Intermittent Costs + Last Year Costs)]

4. The present value was obtained by discounting the aftertax cash flows using a nominal discount rate of 11.24 percent.

5. The annualized aftertax cost was calculated by multiplying the present value by the capital recovery factor (0.0672).

6. The beforetax revenue requirement was obtained by dividing the annualized cost by (1 minus the tax rate).

C. Calculating First Year Cash Requirements and Annual Revenue Requirements

This section provides examples of how first year cash requirements (FYC) and annual revenue requirements (ARR) were calculated for a 35,000 metric ton/year landfill and a 1/4 acre surface impoundment.

1. Landfill example. The cash flows attributable to baseline requirements and Part 264 requirements for a typical 35,000 metric ton/year on-site landfill are provided in Table VI-1. Part 264 costs in the Table assume the use of a single synthetic liner design. The first five columns show the capital, depreciation, initial, annual, and last year cash flows, and the year in which they are incurred during the operating life of the landfill. The sixth column provides the discounted present value (after taxes) of these cash flows. For each year (N), column (6) was calculated as follows:

$$(6) = \frac{[(1)-(2)*TAX+(3)*(1-TAX)+(4)*(1-TAX)-(5)*(1-TAX)]}{1.1124^N} \quad ; \text{ where } TAX=.5$$

Inputs used to derive these numbers were taken from Appendices B and C. The Part 264 inputs reflect "full cost" scenarios (i.e. costs input for Part 264 reflect the baseline plus incremental Part 264 costs). As Table VI-1 indicates, there are no incremental (above the baseline) Part 264 capital costs. Capital costs under the baseline as well as under Part 264 are $240,000. This is because Part 264 liner costs are included as annual expenses rather than capital costs. Baseline initial costs are $363,000 while Part 264 initial costs are $616,000. The Part 264 initial costs were calculated by backing out Pre-ISS excavation ($189,000) from the baseline initial costs and adding in the Part 264 liner system ($442,000 including fees). Baseline annual costs are $822,000 and Part 264 annual costs are $1,091,000. The Part 264 annual costs were calculated by backing out Pre-ISS excavation and Pre-ISS and ISS incremental closure costs ($39,000 and $297,000 respectively), and adding in the Part 264 liner and cover systems ($442,000 and $352,000 respectively). Last year costs under the baseline and Part 264 represent decontamination and certification costs ($6,000), and an adjustment to the year 20 annual costs. The adjustment is necessary because the annual costs include construction and closure of one

cell; however, in the last year, no cell is constructed. Thus, last year costs for the baseline are -$183,000 ($6,000 less a backing out of $189,000 for cell excavation). Last year costs for Part 264 are -$436,000 ($6,000 less a backing out of $442,000 for excavation and liner).

TABLE VI-1
Cash Flows and Present Values Over 20-Year Operating Life
For 35,000 Metric Ton/Year Landfill
($ 000)

Year	(1) Capital Base;264	(2) Depreciation Base;264	(3) Initial Yr. Base;264	(4) Annual Costs Base;264	(5) Last Year Base;264	(6) PV Base;264
0	240		363;616			421;548
1		240/5;240/5		$822*1.08^{1}$;$1091*1.08^{1}$		378;508
2		240/5;240/5		$822*1.08^{2}$;$1091*1.08^{2}$		368;495
3		240/5:240/5		$822*1.08^{3}$;$1091*1.08^{3}$		359;482
4		240/5;240/5		$822*1.08^{4}$;$1091*1.08^{4}$		349;469
5		240/5;240/5		$822*1.08^{5}$;$1091*1.08^{5}$		340;456
6				$822*1.08^{6}$;$1091*1.08^{6}$		344;457
7				$822*1.08^{7}$;$1091*1.08^{7}$		334;444
8				$822*1.08^{8}$;$1091*1.08^{8}$		324;431
9				$822*1.08^{9}$;$1091*1.08^{9}$		315;418
10				$822*1.08^{10}$;$1091*1.08^{10}$		306;406
11				$822*1.08^{11}$;$1091*1.08^{11}$		297;394
12				$822*1.08^{12}$;$1091*1.08^{12}$		288;383
13				$822*1.08^{13}$;$1091*1.08^{13}$		280;371
14				$822*1.08^{14}$;$1091*1.08^{14}$		272;361
15				$822*1.08^{15}$;$1091*1.08^{15}$		264;350
16				$822*1.08^{16}$;$1091*1.08^{16}$		256;340
17				$822*1.08^{17}$;$1091*1.08^{17}$		249;330
18				$822*1.08^{18}$;$1091*1.08^{18}$		241;320
19				$822*1.08^{19}$;$1091*1.08^{19}$		234;311
20				$822*1.08^{20}$;$1091*1.08^{20}$	$183*1.08^{20}$;$436*1.08^{20}$	217;276

	Baseline/Part 264	Incremental Part 264
Total Aftertax NPV	6436/8550	2114
Beforetax Annual Revenue Requirement	865/1149	284
First Year Cash Requirement	603/856	253

NOTE: Results of above calculation may differ slightly from those shown in Appendix E because of rounding.

CHAPTER VII

RESULTS OF COST ANALYSIS

This chapter presents the results of the cost analysis for individual disposal processes. First, for different sizes of landfills, surface impoundments, land treatment areas, and waste piles, the incremental annual revenue required and first year cash required to offset costs of Part 264 D&O and corrective action regulations are reviewed. Second, the aggregate costs for each of the different processes based on the distributions discussed in Chapter II are presented. Finally, the range of total incremental costs that could result from the Part 264 regulations is reviewed.

A. Cost Estimates For Individual Processes By Size

1. Landfill Costs. Table VII-1 presents the Part 264 incremental annual revenue requirements for the eight different sizes of landfills studied. For each size, annual revenue requirements for single synthetic liner, double liner, and double synthetic liner designs[1] are given on a per ton as well as on a per year basis. The estimates are for D&O costs only and do not include corrective action costs.

The table indicates the increased costs that individual landfill units of different sizes are likely to face as a result of the Part 264 regulations. The costs presented in Table VII-1 assume that owner/operators would incur the cost of the liner system (liner and cap) every year for 20 years because of the assumption that a new cell is opened and closed each year of the facility's remaining operating life. Thus, if the owner/operator of a 7,000 metric ton per year (MT/yr) landfill elects to comply with the Part 264 regulations by installing a double liner system in each new cell he opens over the next 20

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1 Liner designs as used in this chapter include both liners and caps.

years, he can expect to incur annualized incremental costs (above the baseline) of $207,000 per year, or $30 per ton.

TABLE VII-1
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 D&O Regulations:†
Landfills by Unit Size

SIZE MT/yr†	Single Synthetic Liner per year ($ 000)	Single Synthetic Liner $ per MT*	Double Liner (Synthetic/Clay) per year ($ 000)	Double Liner (Synthetic/Clay) $ per MT*	Double Synthetic Liner per year ($ 000)	Double Synthetic Liner $ per MT*
500	31	62	52	104	43	86
2,000	49	25	94	47	82	41
5,000	79	16	164	33	145	29
7,000	98	14	207	30	184	26
15,000	149	10	323	22	290	19
35,000	277	8	622	18	561	16
60,000	379	6	862	14	779	13
123,000	566	5	1,306	11	1,180	10

† Costs shown are those estimated for on-site landfills in these size categories. They are slightly different from costs estimated for off-site landfills. If costs were for off-site landfills, double liner (synthetic/clay) costs would be lower than double synthetic liner costs.

* MT indicates metric ton.

Table VII-2 shows the additional annual revenue required if corrective action is needed.

TABLE VII-2
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 Corrective Action Regulations:†
Landfill Units by Size

SIZE MT/yr	Detect Year 0 Pump 150 Years per year ($ 000)	Detect Year 0 Pump 150 Years $ per MT	Detect Year 0 Pump 20 Years per year ($ 000)	Detect Year 0 Pump 20 Years $ per MT	Detect Year 49 Pump 20 Years per year ($ 000)	Detect Year 49 Pump 20 Years $ per MT
500	138 - 198	276 - 396	65 - 95	130 - 190	17 - 24	34 - 48
2,000	149 - 225	75 - 113	71 - 109	36 - 55	18 - 27	9 - 14
5,000	172 - 267	34 - 53	82 - 128	16 - 26	21 - 31	4 - 6
7,000	178 - 275	25 - 39	85 - 132	12 - 19	21 - 32	3 - 5
15,000	194 - 309	13 - 21	93 - 148	6 - 10	24 - 36	2 - 2
35,000	216 - 361	6 - 10	104 - 174	3 - 5	26 - 42	1 - 1
60,000	232 - 391	4 - 6	113 - 190	2 - 3	28 - 46	* - 1
123,000	252 - 422	2 - 3	123 - 206	1 - 2	30 - 50	* - *

† Ranges reflect difference in costs between counterpumping strategies 1 and 2. (See Chapter V for a description of the strategies.)

* Less than 50 cents.

For the example given above, if the facility initiates a counterpumping program that starts in year zero and continues for 20 years, the additional annualized costs would be $85,000 to $132,000, or $12 to $19 per ton, depending on the counterpumping strategy employed.

Table VII-3 shows the incremental first year cash requirements for each landfill size due to the Part 264 regulations. These represent the maximum impact the regulations are likely to have in any given year. For the 7,000 MT/yr landfill, first year costs would be $196,000 more than under the ISS baseline, assuming a double liner system is installed. If corrective action is needed immediately, first year costs would increase by an additional $265,000 to $415,000.

First year cash and annual revenue required to offset incremental Part 264 D&O costs are very similar for landfills. This is because of the assumptions that a new cell is opened every year and must be constructed with a Part 264 liner design.

TABLE VII-3
First Year Costs Resulting from Part 264 Regulations:
Landfills by Unit Size
($ 000)

	First Year Costs For:	
	Basic D&O	Corrective Action
SIZE (MT/Yr)	Double Liner System	Immediate Counterpumping*
500	50	185 - 295
2,000	91	205 - 365
5,000	156	255 - 405
7,000	196	265 - 415
15,000	305	315 - 465
35,000	584	375 - 585
60,000	810	425 - 685
123,000	1,226	475 - 795

* Range of counterpumping costs reflects cost difference between Strategy 1 and Strategy 2

2. Surface Impoundment Costs. Table VII-4 shows the incremental annual revenue required to offset costs of the part 264 D&O regulations for six different sizes of surface impoundments. Costs are given for the three alternative compliance paths available to surface impoundment owner/operators:

- o no action, where a surface impoundment that shows no evidence of leakage merely continues ground-water monitoring activities;
- o retrofitting the facility, where the facility is closed temporarily and relined according to the requirements specified in the Part 264 regulations; or
- o closing the present impoundment permanently, and replacing it with a new impoundment that is constructed according to Part 264 specifications.

For both the retrofit and close/replace cases, annual revenue requirements are estimated for the same three liner systems costed for landfills. Thus, a one acre facility that chooses to retrofit using a double liner would incur incremental annualized costs of $37,000. This compares to an annual revenue requirement of $10,000 to $16,000, if the same size facility continues ground-water monitoring and never detects leakage from the impoundment.

TABLE VII-4
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 D&O Regulations:†
Surface Impoundments by Unit Size
($ 000)

		Retrofit Cases			Replacement Cases		
Size (Acres)	No Action Case*	Single Synthetic Liner	Double Liner	Double Synthetic Liner	Single Synthetic Liner	Double Liner	Double Synthetic Liner
1/4	4 - 6	9	13	9	19	23	18
1/2	6 - 9	15	22	18	26	31	27
1	10 - 16	25	37	34	35	45	42
2	16 - 25	48	71	71	59	78	76
5	48 - 81	92	148	157	106	153	156
11	95 - 157	228	348	374	252	354	367

† Because the landfill annual revene requirement estimates do not account for the cost transfers resulting from surface impoundment dredging disposal, the costs in Table VII-1 are somewhat overstated.

* For the no action case, it was assumed that dredged material is disposed of in a 123,000 MT/yr off-site landfill with any one of the three Part 264 liners costed. For the retrofit and replace cases, the landfill disposal sites were assumed to have the same liner as the surface impoundment. In all cases, no corrective action at the landfill was assumed. If corrective action was assumed, costs would be slightly higher.

Table VII-5 gives the additional annual revenue required if surface impoundments must undertake corrective action. In the example above, if the facility needs to take corrective action immediately and pumps for 20 years, the additional annual revenue requirement would be $61,000 to $86,000, depending on the counterpumping strategy used.

TABLE VII-5
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 Corrective Action Regulations:
Surface Impoundments by Unit Size
($ 000)

Size (Acres)	Range of Counterpumping Costs* Detect Year 0 Pump 150 Years	Detect Year 0 Pump 20 Years	Detect Year 49 Pump 20 Years
1/4 & 1/2†	122 - 163	58 - 77	15 - 19
1	128 - 180	61 - 86	16 - 22
2	138 - 198	65 - 95	17 - 24
5	149 - 225	71 - 109	18 - 27
11	169 - 261	81 - 125	20 - 31

† Costs for plumes associated with surface impoundments smaller than 1/2 acre were not estimated. Cost reported is for a 1/2 acre facility.

* Range of counterpumping costs under each option reflects cost difference between Strategy 1 and Strategy 2.

Table VII-6 shows the additional first year cash required for surface impoundments of different sizes assuming no action, corrective action, unit retrofitting, and unit replacement. For the 1 acre surface impoundment, first year costs would be $2,000 if no action is taken. Where the facility retrofits to comply with the Part 264 requirements, incremental first year costs would be $442,000. First year costs would be $390,000 if the facility is replaced. Where corrective action must be undertaken immediately, first year costs would increase by an additional $169,000 to $254,000.

TABLE VII-6
First Year Costs Resulting from Part 264 Regulations:
Surface Impoundments by Unit Size
($ 000)

Size (Acres)	Incremental First Year Costs For: No Action	Corrective Action: Immediate Counterpumping†	Facility Alteration: Retrofit Liner	Facility Alteration: Replace Facility
1/4	*	159 - 209	123	142
1/2	1	159 - 209	226	220
1	2	169 - 254	442	390
2	3	189 - 299	862	718
5	8	209 - 369	2,141	1,765
11	18	254 - 399	4,622	3,868

† Assumes corrective action begins in year zero. The range of counterpumping costs reflects cost difference between Strategy 1 and Strategy 2.

* Less than $500.

3. Land Treatment Costs. Table VII-7 shows the incremental annual revenue requirements that would be incurred by five sizes of land treatment units due to the Part 264 regulations. The table shows that a 74 acre unit would need incremental annual revenues of $122,000 to recoup the D&O costs of the regulations.

TABLE VII-7
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 D&O Regulations:
Land Treatment by Unit Size
($ 000)

Size (Acres)	Basic D&O Cost: Per Land Treatment Unit	Basic D&O Cost: $ Per Ton*
1.7	17	48
6.5	19	14
20.1	45	11
74.3	122	8
247.1	361	7

* Based on an average application rate of 206 MT per acre per year. In practice the annual amount of waste applied per acre is highly variable.

Table VII-8 shows the additional revenue required if corrective action is needed. For the 74 acre unit discussed above, if counterpumping is required in year zero and continues for 20 years, the additional annualized costs would be $109,000 to $180,000, depending on the counterpumping strategy employed.

TABLE VII-8
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 Corrective Action Regulations:
Land Treatment Units By Size
($ 000)

SIZE (Acres)	Range of Counterpumping Costs* Detect Year 0 Pump 150 Year	Detect Year 0 Pump 20 Years	Detect Year 49 Pump 20 Years
1.7	134 - 187	63 - 89	16 - 22
6.5	154 - 236	73 - 114	19 - 28
20.1	178 - 276	85 - 133	21 - 33
74.3	225 - 371	109 - 180	27 - 44
247.1	285 - 472	140 - 234	34 - 56

* Range of counterpumping costs under each option reflects cost difference between Strategy 1 and Strategy 2.

Table VII-9 gives the Part 264 incremental first year costs for land treatment areas.

TABLE VII-9
First Year Costs Resulting from Part 264 Regulations:
Land Treatment by Unit Size
($ 000)

SIZE (Acres)	First Year Costs For: Basic D&O	Corrective Action Immediate Counterpumping*
1.7	76	175 - 265
6.5	81	205 - 365
20.1	103	265 - 425
74.3	134	395 - 625
247.1	226	565 - 1,025

* Assumes corrective action begins in year zero. The range of counterpumping costs reflects cost difference between Strategy 1 and Strategy 2.

For the 74 acre unit, $134,000 would be spent in the first year because of the regulations. If corrective action is necessary in the first year for the same facility, an additional $395,000 to $625,000 more would be spent.

4. Waste Pile Costs. Annual revenue requirements due to the Part 264 D&O requirements for waste piles are presented in Table VII-10. For each of the six pile sizes, three compliance options were costed: ground-water monitoring, base inspection, and installation of a double synthetic liner base system. Thus, the owner/operator of a 10,000 cubic foot pile choosing the ground-water monitoring option would require annual revenues of about $17,000 over the remaining life of the facility (20 years) to offset his Part 264 compliance costs.

TABLE VII-10
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 D&O Regulations:†
Waste Piles by Unit Size*
($ 000)

	Compliance Options		
SIZE (000 ft^3)	Ground-Water Monitoring	Base Inspection	Liner and Leachate Collection System
2	15	7	7
10	17	9	9
25	21	13	13
100	27	20	19
500	27	23	17
1,000	26	27	15

† Because the landfill annual revene requirement estimates do not account for the cost transfers resulting from waste pile disposal, the costs in Table VII-1 are somewhat overstated.

* Costs for waste piles sized at 2,000 to 25,000 cubic feet assume a 1 year pile life (i.e. piles are built up and disposed of every year). Costs for a 100,000 cubic foot pile assume a 2 year pile life, costs for a 500,000 cubic foot pile assume a 10 year pile life, and costs for a 1,000,000 cubic foot pile assume a 20 year pile life. All sizes retain their base for 20 years. Completed piles are assumed to be disposed of in a 123,000 MT off-site landfill with a Part 264 double liner. At closure, the pile, base and contaminated subsoils are disposed of similarly.

Table VII-11 shows the additional annual revenue requirements associated with corrective action for each pile size if it is needed. For the 10,000 cubic foot pile, if pumping is necessary from year zero to year 20, the maximum costs incurred would be $71,000 to $93,000, depending on the counterpumping strategy used.

TABLE VII-11
Annual Revenue Required to Offset
Incremental Costs Due to Part 264 Corrective Action Regulations:
Waste Piles by Unit Size†
($ 000)

SIZE (000 ft^3)	Detect Year 0 Pump 150 Years	Detect Year 0 Pump 20 Years	Detect Year 49 Pump 20 Years
2 - 500	[150 - 196]	[71 - 93]	[18 - 23]
1,000	153 - 207	72 - 98	18 - 24

† Costs for plumes associated with waste piles smaller than 500,000 cubic feet were not estimated. Cost reported is for a 500,000 cubic foot pile.

Table VII-12 shows the Part 264 incremental first year cash requirements by size for the three waste pile D&O options and for counterpumping. The table shows that the owner/operator of a 10,000 cubic foot pile who elects to comply with the Part 264 regulations by initiating a ground-water monitoring program would spend $44,000 in the first year. If corrective action is needed immediately, an additional $165,000 to $237,000 (as upper bounds) would be spent in the first year.

TABLE VII-12
First Year Costs Resulting from Part 264 Regulations:
Waste Piles by Unit Size
($000)

SIZE (000 ft^3)	Ground-water Monitoring	Inspect Base	Double Synthetic Liner	Immediate Counterpumping
2	44	4	12	*
10	44	4	12	*
25	44	4	12	*
100	44	4	12	*
500	44	4	14	165 - 237
1,000	44	4	17	170 - 265

* Counterpumping costs were not estimated for these pile sizes. Costs for 500,000 cubic foot pile provide an upper bound.

B. Total Cost Estimates

1. Landfill Total Costs. Table VII-13 lists the total ISS and incremental Part 264 costs for all landfills units. Total landfill costs were calculated by multiplying the number of landfills in each size category by the unit costs that were provided in the previous section, and summing across all landfill sizes. Table VII-13 lists total costs for basic D&O as well as for D&O plus corrective action. Total costs are provided for all three sets of counterpumping timing assumptions for both Strategy 1 and Strategy 2 conditions, as well as for the three landfill liner systems.

TABLE VII-13
Total ISS and Incremental Part 264
Annual Revenue Requirements for Landfills*
(in Millions of Dollars)

			Incremental Costs of Part 264 Designs		
		ISS Costs	Single Synthetic Liner	Double Liner	Double Synthetic Liner
Basic D&O		300.6	81.4	157.2	159.4
D&O plus CP-1	49-69	-	93.5	169.2	171.5
CP-2	49-69	-	99.6	175.3	177.6
D&O plus CP-1	0-20	-	129.2	204.9	210.0
CP-2	0-20	-	155.3	231.1	236.2
D&O plus CP-1	0-150	-	181.4	257.2	264.4
CP-2	0-150	-	234.7	310.5	317.6

* These cost estimates do not account for transfer payments resulting from either dredged material from surface impoundments or waste pile disposal, and are therefore overstated.

The Table shows, for example, that if all landfills complied with the Part 264 regulations by installing double liner designs, the total incremental annual revenue required would be $157 million. If all landfills needed to take corrective action immediately and had to counterpump for 20 years, total incremental costs would be $205 to $231 million, depending on the counterpumping strategy employed.

Table VII-14 shows the total ISS and Part 264 incremental first year cash requirements for landfills. Corrective action timing and liner design assumptions are the same as in Table VII-13. For the example used above, incremental first year cash requirements for D&O alone would be $147.5 million. Costs for D&O plus corrective action starting in year 0 would be $313 to $405 million, depending on the pumping strategy used.

TABLE VII-14
Total ISS and Incremental Part 264
First Year Cash Requirements for Landfills
(in Millions of Dollars)

			Part 264 Incremental Costs		
		ISS Cost	Single Synthetic Liner	Double Liner	Double Synthetic Liner
Basic D&O		260.9	75.4	147.5	147.5
D&O plus CP-1	49-69	-	75.4	147.5	147.5
CP-2	49-69	-	75.4	147.5	147.5
D&O plus CP-1	0-20	-	240.5	312.6	312.6
CP-2	0-20	-	332.9	405.0	405.0
D&O plus CP-1	0-150	-	240.5	312.6	312.6
CP-2	0-150	-	332.9	405.0	405.0

2. Surface Impoundment Total Costs. Table VII-15 shows the total ISS and incremental Part 264 costs for surface impoundments, based on the unit costs by size contained in Section A.2 of this chapter and on the distribution of surface impoundments by size described in Chapter 2. The table includes Part 264 D&O costs for three compliance options: perform detection monitoring only, retrofit the existing impoundment, and replace the current impoundment. The three different liner designs are costed for both the retrofit and replace cases. In addition, costs for both Strategy 1 and Strategy 2 counterpumping for the three different time periods studied are included in the table. Thus, if all facilities chose to retrofit with double liners, and all needed to perform corrective

action (under strategy one) for years 0 through 20, the total incremental Part 264 annual revenue requirement would be about $639 million.

TABLE VII-15
Total ISS and Incremental Part 264
Annual Revenue Requirements for Surface Impoundments
(in Millions of Dollars)

		Part 264 Incremental Costs		
	ISS Cost	Single Synthetic Liner	Double Liner	Double Synthetic Liner
Basic D&O†	534.0	101.9	139.8	166.4
Retrofit D&O	-	242.8	369.2	379.2
Replace D&O	-	297.0	404.7	401.0
CP-1 49-69	-	69.3	69.3	69.3
CP-2 49-69	-	94.9	94.9	94.9
CP-1 0-20	-	270.3	270.3	291.5
CP-2 0-20	-	381.5	381.5	402.7
CP-1 0-150	-	568.0	568.0	606.2
CP-2 0-150	-	807.4	807.4	839.2

† Costs for basic D&O differ with liner type because of different costs of disposal in offsite landfills (assumed to have different liners).

Table VII-16 shows the total ISS and Part 264 incremental first year cash requirements for surface impoundments. As with Table VII-15 above, requirements for corrective action are shown separately from D&O costs. Total first year costs for the example given above would be about $5.3 billion ($4.5 billion for D&O plus $.8 billion for counterpumping).

TABLE VII-16
Total ISS and Incremental Part 264
First Year Cash Requirements for Surface Impoundments
(in Millions of Dollars)

	ISS Cost	Part 264 Incremental Costs: Single Synthetic Liner	Double Liner	Double Synthetic Liner
Basic D&O	1001.9	17.5	17.5	17.5
Retrofit D&O	-	3325.6	4569.4	4765.0
Replace D&O	-	3129.6	4077.5	4075.2
CP-1 49-69	-	0.0	0.0	0.0
CP-2 49-69	-	0.0	0.0	0.0
CP-1 0-20	-	773.4	773.4	773.4
CP-2 0-20	-	1126.2	1126.2	1126.2
CP-1 0-150	-	773.4	773.4	773.4
CP-2 0-150	-	1126.2	1126.2	1126.2

3. Land Treatment Total Costs. Table VII-17 shows the total ISS and incremental Part 264 costs for land treatment areas. Total costs were derived by multiplying the first year unit costs calculated for each land treatment size by the number of units in each size category, and summing across all size categories. The table lists total Part 264 D&O costs and total D&O plus corrective action costs, assuming three counterpumping timing periods for both strategies 1 and 2. The table indicates that total incremental Part 264 D&O costs are estimated to be $20 million. If all land treatment areas needed to take corrective action immediately and counterpumped for 20 years, total annual revenue requirements could range from $41 to $53 million, depending on the pumping strategy used.

TABLE VII-17
Total ISS and Incremental Part 264
Annual Revenue Requirements for Land Treatment Facilities
(in Millions of Dollars)

		ISS Costs	Part 264 Incremental Costs
Basic D&O		51.1	20.4
D&O plus CP-1	49-69	-	25.6
CP-2	49-69	-	28.4
D&O plus CP-1	0-20	-	41.2
CP-2	0-20	-	53.0
D&O plus CP-1	0-150	-	63.8
CP-2	0-150	-	87.7

Table VII-18 shows the total ISS and Part 264 incremental first year cash requirements for land treatment areas. For the example used above, total incremental Part 264 first year cash requirements could range from $96 million to $142 million depending on which counterpumping strategy is used. About $27 million of the total would be for D&O.

TABLE VII-18
Total ISS and Incremental Part 264
First Year Cash Requirements for Land Treatment Facilities
(in Millions of Dollars)

		ISS Costs	Part 264 Incremental Costs
Basic D&O		47.5	26.9
D&O plus CP-1	49-69	-	26.9
CP-2	49-69	-	26.9
D&O plus CP-1	0-20	-	95.8
CP-2	0-20	-	141.7
D&O plus CP-1	0-150	-	95.8
CP-2	0-150	-	141.7

4. Waste Pile Total Costs. Table VII-19 shows the total ISS and incremental Part 264 costs for waste piles, derived by multiplying the unit costs by size calculated in Section A by the number of waste piles in each size category,

and summing across all size cateogories. The table includes total Part 264 incremental D&O costs for three different compliance options: ground-water monitoring, base inspection, and double liner and leachate detection system. The table also provides total D&O plus corrective action costs using three counterpumping timing assumptions for the two counterpumping strategies examined in the analysis. All costs in the table assume that wastes are disposed of at closure[1] in a 123,000 MT offsite landfill with a double liner (synthetic and clay). Based on the costs presented in Table VII-19, if all waste pile owner/operators choose the base inspection option, total incremental annual revenue requirements for D&O would be about $8 million. If all waste pile units need corrective action immediately and counterpump for 20 years, total incremental costs would be $48 to $61 million, depending on the pumping strategy employed.

TABLE VII-19
Total ISS and Incremental Part 264
Annual Revenue Requirements for Waste Piles
(in Millions of Dollars)

		ISS Costs	Part 264 Incremental Costs		
			H_2O Mon.	Inspect	Liner/Leach.
Basic D&O		16.4	11.9	7.8	6.8
D&O plus CP-1	49-69	-	21.6	17.5	16.5
CP-2	49-69	-	24.7	20.6	19.6
D&O plus CP-1	0-20	-	49.0	48.0	47.0
CP-2	0-20	-	62.6	61.5	60.5
D&O plus CP-1	0-150	-	89.9	91.2	90.2
CP-2	0-150	-	118.3	119.6	118.6

Table VII-20 shows the total ISS and Part 264 incremental first year cash requirements for waste piles. For the example given above, incremental first

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1 Closure can occur each year for small piles, although the life of the base is assumed to be 20 years for all waste pile sizes.

year D&O costs would be about $2 million without any corrective action, and about $105 million assuming Strategy 1 counterpumping.

TABLE VII-20
Total ISS and Incremental Part 264
First Year Cash Requirements for Waste Piles
(in Millions of Dollars)

		ISS Costs	Part 264 Incremental Costs		
			H_2O Mon.	Inspect	Liner/Leach.
Basic D&O		55.0	26.8	2.4	7.6
D&O plus CP-1	49-69	-	26.8	2.4	7.6
CP-2	49-69	-	26.8	2.4	7.6
D&O plus CP-1	0-20	-	129.8	105.4	110.7
CP-2	0-20	-	174.7	150.4	155.6
D&O plus CP-1	0-150	-	129.8	105.4	110.7
CP-2	0-150	-	174.7	150.4	155.6

D. Calculating Total Incremental Costs of the Regulations

Total D&O costs calculated for each of the four disposal processes were summed to estimate a range of possible total D&O costs imposed by the Part 264 regulations. Total D&O costs needed to be adjusted for the internal transfer payments or "doublecounting" which resulted because the annual revenue requirements calculated for landfills did not account for the moneys paid to landfills by surface impoundments and waste piles to have wastes disposed of.

Total corrective action costs were calculated on a facility basis. Counterpumping costs calculated for each average facility size were multiplied by the number of facilities in that size category, and summed across all facility sizes to derive total corrective action costs. This total was then added to the adjusted D&O total cost to arrive at the total cost of the regulations. The range of total incremental costs of the Part 264 regulations is shown in Table VII-21.

TABLE VII-21
Total Annual Revenue Requirements for Part 264 Regulations:
All Land Disposal Facilities
(in Millions of Dollars)

	BASELINE (Pre-ISS+ISS)†	INCREMENTAL PART 264 LOW ESTIMATE	INCREMENTAL PART 264 HIGH ESTIMATE
Landfill D&O	301	81	159
Surface Impoundment D&O	534	102	401
(adjustment for landfilled material)	(190)	(57)	(118)
Waste Pile D&O)	16	7	12
(adjustment for landfilled material)	(10)	(3)	(6)
Land Treatment D&O	51	20	20
Corrective Action	-	0	677
TOTAL	702	150	1,145

† The total baseline costs of $702 million includes pre-ISS costs of about $181 million for landfills and $180 million for surface impoundments. Similar data are not available for waste piles and land treatment facilities. Pre-ISS costs include land, excavation, and infrastructure costs incurred in establishing a land disposal facility. ISS cost include more than "good housekeeping" requirements. Approximately 72 percent of the ISS costs of $341 million included in the baseline are due to ISS closure ($82 million), post closure ($40 million), ground-water monitoring ($42 million), and financial assurance ($82 million) requirements.

CHAPTER VIII

IMPACT OF THE REGULATIONS ON SELECTED INDUSTRIES

This chapter reviews the impacts of the land disposal regulations on selected industries. The impact analysis includes the following major steps:

- o Definition of the affected population,
- o Calculation of the costs of compliance by industry, and
- o Measurement of the cost impact.

Each of these steps is reviewed in more detail below. The limitations of the analysis are then discussed.

A. Definition of the Affected Population

While the cost portion of this analysis was concerned with estimating the total incremental costs that the Part 264 regulations would impose on individual land disposal units (e.g., individual landfills or individual surface impoundments), this portion of the analysis addressed the costs that the regulations will impose on specific industries and the impacts that are likely to result. To perform the industry impact analysis, it was necessary to define two new populations (as opposed to the populations of land disposal units and facilities defined in Chapter II) that are directly affected by these regulations:

- o Industrial establishments that generate hazardous wastes and dispose of these wastes on-site; and
- o Industrial establishments that generate hazardous wastes but dispose of these wastes at off-site (commercial) land disposal facilities.

Establishments with on-site land disposal facilities will be required to make expenditures in order to bring their facilities into compliance with the regulations. Generators of hazardous wastes who dispose of these wastes at off-site land disposal facilities are likely to face increased prices for disposal services.

To determine the number and size of existing land disposal facilities by industry, it was necessary to first determine which industries maintain on-site disposal facilities and which industries tend to generate waste that is disposed of off-site. A list of all establishments with land disposal facilities by standard industrial classification (SIC) code was derived from the Part A data. The following adjustments were then made to these data.

o Classification of On-site and Off-site Facilities

Facilities were classified as on-site or off-site in the following manner:

--Facilities within SIC code 4953 (refuse systems) were classified as off-site.

--Facilities owned by a known hazardous waste contract disposal firm[1] were classified as off-site regardless of the SIC code reported.

--All other facilities were designated as on-site.

o Exclusion of Certain Facilities

Facilities owned by establishments in SIC codes 333 (primary non-ferrous metals), 10 (metal mining), and 4911 and 4931 (electric and gas utilities) were excluded from the analysis since the wastes from these industries are not thought to be hazardous. Facilities owned by the federal government were excluded.[2] Waste water treatment plants were excluded since it is unclear whether the regulations will affect these plants.

o Estimation of the Number of Surface Impoundments

The Part A's provided only total capacity of surface impoundments at each establishment by type--storage, treatment or disposal. They did not provide data on the number of surface impoundments at each establishment.

The same methodology was used to calculate the number of surface impoundments by industry that was used to calculate the total number of surface impoundments for the cost analysis. That methodology was described in Chapter II (Section A.2).

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[1] For a list of contract disposal firms, see Booz, Allen and Hamilton, Inc. and Putnam, Hayes and Bartlett, Inc., Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity: An Assessment, November 1980.

2 These facilities are mostly ammunition plants.

o Determination of Affected Industries

The following guidelines were used to determine which industries[1] were likely to be affected by the regulations.

--If a significant amount of hazardous waste generated by the industry was disposed of at off-site land disposal facilities, the industry was included in the analysis.[2]

--Industries where 3 or more establishments reported on-site landfills or land treatment areas were included in the analysis.

--Industries where 7 or more establishments reported on-site waste piles or surface impoundments were included in the analysis.

The industries included in the analysis are listed in Table VIII-1. (Tables in this chapter follow the text.)

o Adjustments for Missing Data

For reasons of confidentiality, Part A data were not available for all establishments. To account for the missing data, the number of facilities within each SIC code was scaled upwards by the following factors:

Type of Facility	Factor
Landfills	1.23
Land Treatment Areas	1.20
Surface Impoundments	1.11
Waste Piles	1.20

The adjusted total number of landfills, surface impoundments, waste piles, and land treatment units by industry is shown in Table VIII-2. These totals are smaller than the total number of land disposal units used to estimate the total costs of the regulations, because they reflect only on-site land disposal units. Table VIII-3 provides data, for each industry, on the number of hazardous

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[1] Industries were defined by 4-digit SIC codes.

[2] Estimates of the amount of waste generated by industries going to off-site disposal were estimated using the reported volumes and waste disposal practices in Development Planning and Research Associates, Summary of Data for Selected Hazardous Wastes Generator Industries, October 1981; Arthur D. Little, Economic Impact Analysis of RCRA Interim Status Standards, November 1981; and Booz, Allen & Hamilton and Putnam, Hayes and Bartlett, Op. Cit. Where discrepancies in the figures exist, the higher number was used in this analysis.

waste generators that ship their waste off site for disposal and the amount of waste shipped.[1]

As explained in Chapter II, to estimate corrective action costs it was necessary to determine the total acreage of land disposal facilities (combinations of individual land disposal units) at each establishment. The number of establishments within each SIC code with hazardous waste facilities and the total acreage of these facilities are provided in Table VIII-4.

B. Calculations of the Costs of Compliance

The cost of compliance with the regulations includes:

- o The cost of meeting the required design and operating standards, and
- o The cost of any necessary corrective action.

The unit costs of compliance by size and type of facility are detailed in Chapters IV and V. The annual revenue requirements and first year cash requirements derived from these unit costs for each size and type of land disposal unit are summarized in Chapter VII and are listed in detail in Appendix E. The two cost components are discussed in more detail below.

1. Design and Operating Costs. To determine the costs of meeting the design and operating (D&O) standards by industry, the number of land disposal units of each type and size category within the industry was multiplied by the corresponding annual revenue requirement calculated to recover D&O costs for that size and type of unit, and summed to arrive at the total D&O costs for on-site facilities within each industry.

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[1] The number of generators within each industry was derived from EPA's Notification data. Only 26,700 generators of the 63,000 notifiers had been assigned to SIC codes at the time of this analysis. However, the number of generators was not scaled upwards to account for the missing data. EPA assumed that most of the manufacturing plants of concern had been identified. This assumption is supported by the fact that the number of generators within the SIC codes of concern did not increase when an additional 7,000 plants were assigned SIC codes recently.

The annual revenue requirements calculated for off-site facilities were allocated to generators who dispose of their wastes at off-site land disposal facilities in the following manner.

- o The total D&O costs for the off-site facilities were divided by the annual capacity of these off-site facilities[1] to arrive at the average price increase per ton of waste required to recover the compliance costs.
- o The potential cost increase for off-site disposal for each generator industry is the average price increase per ton multiplied by the total tons of waste disposed of off-site by that industry. (See Table VIII-3.)

The costs borne by the generators disposing of wastes off-site were then added to the D&O costs faced by owners and operators of on-site facilities to arrive at the total D&O costs for each industry. These costs are shown in Table VIII-5.

2. Corrective Action Costs. To estimate corrective action costs by industry, "worst case" corrective action costs (counterpumping for 150 years under Strategy 2 conditions) estimated for all types and sizes of land disposal facilities were distributed across industries as follows:

- o First, the number and average acreage of facilities within each industry were derived by type of facility from the Part A data as described in Chapter II, Section B. If an establishment reported both a landfill and a surface impoundment, it was treated as a single facility with an estimated acreage of 45 acres (from Table II-5).
- o Second, the annual revenue required to offset incremental corrective action costs was calculated for each facility type and size based on the corrective action unit costs shown in Table V-2.
- o Third, these annual revenue requirements were multiplied by the number of facilities of that type and size within the industry to arrive at the total cost of corrective action by type and size of facility.
- o Fourth, these corrective action costs were summed for all facility types and sizes within each industry to estimate total corrective action costs for the industry's on-site facilities.

Corrective action costs calculated for off-site facilities were allocated to generators who dispose of their wastes at off-site land disposal facilities.

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[1] The total annual capacity of off-site land disposal facilities is estimated to be 6.15 million metric tons.

The allocation method used for corrective action costs was the same as the method used to allocate D&O costs. The tons of waste disposed off-site for each industry was multiplied by the price increase per ton required to recover the costs of corrective action for the off-site facilities.

The off-site corrective action costs for each industry were then added to the corrective action costs for the on-site facilities within the industry. Total corrective action costs by industry are provided in Table VIII-6.

C. Measurement of the Cost Impact

Four measures of impact were used in this analysis.

- The ratio of annual compliance costs to the industry's cost of production was employed as an estimate of the increase in production costs of that industry.
- The ratio of annual compliance costs to the industry's value of shipments was employed as an estimate of the increase in product prices which may occur in that industry should the industry pass along the compliance costs to its customers.
- The ratio of annual compliance costs to the industry's value added was employed as an estimate of the potential decrease in the profitability of the industry should the industry be unable to pass along the increased costs in product prices.
- The cash expenditures required in the first year the regulations take effect were compared to the industry's annual capital expenditures to determine the ability of the industry to finance the required expenditures.

The calculation of these four ratios is fairly straightforward. The cost of production, value added, value of shipments and capital expenditures for each of the industries were derived by multiplying the industry totals provided by the Census of Manufacturers by the proportion of the industry establishments that are generators of hazardous wastes. For example, the value added for industry "i" is as follows:

$$\text{Value Added}_i = \text{Total Value Added}_i \times \frac{\text{Number of Generators}_i}{\text{Number of Establishments}_i}$$

The effect of this calculation is to eliminate an estimate of the portion of the industry's value added attributable to establishments which do not generate

hazardous wastes. If the economic variables were not scaled in this manner, the value added, cost of production, value of shipments, and capital expenditures would be overstated. This would lead to an understatement of the impacts of the regulations.

Estimates of 1981 cost of production, value added, value of shipments and capital expenditures were derived by applying an estimated real growth rate and an estimated inflation rate to the 1977 Census values. The estimated inflation and real growth rates by industry were set equal to the compound annual rates experienced by the industry from 1972 to 1977.[1]

The compliance costs derived for each industry were compared to these four adjusted economic measures to determine the magnitude of the impact. Impacts by industry are listed in Tables VIII-7 through VIII-9. These are the same tables that appeared in Section IX.G of the Preamble to the Part 264 regulations.

D. Limitations of the Analysis

In addition to the limitations presented in other chapters of this report, there are specific limitations which should be kept in mind when evaluating the impacts on specific industries. These limitations are discussed below.

- Discrepancies between databases.

  The number of generators was derived from the Notification data, while the number of land disposal facilities was derived from the Part A data. These databases have not been reconciled so there may be discrepancies and inconsistencies between the two. In addition, neither database has yet been verified.[2] Some attempt was made to adjust the data for obvious inaccuracies but errors may still exist.

- Inaccuracy of Part A data.

  As mentioned above, the Part A data has not yet been verified. In particular, EPA believes three problems exist with the Part A data.

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[1] These real growth rates and inflation rates are provided in Development Planning and Research Associates, Op. Cit.

[2] EPA is now in the process of verifying both the Part A and the Notification data.

First, many establishments have submitted data on land disposal facilities even though hazardous wastes are not present in their waste streams. These facilities would not be subject to the regulations and therefore, this could seriously overstate the impact of the regulations.

Second, some facilities that are not subject to hazardous waste regulations for other reasons may be included in the Part A data and again this will result in an overstatement of the impacts.

Third, preliminary results from the verification indicate that many of the reported facilities do not currently exist. Firms have sometimes filed Part A applications if they are planning to add a land disposal facility. These planned facilities should not be included in an analysis of the impacts of the regulations on existing facilities.

o Updating of Part A and Notification data.

EPA has also been continually updating and correcting the Part A and Notification data as more and better data become available. This analysis has attempted to keep pace with these updates to the extent practical but the most recent updates have not been incorporated in the analysis.

o No change in generation or disposal practices assumed.

EPA assumed that increased costs resulting from the Part 264 requirements would not change the hazardous waste generation or disposal practices of the industries for this analysis. However, firms can choose to decrease the amount of hazardous waste generated or alter their disposal practices in order to minimize the costs of compliance. Because no such changes are assumed, the resulting impacts will be overestimated.

o Off-site facilities will be able to recover costs.

EPA assumed that the off-site facilities will be able to recover the costs of compliance through increased prices. This may not prove to be true for some of the smaller or less efficient off-site facilities. However, most facilities should be able to recover their costs since there are significant barriers to entry in this industry and since on-site disposal is not an economically viable option for many hazardous waste generators.

o Existence of other processes on site.

This analysis includes only the effect of the regulations on land disposal facilities. Some firms will have other types of facilities--storage, incineration, and so forth--at the same site as well. Regulations which affect these other types of facilities will also increase the costs of hazardous waste disposal. These other costs are not included here and therefore, this analysis does not represent the total impact of hazardous waste regulations on industry.

- Analysis based on average plant within the industry.

  This analysis is designed to provide an indication of the magnitude of the impact on an "average" plant within specific industries. As such, the analysis will fail to indicate more or less severe impacts felt by some subsegments of an industry. Further analysis of individual plants within an industry would have to be undertaken to derive more specific impacts.

- Accuracy of data and assumptions.

  Many data and assumptions were necessary in the course of this analysis. The sources of the data employed are provided in this chapter. The assumptions used in the analysis are also provided. To the extent that the data or assumptions are inaccurate, the impacts will also be inaccurate.

TABLE VIII-1

Industries Included in This Analysis

SIC Code	Industry
0721	Crop Planting & Protections
1300	Oil and Gas Extraction
2491	Wood Preserving
2812	Alkalies & Chlorine
2816	Inorganic Pigments
2819	Industrial Inorganic Chemicals
2821	Plastic Materials & Resins
2822	Synthetic Rubber
2823	Cellulosic Manmade Fibers
2824	Organic Fibers, Noncellulosic
2833	Medicinals & Botanicals
2851	Paints & Allied Products
2861	Gum & Wood Chemicals
2865	Cyclic Crudes & Intermediates
2869	Industrial Organic Chemicals
2873	Nitrogenous Fertilizers
2874	Phosphatic Fertilizers
2879	Agricultural Chemicals
2892	Explosives
2899	Chemical Preparations, NEC
2911	Petroleum Refining
2992	Lubricating Oils & Greases
3312	Blast Furnaces & Steel Mills
3313	Electrometallurgical Projects
3315	Steel Wire & Related Products
3321&5	Gray Iron Foundries & Steel Foundries, NEC
3341	Secondary Nonferrous Metals
3351&6	Cooper Rolling & Drawing & Nonferrous Rolling & Drawing, NEC
3471&9	Plating & Polishing, and Metal Coating
3711	Motor Vehicles and Bodies
3714	Motor Vehicles Parts & Accessories

NEC = not elsewhere classified

TABLE VIII-2

Number of Land Disposal Facilities by Industry

SIC Code	Landfills	Surface Impoundments	Land Treatment Facilities	Waste Piles
0721	0	43	1	3
1300	15	68	4	3
2491	0	121	5	4
2812	5	68	0	10
2816	2	49	0	4
2819	29	314	12	21
2821	13	108	5	13
2822	1	33	0	2
2823	3	16	0	2
2824	1	30	0	0
2833	0	25	1	2
2851	0	24	1	10
2861	2	18	0	2
2865	4	55	1	3
2869	10	120	5	8
2873	3	34	1	2
2874	0	13	1	4
2879	5	49	0	11
2892	6	40	1	3
2899	4	38	0	6
2911	34	370	83	30
2992	2	7	0	2
3312	44	65	3	51
3313	3	12	0	0
3315	6	24	3	7
3321&5	9	9	1	9
3341	11	40	1	24
3351&6	6	49	0	12
3471&9	13	107	0	14
3711	0	50	0	3
3714	3	44	0	6
TOTAL	288	2268	155	325

TABLE VIII-3

Number of Hazardous Waste Generators and Amount of Waste Going to Off-Site Land Disposal Facilities by Industry

SIC Code	Number of Generators	Amount of Waste Disposed Off-Site (MT)
0721	170	17,173
1300	243	0
2491	163	4,378
2812	42	54,561
2816	49	2,071
2819	391	17,352
2821	285	22,962
2822	39	2,475
2823	10	35,280
2824	24	38,977
2833	75	6,961
2851	610	119,430
2861	24	548
2865	45	4,464
2869	130	19,490
2873	91	0
2874	41	0
2879	107	38,202
2892	35	985
2899	224	0
2911	239	212,492
2992	76	86,505
3312	177	90,000
3313	15	27,500
3315	60	16,750
3321&5	131	32,000
3341	90	62,898
3351&6	85	503,557
3471&9	1,168	698,666
3711	83	0
3714	343	0

TABLE VIII-4

Acreage of Land Disposal Facilities by Industry

SIC Code	Number of Establishments With Land Disposal Facilities	Total Acreage of Facilities
0721	26	0.9
1300	21	108.5
2491	76	64.3
2812	23	361.7
2816	13	421.7
2819	128	2,259.3
2821	46	645.5
2822	5	260.3
2823	8	150.5
2824	10	96.2
2833	14	10.4
2851	20	93.0
2861	12	99.4
2865	25	503.6
2869	47	530.0
2873	16	187.5
2874	10	13.8
2879	23	218.0
2892	21	153.7
2899	21	147.1
2911	148	670.0
2992	9	125.0
3312	80	670.0
3313	8	61.8
3315	14	42.9
3321&5	19	282.5
3341	30	191.5
3351&6	27	106.2
3471&9	59	259.9
3711	17	46.2
3714	26	44.9

TABLE VIII-5

Design and Operating Costs for Part 264
Regulations by Industry
(Thousands of 1981 Dollars)

SIC Code	Annual Revenue Requirements		First Year Expenditures	
	Low Estimate	High Estimate	Low Estimate	High Estimate
0721	322	784	182	6,440
1300	1,392	3,354	991	31,858
2491	774	2,001	474	23,899
2812	2,187	10,813	995	119,146
2816	3,204	12,077	754	145,141
2819	11,079	36,027	4,556	402,346
2821	4,896	13,215	3,090	106,101
2822	2,484	9,248	590	111,114
2823	1,640	4,997	869	42,445
2824	1,303	4,524	435	49,453
2833	218	573	141	5,633
2851	996	2,800	774	10,872
2861	1,037	3,567	333	40,283
2865	2,517	8,746	698	105,028
2869	3,756	11,222	1,719	118,125
2873	1,003	3,267	376	37,150
2874	151	424	106	4,605
2879	2,595	7,969	1,115	76,657
2892	850	2,253	433	23,663
2899	1,322	3,435	787	24,940
2911	23,939	69,285	15,049	705,099
2992	1,068	2,750	863	7,942
3312	8,495	17,317	6,671	50,471
3313	593	1,868	297	16,595
3315	1,037	2,382	889	12,922
3321&5	1,327	2,460	949	8,082
3341	1,984	4,008	1,380	14,289
3351&6	4,721	14,145	3,216	75,712
3471&9	6,208	18,001	4,424	83,430
3711	930	3,248	155	40,905
3714	716	2,113	265	21,929

TABLE VIII-6

Remedial Action Costs for Part 264
Regulations by Industry *

SIC Code	Annual Revenue Requirement	First Year Expenditures
0721	2,525	2,990
1300	4,750	7,139
2491	13,571	19,001
2812	6,131	9,661
2816	4,241	7,102
2819	37,007	59,356
2821	11,263	17,493
2822	1,728	2,915
2823	2,245	3,607
2824	2,854	4,532
2833	2,133	2,874
2851	2,939	4,010
2861	3,008	4,675
2865	7,139	11,512
2869	12,213	19,079
2873	3,934	6,083
2874	1,923	2,753
2879	4,824	7,227
2892	5,197	8,002
2899	4,380	6,493
2911	47,402	78,214
2992	2,480	3,941
3312	19,836	30,613
3313	2,142	3,349
3315	3,118	4,641
3321&5	4,538	6,957
3341	6,329	9,365
3351&6	5,940	8,885
3471&9	13,519	20,387
3711	3,838	5,720
3714	4,929	7,093

* High estimate shown here only; low estimate of remedial action costs is zero.

TABLE VIII-7

Comparison Of Annual Revenue Requirements Due to
Part 264 Land Disposal Regulations to Selected Industry Measures,
By SIC Code

(Low and High Cost Cases)

SIC Code	Annualized Cost ($ 000)	Annualized Cost as a Percentage of: Cost of Production	Value Added	Value of Shipments
0721	322 - 3,309	*	*	*
1300	1,392 - 8,104	*	*	*
2491	774 - 15,572	.16 - 3.17	.38 - 7.61	.13 - 2.58
2812	3,187 - 16,944	.20 - 1.09	.26 - 1.37	.13 - .68
2816	3,204 - 16,318	.44 - 2.26	.68 - 3.49	.31 - 1.57
2819	1,079 - 73,034	.15 - .97	.19 - 1.27	.10 - .64
2821	4,896 - 24,478	.04 - .22	.08 - .41	.03 - .16
2822	2,484 - 10,976	.18 - .78	.46 - 2.03	.14 - .62
2823	1,640 - 7,242	.12 - .53	.33 - 1.46	.11 - .48
2924	1,303 - 7,378	.05 - .27	.08 - .46	.04 - .20
2833	218 - 2,706	.02 - .23	.02 - .19	.01 - .12
2851	996 - 5,739	.03 - .20	.06 - .34	.02 - .14
2861	1,037 - 6,575	1.74 - 11.03	2.44 - 15.45	1.15 - 7.31
2865	2,517 - 15,885	.12 - .73	.21 - 1.35	.08 - .53
2869	3,756 - 23,435	.04 - .27	.07 - .42	.03 - .18
2873	1,003 - 7,201	.05 - .36	.07 - .49	.03 - .23
2874	151 - 2,347	.01 - .15	.02 - .31	.01 - .10
2879	2,595 - 12,793	.23 - 1.13	.38 - 1.86	.18 - .87
2892	850 - 7,450	.36 - 3.19	.38 - 3.35	.24 - 2.06
2899	1,322 - 7,815	.23 - 1.37	.33 - 1.94	.15 - .90
2911	23,939 - 116,687	.02 - .08	.09 - .43	.01 - .07
2992	1,068 - 5,230	.28 - 1.35	.66 - 3.24	.21 - 1.04
3312	8,495 - 37,153	.04 - .19	.10 - .44	.04 - .16
3313	593 - 4,010	.13 - .86	.38 - 2.59	.11 - .76
3315	1,037 - 5,500	.20 - 1.07	.39 - 2.06	.16 - .84
33215	1,327 - 6,998	.12 - .66	.16 - .85	.09 - .48
3341	1,984 - 10,337	.24 - 1.23	.94 - 4.91	.20 - 1.06
33516	4,721 - 20,085	.22 - .92	.79 - 3.37	.19 - .79
34719	6,208 - 31,520	.65 - 3.31	.84 - 4.24	.47 - 2.41
3711	930 - 7,086	.00 - .02	.01 - .07	.00 - .02
3714	716 - 7,042	.01 - .09	.02 - .16	.01 - .07

* Necessary data unavailable

TABLE VIII-8

Comparison of First Year Expenditures Due to
Part 264 Land Disposal Regulations to Yearly Capital Outlays
By SIC Code

(Low and High Cost Cases)

SIC Code	First Year Expenditure ($ 000)	First Year Expenditure as % of Yearly Capital Expenditures
0721	182 - 9,430	*
1300	991 - 38,997	*
2491	474 - 42,900	2.37 - 124.75
2812	995 - 128,807	.25 - 41.58
2816	754 - 152,243	.73 - 141.54
2819	4,556 - 461,702	.72 - 65.01
2821	3,090 - 123,594	.23 - 8.05
2822	590 - 114,029	1.14 - 219.32
2823	869 - 46,052	1.51 - 90.74
2824	435 - 53,985	.11 - 24.31
2833	141 - 8,507	.07 - 3.49
2851	774 - 14,883	.12 - 4.27
2861	333 - 44,958	5.31 - 648.31
2865	698 - 116,540	.84 - 131.04
2869	1,719 - 137,204	.10 - 6.90
2873	376 - 43,233	.04 - 4.17
2874	106 - 7,358	.10 - 4.52
2879	1,115 - 83,884	.78 - 64.21
2892	433 - 31,665	3.03 - 166.98
2899	787 - 31,433	1.97 - 62.38
2911	15,049 - 783,313	.35 - 17.42
2992	863 - 11,883	4.97 - 40.56
3312	6,671 - 81,084	.52 - 3.83
3313	297 - 19,944	.49 - 50.22
3315	889 - 17,563	3.48 - 52.33
33215	949 - 15,039	8.39 - 68.53
3341	1,380 - 23,654	3.31 - 34.61
33516	3,216 - 84,597	1.02 - 105.25
34719	4,424 - 103,817	1.33 - 98.34
3711	155 - 46,625	.02 - 4.68
3714	265 - 29,022	.05 - 4.38

* Necessary data unavailable.

TABLE VIII-9

Comparison Of Annual Revenue Requirements Due to
Part 264 Land Disposal Regulations
And Part 265 Land Disposal Regulations
To Selected Industry Measures
By SIC Code

(Low and High Cost Cases)

SIC Code	Annualized Cost ($ 000,000)	Annualized Cost as a Percentage of: Cost of Production	Value Added	Value of Shipments
0721	2 - 5	*	*	*
1300	6 - 13	*	*	*
2491	6 - 21	1.24 - 4.25	2.96 - 10.19	1.01 - 3.46
2812	12 - 26	.78 - 1.66	.99 - 2.10	.49 - 1.05
2816	12 - 25	1.65 - 3.46	2.54 - 5.34	1.14 - 2.41
2819	4 - 106	.59 - 1.42	.77 - 1.85	.39 - .93
2821	17 - 36	.15 - .32	.28 - .60	.11 - .23
2822	9 - 18	.64 - 1.25	1.68 - 3.25	.51 - .99
2823	5 - 11	.38 - .79	1.04 - 2.17	.34 - .71
2924	5 - 11	.19 - .41	.31 - .69	.14 - .30
2833	1 - 4	.12 - .34	.10 - .28	.06 - .17
2851	4 - 8	.13 - .29	.21 - .49	.09 - .21
2861	4 - 9	6.35 - 15.64	8.91 - 21.93	4.21 - 10.37
2865	10 - 23	.45 - 1.07	.84 - 1.98	.33 - .78
2869	15 - 35	.18 - .41	.27 - .62	.12 - .27
2873	4 - 10	.06 - .20	.29 - .71	.13 - .33
2874	1 - 4	.82 - 1.72	.12 - .42	.04 - .13
2879	9 - 19	1.63 - 4.45	1.34 - 2.82	.63 - 1.32
2892	4 - 10	.80 - 1.94	1.71 - 4.68	1.06 - 2.88
2899	5 - 11	.06 - .12	1.13 - 2.74	.53 - 1.28
2911	89 - 181	.77 - 1.84	.33 - .67	.05 - .11
2992	3 - 7	.12 - .26	1.84 - 4.42	.59 - 1.41
3312	23 - 52	.46 - 1.20	.27 - .61	.10 - .22
3313	2 - 6	.72 - 1.59	1.39 - 3.60	.41 - 1.06
3315	4 - 8	.37 - .90	1.38 - 3.05	.57 - 1.25
33215	4 - 10	.78 - 1.78	.48 - 1.17	.27 - .66
3341	7 - 15	.69 - 1.39	3.11 - 7.08	.67 - 1.53
33516	15 - 31	.96 - 2.09	2.55 - 5.13	.60 - 1.21
34719	21 - 46	2.20 - 4.86	2.81 - 6.22	1.60 - 3.53
3711	4 - 11	.01 - .03	.05 - .11	.01 - .03
3714	3 - 10	.04 - .13	.08 - .22	.03 - .10

* Necessary data unavailable