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HIGHLIGHTS FROM

A Study of the Implementation of the
RCRA Corrective Action Program

Office of Solid Waste
U.S. Environmental Protection Agency

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Highlights Report

A Study of the Implementation of the RCRA Corrective Action Program, published on April 9, 2002, provides a complete discussion of the findings from EPA's data collection on facilities which have a final and/or stabilization remedy in place.[1] This highlights report presents background on the data collection effort, information on the characteristics of the facilities examined in the study, and an overview of the main findings from the report related to facility contamination, remedy selection process, remedies selected, and remedy implementation. For more information on the full study, or to obtain a copy of the study, please check the Office of Solid Waste website http://www.epa.gov/osw/ under "corrective action," or contact Paul Balserak (703-308-0486).

I. Background

A. Introduction

The Permits and State Programs Division (PSPD) of EPA's Office of Solid Waste (OSW) developed the RCRA Corrective Action Questionnaire in the Spring of 1997. This survey was designed to provide a national level understanding of how the Corrective Action program has been implemented since its promulgation. The questionnaire collected site-specific information on the implementation of Corrective Action, including the nature of contamination, the Corrective Action decision-making process, and the remedies selected. This information will enable EPA headquarters to more effectively support states and EPA Regions in implementing the Corrective Action program.

As the purpose of the project was to collect information on Corrective Action implementation, EPA queried the Resource Conservation and Recovery Information System (RCRIS) database for those hazardous waste management facilities subject to Corrective Action that had selected a final remedy and/or implemented stabilization measures. This search generated a list of 889 facilities. From this list, EPA selected a statistically representative sample of facilities from which to gather information. EPA surveyed the EPA Regional and/or state regulator responsible for overseeing Corrective Action at each sample facility.

The questionnaire included 53 questions that applied to the entire facility. These questions covered topics such as facility background, status of Corrective Action, contamination at the facility, remedy selection, institutional control usage and public participation. In addition, each respondent was requested to answer a set of 18 questions for up to four specific waste management units at the facility. This report presents the results of the facility-wide questions. It does not present results from the 18 unit-specific as these results are not statistically representative of the larger sample.

Regulators responsible for 65 facilities completed the survey. EPA entered the information from these facilities into the RCRA Corrective Action Implementation Database (RCAID). EPA then extrapolated the RCAID data to represent all 889 Corrective Action facilities with a final remedy selected and/or stabilization measures implemented. *The results presented in this report are based on the*

[1] EPA published a version of the complete report on September 25, 2000, and a version of the *Highlights Report* on October 18, 2000. Based on a subsequent review of the groundwater point of compliance (POC) data (in particular, the response rates to the POC questions) and the statistical methods used in analyzing those data, EPA has reevaluated the POC findings. The new POC findings are discussed in a new April 9, 2002 version of the complete report (see page 4-7). The *Highlights Report* no longer presents the POC results. These changes regarding the POC findings represent the only changes made in producing the April 9, 2002 version of each report.

extrapolated data. Also, unless otherwise noted, the results reflect extrapolated facilities for which there was a response, excluding "unknown" responses and cases where no response was given.

The facilities surveyed are not representative of all facilities subject to Corrective Action. Facilities that had selected final remedies and/or implemented stabilization measures were the focus of the survey. These facilities were further along in the Corrective Action process than other Corrective Action facilities, and therefore may differ significantly from other facilities subject to Corrective Action. The findings presented in this report are subject to three primary limitations:

- The design of the survey does not allow for analysis of the unit-specific data. These data could not be extrapolated because respondents did not answer the unit-specific questions for all units subject to Corrective Action at the facility.

- The accuracy of the survey responses determines the quality of the analysis. While internal inconsistencies within an individual facility survey were resolved where possible, other errors or mistakes made by survey respondents, such as those resulting from the lack of readily available information on the respondents part, could not be detected and corrected.

- The small sample size results in relatively large confidence levels associated with extrapolated variables. Thus, many results are not statistically significant.

B. Facility Description

Thousands of facilities that generate and manage hazardous waste have releases that are subject to RCRA Subtitle C Corrective Action requirements. The facilities that were the focus of this analysis all had selected a final remedy and/or implemented interim measures as of 1996 according to RCRIS.

Number of Units and Facility Size. The extrapolated RCAID facilities ranged from sites with one small contaminated solid waste management unit to facilities with extensive contamination spread over more than 25 units. Most RCAID facilities had at least five solid waste management units that were potentially subject to Corrective Action (see Exhibit 1). Over 90 percent of all RCAID facilities were smaller than 1,000 acres; about a third were smaller than 10 acres. There was no clear relationship between number of units and facility size.

Exhibit 1
Number of Units Per Facility

Number of Units	Percent of Responses
Less than 5 units	30%
5 to 9 units	35%
10 to 25 units	25%
More than 25 units	15%
Total*	100%

* Total does not sum due to rounding.

Location. The survey was designed to be statistically representative at the national level, not the state or EPA Regional level. Thus, the results should not be used for state-by-state or Region-by-Region comparisons. Whether the lead regulator is the state or EPA Region is affected by the state in which a

facility is located. The lead regulatory authority was generally divided evenly between EPA Regions and states.

Priority. RCAID facilities that had implemented stabilization measures and/or selected a final remedy tended to be high priority facilities. Almost 80 percent of them were high priority under the National Corrective Action Priority System (NCAPS) ranking. The NCAPS rankings were similar for facilities that had and those that had not selected a final remedy. RCAID facilities also had NCAPS rankings similar to the 1,714 facilities identified by the Agency for purposes of tracking Government Performance Results Act (GPRA) goals.

Land Use and Industry Classification. The types of land use at or near facilities often influence RCRA Corrective Action decisions. As expected, most RCAID facilities, 87 percent, were used primarily for industrial purposes. Only 6 percent of facilities had an on-site residential land use. However, 60 percent of facilities had residential land use within one-half mile of the facility boundary in the direction of contaminant migration, and 30 percent had recreational land use within one-half mile.

The majority of all RCAID facilities were in manufacturing industries. Of the facilities reporting a SIC:

- 35 percent were in the chemical manufacturing sector;
- 20 percent were in wood preserving, petroleum refining, or other manufacturing;
- 18 percent were in a services sector; and
- 25 percent were scattered among other classifications.

II. Study Highlights

Below, EPA presents abbreviated discussions on the main findings from the RCAID study. More complete presentations of these findings can be found in the main report.

A. Nature of Contamination and Exposure

The nature and extent of contamination at RCRA corrective action facilities are diverse. Contamination ranges from small spill areas requiring soil cleanup to extensive on-site and off-site soil, sediment, and groundwater contamination, including polluted drinking water sources.

Major Sources of Contamination. Survey respondents were asked to name one or two areas of concern that contributed most significantly to contamination at the facility (see Exhibit 2). Spills were a major source of concern at over half of the facilities. Landfills, surface impoundments, and underground storage tanks also contributed significantly to facility contamination.

Types of Contaminated Media. Almost all RCAID facilities had both soil and groundwater contamination, while almost one-third had sediment contamination. At roughly half of all RCAID facilities, contamination had migrated beyond the facility boundary (see Exhibit 3). About half of the facilities with contaminated ground water reported off-site plume migration.

Exhibit 2
Primary Areas of Concern for RCAID Facilities

Area of Concern	Percent of Facilities*	Area of Concern	Percent of Facilities*
Spill area	55%	Waste pile	5%
Landfill	35%	Sewer	3%
Surface impoundment	25%	Container/container storage area	3%
Underground tank	25%	Land treatment unit	< 1%
Above ground tank	10%	Other type of area	20%

* Facilities could provide more than one answer to this question.

Exhibit 3
Off-Site Contamination by Media

Medium	Facilities with Contaminated Media*	Facilities Where Contamination Migrated Off-Site
Soil	99%	5%
Ground Water	90%	45%
Sediments	30%	15%
Surface Water	20%	20%
Air	5%	5%
Total	100% (of 889 facilities)	48% (of 889 facilities)

* Facilities could provide more than one answer to this question.

Types of Contaminants. At over half of the RCAID facilities, the contamination included only one type of contaminant. Less than one-third of all RCAID facilities had three or more types of contaminants. The most common types of contaminants found at RCAID facilities were:

- Volatile organic compounds (VOCs): 85 percent of facilities;
- Semi-volatile organic compounds (SVOCs): 40 percent;
- Metals: 25 percent; and
- Polychlorinated biphenyl (PCBs): 10 percent.

Dense non-aqueous phase liquids (DNAPLs) and light non-aqueous phase liquids (LNAPLs) are classes of contaminants that are difficult to remove from ground water. Approximately 55 percent of RCAID facilities had known or suspected NAPLs on-site. DNAPLs were slightly more common than light non-aqueous phase liquids LNAPLs. About one-fourth of facilities were contaminated with both DNAPLs and LNAPLs.

Groundwater and Surface Water Use and Contamination. Almost half of the extrapolated RCAID facilities were located above an actual or potential source of on-site drinking water. One-fourth of these facilities had been using the on-site aquifer as a source of drinking water. Contamination had been detected in an actual or potential source of drinking water at approximately 90 percent of facilities.

Over half of the RCAID facilities were located within two miles, in the direction of contamination, of an aquifer that was designated as an actual or potential source of drinking water. At half of these facilities, the off-site ground water was used for drinking water. Also, at 80 percent of these facilities, contamination had been detected in an actual or potential source of drinking water.

Bodies of surface water were found within a quarter mile of over half of all RCAID facilities.

- Nearly all of the facilities were located within two miles of a body of water;
- The surface water body closest to the facility was used as a source of drinking water for 15 percent of RCAID facilities; and
- Of this 15 percent, over half detected contamination in a medium associated with the surface water body.

B. Remedy Selection Process

EPA has long recognized the need for the Corrective Action program to be procedurally flexible, with many different approaches to remedy selection. This section presents the data on several aspects of the remedy selection process for RCAID facilities.

Innovative Site Characterization and Phased Corrective Action. Almost 30 percent of all RCAID facilities used some type of innovative characterization approach. Low priority facilities were more likely than medium and high priority facilities to employ these approaches.

Approximately 70 percent of all RCAID facilities used a phased approach for at least one step in the Corrective Action process. The phased approach was used more often by facilities with medium and low NCAPS rankings than by facilities with high rankings.

Action Levels and Risk Assessments. About 60 percent of all RCAID facilities used one or more types of action levels. Action levels were developed on a facility-specific basis at 15 percent of facilities. More commonly, facilities took action levels from standardized lists such as state action levels, EPA Regional action levels, and proposed Subpart S levels. Use of action levels did not appear to depend on whether the remedial alternative was based on residential or non-residential land use assumptions. Action levels were used most often for soil, as shown in Exhibit 4.

Exhibit 4
Use of Action Levels Across Media Types

Medium	Percent of RCAID facilities
Soil	55%
Ground Water	40%
Surface Water	15%
Sediment	10%
Air	8%

Approximately half of all RCAID facilities conducted some form of facility-specific risk assessment as part of the remedy selection process:

- 15 percent of facilities conducted both a human health and an ecological risk assessment;
- 35 percent conducted only a human health risk assessment; and
- 1 percent conducted only an ecological risk assessment.

RCAID facilities with residential, recreational, or agricultural use on-site were more likely to have both human health and ecological risk assessments than facilities with industrial and commercial land uses. About 80 percent of the human health risk assessments were conducted by the owner or operator rather than by the lead regulatory agency. Most of the human health risk assessments used the Risk Assessment Guidance for Superfund (RAGS), either alone or in conjunction with other guidance. Almost all the RCAID facilities performing an ecological risk assessment employed EPA ecological risk assessment guidance.

Public Participation. Over 80 percent of all RCAID facilities engaged in some form of public participation. As shown in Exhibit 5, the most common forms were announcements in newspapers, magazines, and journals. According to the data, the use of public participation mechanisms did not appear to depend on the oversight mechanism used, the lead regulatory agency, or the NCAPS ranking of the facility. Public participation was reported to have rarely influenced the selection of the remedial alternatives. No public comments were received at over 40 percent of facilities.

Exhibit 5
Methods of Public Participation at RCAID Facilities

Method of Public Participation	Percent of Facilities that Used Method
Announcements	55%
Fact Sheets	40%
Information Repository	40%
Mailings to Facility Mailing List	40%
Informal Public Meetings	25%
Formal Public Meetings	20%
Door-to-Door Communication	3%
Multilingual Communication	3%

Voluntary Corrective Action. Over half of all RCAID facilities were reported to have conducted some remedial action at the facility as a voluntary action. Voluntary remedial actions are those actions that are designed to meet RCRA requirements, but are not specifically required in a permit or order. High priority facilities, as well as facilities with EPA as the lead regulatory agency, were slightly more likely to undertake voluntary Corrective Actions than were lower ranked facilities or facilities with state leads.

Of the facilities with a voluntary action subject to oversight, the majority conducted "routine communications" with the lead regulatory agency, had regulator "review of proposed work," or had regulator "review of completed work." Of the facilities that conducted voluntary remedial actions, over half were provided some level of assurance that the cleanup should satisfy regulatory requirements, primarily through the lead regulatory agency's approval of proposed work plans.

C. Characteristics of Selected Remedies

This section presents the main findings from the RCAID work on remedy selection.

Institutional Controls. Slightly more than half of all RCAID facilities employed some form of institutional controls. Generally, when a facility used institutional controls as a part of the remedy, it employed multiple institutional controls. The most common institutional controls were compliance monitoring and restrictive

covenants (see Exhibit 6). Approximately 70 percent of the facilities using institutional controls selected remedies that were based on a non-residential land use scenario.

Exhibit 6
Institutional Controls at RCAID Facilities

	% of Facilities with Institutional Controls	% of all RCAID Facilities
Compliance Monitoring	70%	40%
Restrictive Covenants	70%	40%
On-Site Use Restrictions	60%	30%
Access Restrictions	50%	28%
Notices	45%	25%
Off-Site Use Restrictions	15%	10%

Institutional controls were used less frequently at facilities with low Corrective Action costs than at facilities with high costs. Whether the facility had employed interim measures or implemented a final remedy did not appear to significantly affect the use of institutional controls.

Treatment in Final Remedies. Approximately 70 percent of facilities anticipate some on-site treatment of contaminated media.

- Almost 60 percent of all RCAID facilities anticipate on-site treatment of over half of the contaminated media at the facility;
- Roughly 50 percent of RCAID facilities anticipate on-site treatment of more than 75 percent of the contaminated media; and,
- Approximately 25 percent of facilities anticipate on-site treatment of 100 percent of the contaminated media at the facility.

Some additional amount of media could be treated off-site. These figures represent expectations about future treatment at facilities, rather than actual treatment performed to date.

Natural Attenuation. Approximately 20 percent of all RCAID facilities selected natural attenuation as one component of the remedial alternative. Ten percent of facilities employed natural attenuation as a part of the remedy for addressing off-site contamination. Natural attenuation was rarely used as the sole remedy for contamination at the facility. At almost all the facilities using natural attenuation for ground water, there was no known or suspected DNAPL contamination. The primary classes of contaminants for which natural attenuation was employed as a remedy were VOCs and organics. None of the sites that used natural attenuation had metal or pesticide contamination.

Financial Responsibility. The survey indicated that about one-fourth of all RCAID facilities had already demonstrated financial responsibility. Financial assurance is commonly not required until a final remedy is selected. The type of financial assurance mechanism used was identified for 15 percent of all RCAID facilities. Of these respondents, 70 percent used the financial test or corporate guarantee and 20 percent used a letter of credit.

The Corrective Actions that were subject to financial responsibility took longer to complete on average than other Corrective Actions. While it may be expected that financial assurance would be required more frequently for higher cost cleanups, the data did not clearly indicate such a difference.

D. Remedy Implementation

Facilities with more extensive contamination were likely to require more costly cleanup activities, as well as more effort by EPA or the state to oversee the remedial activities. The time and costs estimated by respondents varied widely.

Cost. The cost of cleanup at RCAID facilities varied widely, with estimates ranging from under $1 million to over $50 million. Of facilities with reported total costs, over half estimated total cleanup costs of under $5 million. Less than 10 percent had estimated total costs of over $50 million. Other cost findings included the following:

- Facilities with only one contaminated medium tended to be less costly to remediate than facilities with several contaminated media (see Exhibit 7).
- The percentage of facilities with off-site migration of contaminated ground water had higher cleanup costs on average than facilities without off-site migration.
- Facilities with commercial or industrial land use on-site tended to have significantly lower costs than facilities with residential, recreational, or agricultural land use on-site.

Time Required to Complete Corrective Actions. As would be expected, the cost of Corrective Action and the time required to complete Corrective Action were positively correlated:

- 85 percent of facilities with estimated costs under $1 million were expected to complete all remedial activities in less than 5 years; and
- 80 percent of facilities with estimated costs over $50 million were expected to take at least 10 years to complete remedial activities.

Exhibit 7
Corrective Action Costs and Number of Contaminant Types
(Cumulative Percentages)

Number of Contaminants Types	< $ 1 million	< $ 5 million	< $ 10 million	< $ 25 million	< $ 50 million	< or ≥ $50 million
1 type	65%	80%	85%	95%	95%	100%
2 types	10%	60%	65%	90%	90%	100%
3 types	0%	30%	65%	90%	90%	100%
4 types	0%	0%	2%	10%	45%	100%
5 types	0%	0%	0%	85%	85%	100%
Total	30%	55%	70%	90%	90%	100%

Multiple contaminant types (e.g., VOCs, SVOCs, etc.) at a facility were positively correlated with the length of time required to complete Corrective Action (see Exhibit 8). In addition, facilities with off-site

contaminant migration on average were expected to spend more time to complete remedial actions than facilities without off-site contaminant migration.

Exhibit 8
Time to Complete Remedial Activities by Number of Contaminant Types
(Cumulative Percentages)

Types of Contaminants	Time to Complete Remedial Activities			
	< 5 years	< 11 years	< 30 years	All years
5 types (1%)	0%	0%	90%	100%
4 types (5%)	0%	50%	60%	100%
3 types (27%)	0%	2%	75%	100%
2 types (17%)	10%	70%	90%	100%
1 type (50%)	45%	80%	85%	100%
Total (100%)	25%	55%	80%	100%