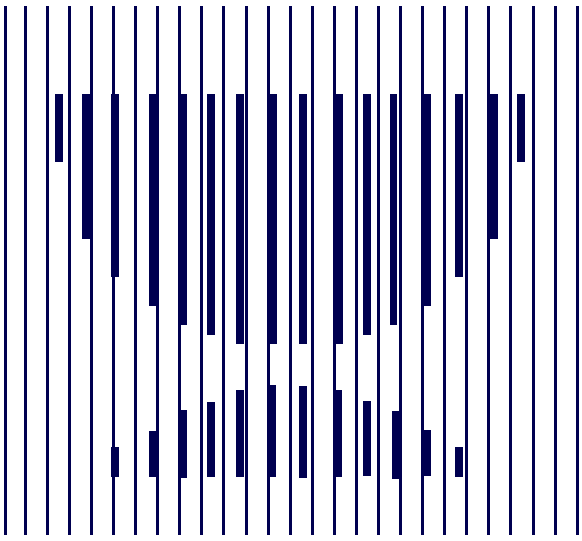
CBO MEMORANDUM

ANALYZING THE DURATION OF CLEANUP AT SITES ON SUPERFUND'S NATIONAL PRIORITIES LIST

March 1994



CONGRESSIONAL BUDGET OFFICE

CBO MEMORANDUM

ANALYZING THE DURATION OF CLEANUP AT SITES ON SUPERFUND'S NATIONAL PRIORITIES LIST

March 1994

CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, S.W.
WASHINGTON, D.C. 20515

This Congressional Budget Office (CBO) memorandum presents new data on the average time required to complete cleanup work at Superfund sites and explores the factors responsible for making some sites take much longer than others. Perry Beider of CBO's Natural Resources and Commerce Division wrote the memorandum, under the direction of Jan Paul Acton and Roger Hitchner, with research assistance from Aaron Zeisler. Mike Cullen, Dave Evans, Lisa Feller, and Edward Ziomkoski of the Environmental Protection Agency cooperated with the author, and Elizabeth Pinkston of CBO and Dave Evans provided valuable comments. Angela Z. McCollough produced the memorandum.

Questions about the memorandum may be addressed to Perry Beider at (202) 226-2946.

CONTENTS

TABLES

FIGURES

INTRODUCTION AND SUMMARY

Since its creation in 1980, the federal Superfund program to clean up the nation's worst hazardous waste sites has been subject to many criticisms, not all of them consistent.[1] One criticism on which widespread agreement exists is that sites on Superfund's National Priorities List (NPL) take too long to be cleaned up. The Environmental Protection Agency (EPA), which administers the program, places sites on the NPL after it has determined that they pose large enough threats to human health and the environment and are too complex or costly to be cleaned up under Superfund's "removal" authorities.[2]

Heretofore, however, the high level of concern over the time required to clean up Superfund sites has not produced much systematic analysis of the problem. EPA's reported statistics on the average duration of cleanups have suffered from problems of consistency and interpretation, and discussions of possible underlying causes have relied primarily on anecdotal evidence from individual sites.[3]

This memorandum by the Congressional Budget Office (CBO) analyzes the time required to clean up NPL sites. The analysis relies primarily on data EPA collected in August 1993 by interviewing remedial project managers (RPMs), the EPA regional employees who oversee the cleanup efforts. The memorandum also discusses and interprets EPA's existing estimates of the average duration of cleanup.

The 1993 interviews asked the RPMs about land use, waste management activities, parties involved, cleanup decisions, and costs at all 1,249 sites on the NPL. The RPMs' answers represent a mixture of hard data and personal judgments. EPA has conducted checks to verify that the data derived from the interviews accurately reflect the answers. CBO has not independently validated the data, but believes that they represent an important addition to the information available about Superfund sites.[4]

---

1. More background on the Superfund program and its areas of controversy can be found in Chapter 1 of Congressional Budget Office, *The Total Costs of Cleaning Up Nonfederal Superfund Sites* (January 1994).

2. By law, removal actions financed by the federal government are generally limited to one year in length and $2 million in cost. Removal actions may be taken at both NPL and non-NPL sites.

3. In 1990 and 1991, EPA collected and analyzed data on the proximate explanations for sites that failed to pass certain milestones by the expected dates. This effort did not examine the underlying explanations for fast or slow cleanup of an entire site from start to finish.

4. The data analyzed here are no exception to the rule that any large data set contains some errors. For example, the information CBO obtained from EPA indicates that 125 of the 1,249 NPL sites are federal facilities; reports produced by EPA, however, give the number of federal facilities as 123. The results of the analysis are not sensitive to minor discrepancies such as these.

The main findings of the analysis concern the average cleanup time for all NPL sites and the deviations of individual sites from the average; the RPMs' assessments of the problems that lead to slow cleanups as well as the advantages that promote fast cleanups; and finally, specific site characteristics that seem to be associated with the problems at sites with slow cleanups (henceforth, "slow sites").

- o National Average. The best available data indicate that the average time between proposed listing on the NPL and "construction completion" (loosely, completion of principal cleanup work) will be at least 12 years for the first 1,249 sites. Given the limitations of the data, the true average is more likely to lie between 13 and 15 years.

- o Early and More Recent Sites. EPA's cleanup managers expect that sites proposed for the NPL after 1983 (almost 60 percent of the total) will be completed much more quickly than those proposed during the 1981-1983 period (roughly 40 percent). This expectation may reflect improvements made in the Superfund program since its early years and a reduction in complexity among the sites listed more recently. It may also, however, reflect more limited knowledge about the recent sites and insufficient consideration of budget constraints and other sources of future delays.

- o Variability. The durations of cleanups vary widely. Because of early actions taken by EPA, the states, or responsible parties, some sites are finished by the time they are formally listed or shortly thereafter. At the other end of the spectrum, RPMs expect a few sites to take as long as 30 or 40 years to reach construction completion. Sites owned or operated by the federal government are much more likely than nonfederal sites to be among those requiring the most time; federal sites also require more time on average--probably at least three years more.

- o Main Explanations. RPMs find the major causes of slow cleanups to be intrinsic site difficulties (such as size and complexity of contamination) and enforcement and legal problems (such as delays in negotiations with potentially responsible parties--PRPs--and shifts in the management of cleanup projects between EPA and the PRPs). Conversely, sites with simple contamination problems and few PRP problems predominate among the cases of fast cleanups.

- Other Explanations. RPMs view constraints on funding and staffing as important secondary contributors to slow cleanups. Other contributing factors that they cite less frequently include problems with achieving the remedy, state governments, and local communities. State problems include objections to remedies chosen by EPA, coordination problems between the states and the federal government, and delays at sites where a state has taken the lead role.

- Characteristics Associated with the Length of Cleanup. According to preliminary analysis, specific site characteristics that appear to be associated with the duration of cleanup at nonfederal sites include the site's size (area) and waste quantity, the existence and number of financially viable PRPs, and the use of part or all of the site by chemical manufacturers.

- Characteristics of Intrinsically Difficult Slow Sites. Specific factors that appear to be associated with intrinsic difficulties at slow nonfederal sites include size exceeding 200 acres, land use that includes chemical manufacturing, and waste disposal to a lake or river. RPMs did not identify mixed-waste landfills as particularly difficult.

- Characteristics of Slow Sites with Enforcement Problems. Characteristics that appear to be associated with enforcement problems at slow sites include the presence of more than 10 PRPs that contributed under 1 percent of the waste, a large waste share from parties that cannot be located or are not financially viable, a large share of municipal solid waste, land use that includes mixed-waste landfills or chemical manufacturing, and expected PRP costs exceeding $15 million. Often, many of these characteristics are found together at the same sites.

DEFINING AND ESTIMATING THE DURATION OF CLEANUP

One difficulty involved in measuring the duration of cleanup at Superfund sites is the possible confusion between different definitions of "duration." A more fundamental problem is that the record of experience with NPL completions is still relatively short, which implies that any type of data on duration will be flawed or limited in one way or another.

Different definitions of the beginning and end of a Superfund site's cleanup time are available, which can complicate the comparison of different

duration statistics. The starting point is usually defined by one of two notices published by EPA in the Federal Register: either the notice proposing that the site be included on the NPL and soliciting public comment, or the notice making the decision to list the site final. The first event, sometimes called placement on the "proposed NPL," occurs on average about 17 months before final listing. Definitions of the end of cleanup typically focus on either construction completion or deletion from the NPL. EPA defines construction completion as the date on which it signs a document indicating that "physical construction is complete for all remedial and removal work required at the entire site."[5] A construction-complete site may require several years of monitoring or even, in the case of a pump-and-treat remedy for groundwater contamination, decades of ongoing activity before EPA is able to remove the site from the list, certifying that cleanup goals have been achieved. Through the end of fiscal year 1993, EPA placed 1,249 sites on the final NPL and proposed another 71 sites; it also identified 218 construction completions and deleted 51 of those sites.

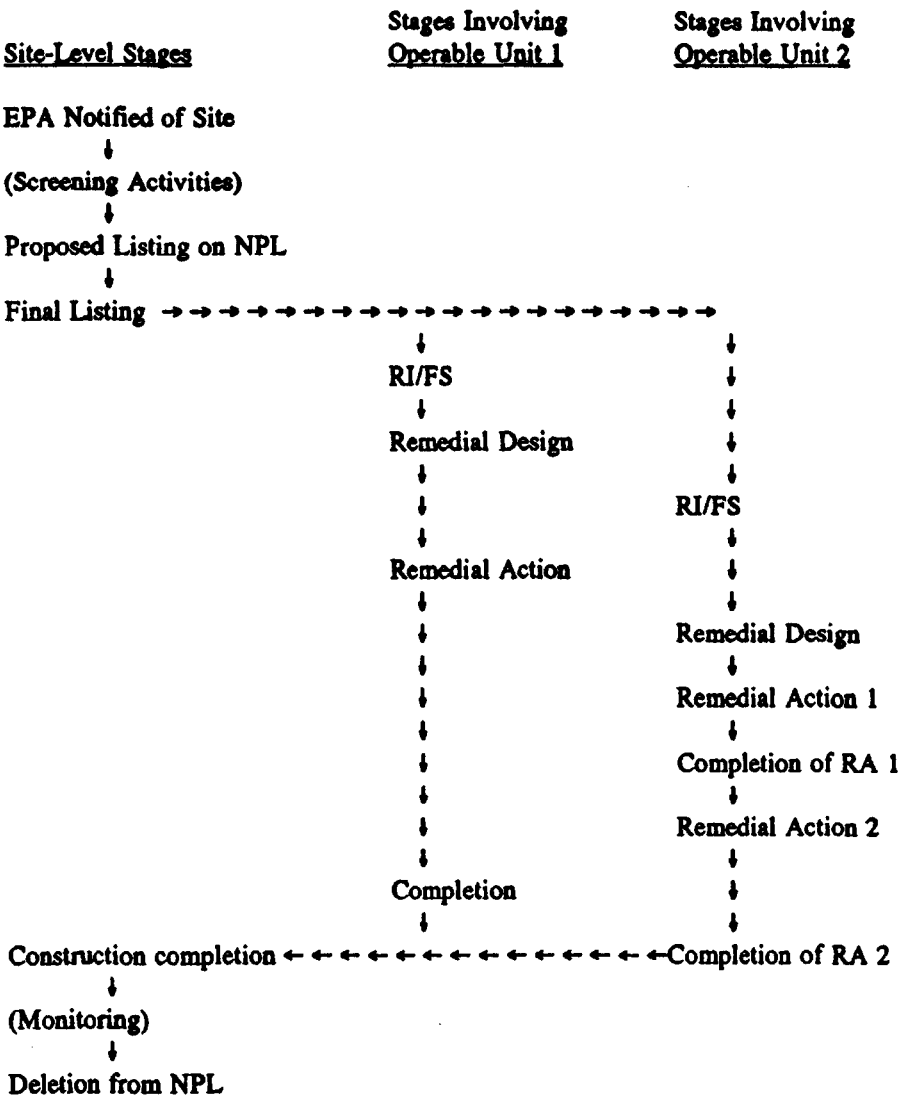
Given a definition of durations at Superfund sites, one way to analyze them is to focus on actual completions observed to date. Such data represent a biased sample of the NPL as a whole, however, because few of the more complex sites have been finished yet. Another approach is to include estimated completion dates for sites to be finished in the future, but such dates are necessarily speculative and may be subject to a variety of biases.

A third approach, which incorporates some data from incomplete sites while reducing the amount of speculation required, uses the cleanup project as the unit of analysis rather than the entire site. EPA may divide a site into multiple "operable units," corresponding to different areas or media (such as soil and groundwater) to be cleaned up, as in the example illustrated in Figure 1. Moreover, each operable unit generally proceeds separately through a series of three stages: the remedial investigation and feasibility study (RI/FS), which maps out the nature and extent of the unit's hazards, evaluates alternative responses, and culminates in the release of a "record of decision" documenting EPA's selection of a particular remedy; the remedial design (RD), which develops the detailed engineering plan for carrying out the remedy; and the remedial action (RA), which is the actual implementation of the remedy. Project-level data generally focus on the level of the individual stage within each operable unit. In rare cases, however, EPA further

---

5. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Directive 9200.2-21 (January 28, 1994). Examples of cleanup construction work include excavation and incineration of contaminated soil, installation of a groundwater treatment system, and construction of a multilayer cap over a landfill. Sites at which physical construction proves unnecessary--because they were listed in error or because their hazards are expected to abate naturally during a monitoring period--are also counted as construction complete.

FIGURE 1. AN ILLUSTRATION OF THE STAGES IN THE SUPERFUND PIPELINE



SOURCE: Congressional Budget Office.

NOTES: EPA = Environmental Protection Agency; NPL = National Priorities List; RI/FS = remedial investigation/feasibility study; RA = remedial action.

subdivides the remedial action within an operable unit into multiple projects for management purposes, as in the case of the second operable unit shown in Figure 1.

The statistics on duration given in EPA's quarterly management reports take the project-level approach, providing separate figures for the average completed or ongoing RI/FS, RD, and RA, and for the time between the end of an RI/FS and the start of the associated RD.[6] This approach allows EPA to avoid speculating on the completion dates of projects in stages or operable units that have not yet begun. It does not, however, totally eliminate the sensitivity of the results to subjective estimates. The reported length of the typical RI/FS-RD-RA sequence rose dramatically from 37.5 quarters to 41.0 quarters, an increase of 10.5 months, in the first six months of fiscal year 1993; EPA staff believe that much of this increase results from an effort to increase the realism of the agency's schedules for finishing RA projects.[7]

Despite their advantages, statistics on the durations of individual cleanup projects are not easily transformed into useful information about whole sites. First, the average RI/FS-RD-RA sequence does not capture any information on the average time between the starts of sequences at sites with multiple operable units, nor does it indicate whether the average applies equally well to first and subsequent units. Second, to the extent that longer RI/FSs, RDs, and RAs tend to be associated with each other, the data are still somewhat biased: the reported average RD and RA length will be pushed downward if the more complex sites or units are disproportionately tied up in the RI/FS stage. Third, the possibility that an operable unit may be subdivided into separate projects at the RA stage implies that adding average RI/FS, RD, and RA project lengths together may not give a meaningful result.

In short, both site-level and project-level data provide imperfect answers to the question of the average time required to clean up a Superfund site. No wholly satisfactory index of average NPL duration will be possible until a more representative sample of sites has completed the process.

---

6. In 1993, the Environmental Protection Agency began also reporting an average duration from a site's proposed NPL listing to the start of its first RI/FS.

7. EPA's review of RA schedules was conducted as part of an effort to evaluate its ability to meet the goal of completing construction work at 650 nonfederal NPL sites by the year 2000.

   Previous CBO testimony to the Congress about increases in Superfund durations has also used data from the quarterly management reports. See, most recently, the statement of Jan Paul Acton, Assistant Director, Natural Resources and Commerce Division, Congressional Budget Office, before the Subcommittee on Transportation and Hazardous Materials, House Committee on Energy and Commerce, April 21, 1993.

ESTIMATES OF AVERAGE DURATION

Three different sets of EPA data provide very similar estimates of the average duration of cleanup at NPL sites. They are the project-level data reported in the quarterly management report for the end of fiscal year 1993; site-level planning data from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS); and site-level data from the regional cleanup managers. The apparent consensus is misleading, however, because each of the data sets has gaps or flaws that bias the estimates downward: the project-level data do not measure site completions and neglect projects that have not yet started, the CERCLIS data use 1999 as the last allowed completion year, and the RPMs do not estimate completion years for 223 sites. The best interpretation of these data is that the average time from proposed listing to construction completion is likely to be at least 12 years and more probably somewhere between 13 and 15 years.

Using project-level data, the trends analysis contained in EPA's quarterly management report for the end of fiscal year 1993 estimates that the sum of the average durations of RI/FS, RD, and RA projects at nonfederal NPL sites, coupled with the time between a site's proposed listing and the start of its first RI/FS, is 11.3 years (see Table 1). The end-point used in this estimate falls short of construction completion, since most sites have more than one operable unit (and a few sites have more than one RA project defined for a given operable unit). If roughly half of NPL sites have multiple operable units and such sites take an average of three years longer than single-unit sites (as suggested by the RPM interview data discussed below), the estimated 11.3 years could correspond to a cleanup duration for the average site (from proposed listing to construction completion) on the order of 13 years. Moreover, optimistic completion dates for ongoing projects or lower representation of complex projects could also bias the given estimate downward.

Coincidentally, site-level planning data from EPA's CERCLIS system also yield an estimate of 11.3 years for cleanup at nonfederal sites, despite the data's broader coverage (from proposal to construction completion). The most obvious problem with these data, entered into CERCLIS by EPA staff in its 10 regional offices, is that the system currently gives 1999 as the completion year for all sites expected to be finished in 1999 or thereafter. Roughly 21 percent of sites in the data set fall into this category; hence, each year beyond 1999 that the average site in this group takes to reach construction completion adds about 0.21 years to the overall average.

TABLE 1. ESTIMATES OF AVERAGE DURATION OF SUPERFUND CLEANUPS

Source	Includes Federal Sites?	Years	Comments
EPA's "Annual FY 1993 Trends Analysis"	No	11.3	Project-level data; excludes projects not yet started. Best interpreted as the time from proposed NPL listing to the completion of one operable unit; the average site has 1.8 operable units.
Planning Data in EPA's CERCLIS Data System	No	11.3	CERCLIS does not currently allow completion dates beyond 1999. Out of 1,104 sites included in the analysis, 237 are listed as finishing in 1999. Each additional year that the average site in this group takes to reach completion adds 0.21 years to the overall average. For example, average completion in 2004 would raise the overall figure to 12.3 years. Officials at EPA headquarters believe that the CERCLIS schedule of completions between 1994 and 1998 is too optimistic.
Responses from Site Cleanup Managers	Yes	11.5	Based on 1,024 sites; excludes 45 federal sites and 178 nonfederal sites for which managers did not estimate completion dates. If all of the excluded sites were finished in 1999, average duration would be 11.8 years. Each year beyond 1999 for the average site in this group adds 0.18 years to the overall figure. Officials at EPA headquarters believe that the managers' combined schedule of completions is too optimistic, at least through the year 2000.

SOURCE: Congressional Budget Office.

NOTES: EPA = Environmental Protection Agency; NPL = National Priorities List; CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System. Durations are from proposed listing on the NPL to construction completion, except where noted.

According to officials at EPA headquarters, a second problem is that the data on completions between 1994 and 1998 are too optimistic, perhaps because the regional staff have not taken adequate account of national budget limits, unexpected site conditions, recalcitrant responsible parties, or other constraints.

The data obtained from interviews with the regional RPMs yield an estimate of 11.5 years as the average duration for cleanup at all NPL sites (and 11.2 years for nonfederal sites alone). To some extent, the similarity between this estimate and the one based on CERCLIS data is not surprising, since the same people often supplied the data in both cases. The real story, however, is again one of different but apparently comparable flaws in the data. The RPMs did not cap their estimates of completion years at 1999, and indeed identified 93 sites expected to reach construction completion between 2000 and 2025. However, they did not supply any completion years for 223 sites (18 percent of the total NPL), which are therefore excluded entirely from the 11.5-year average. If, for the sake of comparison with the CERCLIS estimate, these 223 sites are assumed to finish in 1999, the average duration rises to 11.8 years. Each additional year taken by the average site in this group adds 0.18 years to the overall figure, which might well make 12.4 or 12.9 years a more appropriate estimate.

Moreover, EPA headquarters officials believe that the RPMs' combined schedule of completions by the year 2000, like the similar CERCLIS estimates, are too optimistic. The RPM data show EPA's target of 650 construction completions by the year 2000 being met before the end of 1997, more than three years ahead of time. The significance of this overoptimism, if it exists, depends on the number of sites involved and the amount of slippage from the RPM estimates. If one assumes that 400 sites slip by three years each, for example, the average duration for the NPL as a whole rises by one year. More prolonged slippage from the RPM estimates could lead to an overall average of 15 years or more.

VARIABILITY AROUND THE AVERAGE DURATION

Cleanup durations at individual NPL sites vary widely from the national average. This section discusses the distribution of cleanup times and examines the averages for different subsets of NPL sites.

The 1,024 durations of site cleanups that are known or can be estimated on the basis of the RPM interviews are concentrated most heavily between 9 and 14 years, but almost half of the durations lie outside this range (see

Figure 2).[8] The 9 to 14 year range accounts for 578 sites, 56 percent of the total, with the remaining sites divided almost evenly between those taking 8 years or less (236 sites, or 23 percent) and those taking 15 years or more (210 sites, or roughly 21 percent). Many of the 224 sites for which estimated durations are not available will probably also take 15 years or more.

The far ends of the distribution show that a few sites were finished shortly after they were proposed for the NPL, but others are expected to take 20, 30, or even 41 years. The sites completed within just a few years of being proposed did not undergo the standard RI/FS-RD-RA sequence: early cleanup work conducted by PRPs, the states, or EPA's removal program while the listing process was under way precluded the need for further response. Sites at the upper end of the duration scale include some of the largest and most technically challenging sites, many of which are federal Department of Energy or Department of Defense sites involved in weapons production.[9] In fact, federal facilities account for just 8 percent of all sites with available estimates but 48 percent of those with expected durations of 21 years or more, making a federal site 11 times as likely as a nonfederal site to take that long.

Federal and nonfederal sites are not the only subsets of the NPL to have very different distributions of cleanup times (see Table 2). The average duration of cleanup at federal sites is 14.3 years, three years longer than the average at nonfederal sites. Taking into account the sites for which RPMs could not estimate completion dates (14 percent of nonfederal sites but 36 percent of federal sites), the true difference in average duration could be even larger. Within the set of nonfederal sites, further classification by year of proposed listing on the NPL reveals another sharp distinction: those proposed from 1981 through 1983 have an average estimated duration of 12.9 years, as against 9.6 years for those proposed between 1984 and 1992. Also, sites with more than one operable unit are expected to take almost three years longer, on average, than sites with a single operable unit.

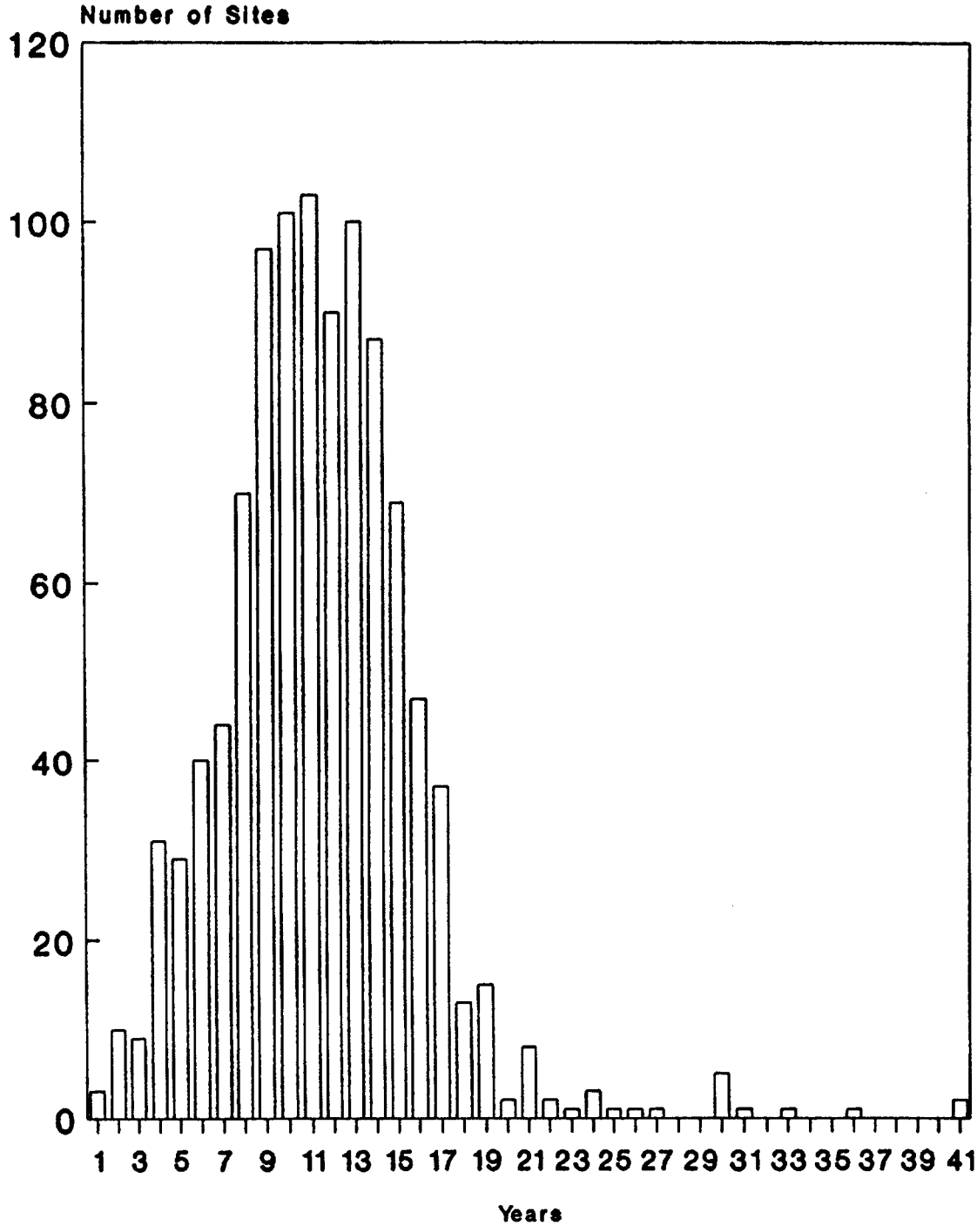
The sharp differences in estimated average duration by year of NPL proposal may reflect a real phenomenon or may be an artifact of the data provided by the RPMs. On the one hand, the finding is consistent with previous CBO research showing a decline in the incidence of the most expensive "mega-sites" among those proposed after 1983; experience and improvements made in the program since its early years could also be

---

8. Durations could not be calculated at 223 sites for which the RPMs did not estimate completion years and 2 sites for which NPL proposal dates were not available.

9. For a discussion of the cleanup challenges at DOE facilities, see Congressional Budget Office, *Cleaning Up the Department of Energy's Nuclear Weapons Complex* (forthcoming).

FIGURE 2. DISTRIBUTION OF ESTIMATED CLEANUP DURATIONS



SOURCE: Congressional Budget Office.

TABLE 2. ESTIMATES OF AVERAGE DURATION FOR SELECTED GROUPS OF NPL SITES

	Total		Proposed 1981-1983		Proposed 1984-1992	
	Number of Sites	Years	Number of Sites	Years	Number of Sites	Years
Federal Sites	80	14.3	3	16.0	77	14.2
Nonfederal Sites	944	11.2	469	12.9	475	9.6
Sites with One Operable Unit	574	10.1	n.c.	n.c.	n.c.	n.c.
Sites with Multiple Operable Units	448	13.4	n.c.	n.c.	n.c.	n.c.

SOURCE: Congressional Budget Office.

NOTES: NPL = National Priorities List; n.c. = not calculated.
Figures exclude sites for which estimates of duration are not available.

contributing to a real reduction in average duration.[10] On the other hand, the differences may merely be evidence of the overoptimism suspected by officials at EPA headquarters. The sites listed more recently have generally not progressed as far through the Superfund pipeline; for example, only 16 percent of those with actual or estimated completion dates had been finished by 1993, compared with 31 percent of the early sites. Hence, estimates of cleanup duration for the later sites would be more strongly affected by any underestimation by RPMs of future budgetary constraints or enforcement problems.

In any event, proposal years and numbers of operable units are likely to be only first-order explanations for the durations of NPL sites. A deeper analysis must identify the site characteristics that explain why some sites were listed earlier or divided into more operable units.

WHY DOES DURATION VARY AMONG SITES?

In its 1993 interviews, EPA asked the remedial project managers to identify the primary and secondary factors involved at fast and slow sites. Other data

10. CBO, *The Total Costs of Cleaning Up Nonfederal Superfund Sites*, pp. 20-24.

available from the interviews shed light on the specific site characteristics associated with the types of problems identified by RPMs at slow sites.

RPM Explanations for Fast and Slow Sites

The RPMs were asked to identify factors contributing to quick progress at sites whose observed or expected duration from final listing on the NPL to construction completion was sufficiently below average. The cutoff time was 8 years for sites with a single operable unit and 10 years for sites with multiple operable units. The interview question about slow sites focused on single-unit sites with duration exceeding 12 years and multiple-unit sites taking more than 14 years.[11] Using these criteria, RPMs identified 493 fast sites and 273 slow sites out of the total NPL of 1,249 sites.[12]

For each fast or slow site, the RPM could select a primary explanation and other major explanations from a list of possible contributing factors. Primary factors were identified for 414 of the 493 fast sites, with five sites receiving two primary explanations each; 620 secondary explanations were given for 359 of the 493 sites (see Table 3). The dominant primary factor at fast sites was simplicity of the contamination problem, cited in 157 cases. No other single response (excluding the catch-all "other" category) was selected at more than 38 sites, although three responses relating to relations with a site's responsible parties together account for 85 cases--"site is single-party," "use of CERCLA settlement tools," and "other unusual PRP cooperation."[13] Secondary responses were distributed more broadly, with the most mentions received by single-party sites (96), simple contamination problems (80), staff stability at EPA (73), other (67), other PRP cooperation (62), and standard problems allowing short RI/FSs (57).

Conclusions based on the analogous data for slow sites are somewhat harder to draw because "other" is the dominant primary category and also the most frequently mentioned secondary category (see Table 4). Review of the notes accompanying the "other" responses indicates that, in many cases, RPMs

---

11. EPA chose these cutoffs as two-year deviations from estimated national averages of 10 and 12 years for single-unit and multiple-unit sites. The interview data themselves produced a lower average of 8.7 years for single-unit sites (neglecting the 1.4 years between proposed and final listing). However, this figure may be biased downward because estimated completion years were not available for 15 percent of such sites.

12. Data transcribed from the RPM interviews list another 50 sites as both shorter and longer than average. These sites, and a half-dozen other anomalous cases, are excluded from the sets of fast and slow sites discussed here.

13. Review of the notes accompanying the 88 "other" responses indicates that prelisting work (mentioned 23 times), sites cleaned up through removal actions or otherwise departing from the standard NPL process (17 cases), and simple remedies (10 cases) account for more than half of the total.

chose "other" only because of problems with the wording of the more specific categories. These problems reflect the time constraints under which EPA collected the data: the agency included the questions on fast and slow sites at CBO's request and did not have time to test fully and improve on the suggested wording.

CBO's interpretation of the RPMs' responses on slow sites, which characterizes most of the "other" responses and brings together related

TABLE 3. PRIMARY AND SECONDARY EXPLANATIONS FOR FAST SITES

Explanation	Citations as Primary Factor	Citations as Secondary Factor
Simple Contamination Problem	157	80
Standard Problem Allowing Short RI/FS	18	57
Unusual EPA Funding Commitment	3	14
Unusual EPA Staff Stability	32	73
Innovative Technology	3	14
Unusual Community Cooperation	4	24
State Lead	13	22
Other Unusual State Cooperation	3	29
Site Is Single-Party	32	96
Use of Settlement Tools	15	16
Other Unusual PRP Cooperation	38	62
Site Is Orphan	6	21
Site Is Not Orphan, but Fund-Lead Cleanup Was Chosen Quickly	4	12
Other	88	67
Do Not Know	3	33

SOURCE: Congressional Budget Office.

NOTES: RI/FS = remedial investigation/feasibility study; EPA = Environmental Protection Agency; PRP = potentially responsible party.

categories of answers, is shown in Table 5. In this interpretation, intrinsic site problems and enforcement and other legal problems are the two most common primary explanations for slow cleanups. (More than one factor within a group may apply to a given site; hence, the number of sites for which a group of factors is a primary or secondary explanation may be less than the sum of the sites affected by the individual factors.) One noteworthy result of classifying the "other" responses is that the number of primary explanations

TABLE 4. PRIMARY AND SECONDARY EXPLANATIONS FOR SLOW SITES

Explanation	Citations as Primary Factor	Citations as Secondary Factor
Novel Problem Requiring Long RI/FS	36	41
Different Areas--Many RI/FSs	36	57
Funding Constraints	11	54
Staffing Constraints	14	53
Size or Availability Constraints on Equipment	1	10
Community Objections to Remedy Selected by EPA	4	29
State Objections to Remedy	11	22
PRP Objections to Remedy	13	48
Use of Settlement Tools	5	14
Other PRP Negotiation Delays	23	65
Lead Changes	20	28
New Remedy Chosen After Start of Remedial Design	8	11
New Remedy Chosen After Start of Remedial Action	1	8
Other	97	69
Do Not Know	4	19

SOURCE: Congressional Budget Office.

NOTES: RI/FS = remedial investigation/feasibility study; EPA = Environmental Protection Agency; PRP = potentially responsible party.

TABLE 5. INTERPRETED EXPLANATIONS FOR SLOW SITES

Explanation	Citations as Primary Factor	Citations as Secondary Factor
Site Problems	107	103
Complex/difficult site	56	57
Many RI/FSs, large site	55	62
Other	4	1
Remedy Problems	29	28
Selected remedy changed or supplemented	9	18
Remedy awaits other events or is phased in	10	2
Innovative remedy	1	0
Other	9	8
Resource Constraints and Miscellaneous Federal Problems	31	96
Funding constraints	12	55
Staff constraints	14	53
Equipment constraints	1	10
Federal facilities and interagency problems (excluding DOJ)	6	6
Other EPA problems	0	7

(Continued)

involving state problems rises from 11 to 29 when problems of state/federal coordination and state-lead sites are included.

The groups cited most often as secondary causes of slow cleanups are those involving enforcement problems, site problems, and resource problems. Individual factors cited more prominently as secondary explanations include objections by PRPs to EPA's chosen remedies, other delays in PRP negotiations, funding constraints, and staffing constraints.[14]

14. Most or all of the reported staffing constraints presumably refer to EPA staff, but the funding constraints may refer to federal and private PRPs as well as to EPA.

TABLE 5. CONTINUED

Explanation	Citations as Primary Factor	Citations as Secondary Factor
State Problems	29	33
Objections to remedy	11	22
Coordination problems with EPA, state leads, other	18	11
Community/Trustee Problems	10	31
Enforcement, Other Legal Problems	84	122
Lead changes	21	28
PRP remedy objections	13	48
Use of settlement tools	6	14
Other PRP negotiation delays	23	65
Large numbers of PRPs; miscellaneous PRP problems	18	14
RCRA coordination; DOJ, court delays	6	6
Other; Do Not Know	11	24

SOURCE: Congressional Budget Office.

NOTES: RI/FS = remedial investigation/feasibility study; DOJ = Department of Justice; EPA = Environmental Protection Agency; PRP = potentially responsible party; RCRA = Resource Conservation and Recovery Act.

Within a category, individual sites may have multiple explanations; hence, the number of individual explanations may add to more than the category totals.

EPA's use of settlement tools such as *de minimis* settlements and mixed funding has been a topic of much interest in recent years. Although the available data do not necessarily indicate the likely effects of more widespread use of the tools, they do show that *de minimis* settlements and mixed funding have had only a minor impact on cleanup times thus far. Accompanying notes show that *de minimis* settlements are cited as primary factors at two fast sites and one slow site, and as secondary factors at three sites of each type; mixed funding is mentioned as a secondary factor twice each at fast and slow sites.

Effects of Individual Site Characteristics

The RPMs' responses to the questions on fast and slow sites provide important information about the types of problems that lead to slow cleanups and the advantages that promote fast cleanups, but they do not go very far in identifying the types of sites at which these problems or advantages are likely to occur. Outlined below are findings (for nonfederal facilities) on a site's likelihood of being fast or slow, and of being slow because of inherent site problems or enforcement and legal problems, as a function of specific site characteristics.[15] These findings cannot be considered definitive because any characteristic examined in isolation may be serving as a proxy for more fundamental causes, but they can help suggest important areas for further study.

Effects on Site Duration. Of the universe of 1,124 nonfederal sites, the RPMs identified 25 percent as slow and 40 percent as fast, as shown in Table 6; the speed of the remaining 35 percent was either intermediate or unknown.[16] To summarize the findings, an above-average chance of slow cleanup is found among sites proposed before 1984; sites with more than two operable units, 200 acres, or 50,000 cubic yards of waste; sites involving dry cleaning, chemical manufacturing, mining land, or waste disposal to a lake or river; sites with more than 10 PRPs; and sites located in New England. Fast sites are disproportionately found among sites proposed after 1983, sites with fewer than 10 PRPs, and orphan sites.

As expected, given the average distributions presented in Table 2, sites proposed for the NPL between 1981 and 1983 and those with three or more operable units have greatly above-average chances of being slow--41 percent and 48 percent, respectively. These characteristics may have a direct influence on the duration of cleanup, if EPA's inexperience and start-up problems delayed the progress of early sites and if dividing a site into several operable units itself leads to a lengthier cleanup schedule. However, they are also likely to be serving, at least in part, as proxies for other characteristics leading to early listing or subdivision into multiple units. Again, the correlation with the year of listing on the proposed NPL may also be partly or wholly an artifact of excessive RPM optimism.

---

15. Sites owned by the federal government (typically military bases or Department of Energy facilities) are excluded from the analysis because their problems of cleanup length are often different from those encountered at nonfederal sites.

16. The RPMs' classification of the 125 federal facilities is 31 percent slow sites, 35 percent fast sites, and 34 percent sites of medium or unknown cleanup time.

Other, more exogenous characteristics related to the size of a site and the complexity of its contamination problem also show correlations with the distribution of cleanup times. The acreage of a site is highly relevant, with almost half of the sites exceeding 200 acres classified as slow. Estimated waste quantity has a noticeable but less dramatic effect: the percentage of slow sites is roughly 7 points higher for sites with more than 50,000 cubic yards of waste than for sites with less than that amount. The data on acreage and waste quantity used here are from EPA's NPL Characterization Project, which contains information collected as sites were screened for placement on the NPL. Data on waste quantity for many sites were not available from the Characterization Project, which explains why the figures for the sites with data on waste do not average out to those for all 1,124 nonfederal sites.

TABLE 6. DISTRIBUTIONS BY DURATION OF NONFEDERAL NPL SITES WITH SELECTED CHARACTERISTICS

		Duration Distribution (In percent)		
	Number of Sites	Slow	Fast	Intermediate or Unknown
All Nonfederal Sites	1,124	25.1	39.9	35.0
Proposed During 1981-1983	538	41.1	22.9	36.1
Proposed During 1984-1992	584	10.4	55.7	33.9
Three or More Operable Units	145	48.3	20.7	31.0
Site Area				
More than 200 acres	89	47.2	21.3	31.5
Not more than 200 acres	919	23.8	41.3	34.8
Waste Quantity				
More than 50,000 cubic yards	157	31.8	33.8	34.4
Not more than 50,000 cubic yards	691	25.2	39.9	34.9
Past or Current Site Use Includes				
Dry cleaners, laundries	27	51.9	22.2	25.9
Chemical manufacturing	151	39.1	36.4	24.5
Metal mining	30	33.3	26.7	30.0
Mixed-waste landfills	127	26.8	31.5	41.7
Contamination Included Lake/River Disposal	47	42.6	17.0	40.4

(Continued)

The type of land uses associated with a site are sometimes implicated in the length of its cleanup. As Table 6 shows, 52 percent of the sites used partly or entirely by dry cleaners and other laundry businesses are slow, more than twice the national average. The small number of sites involved, however, suggests special caution in interpreting this finding. In fact, the very large areas of contamination in the San Fernando and San Gabriel valleys in California, which are divided into four NPL sites each and received contamination from large numbers of sources, account for 8 of the 14 slow sites at which the land use included dry cleaners. Sites involving chemical manufacturing and metal mining are also more likely to be slow; the sample of mining sites is small, however. Mixed-waste landfills--that is, landfills containing both industrial waste and municipal solid waste--are similar to

TABLE 6. CONTINUED

	Number of Sites	Duration Distribution (In percent)		
		Slow	Fast	Intermediate or Unknown
Contamination Includes				
Dioxins, PCP	54	29.6	40.7	29.6
Asbestos	42	28.6	35.7	35.7
PCBs	210	27.6	36.7	35.7
Metals	677	25.0	40.3	34.7
Lead	382	20.7	42.4	36.9
Number of PRPs				
Zero to 10	656	20.6	47.9	31.6
More than 10	400	31.3	28.0	40.8
Orphan Sites	88	10.2	59.1	30.7
Number of PRPs Contributing Less Than 1 Percent of Waste				
Zero to 10	532	22.6	44.4	33.1
More than 10	113	31.9	31.0	37.2
Located in EPA Region 1	77	39.0	19.5	41.6

SOURCE: Congressional Budget Office.

NOTES: NPL = National Priorities List; PCP = pentachlorophenol; PCBs = polychlorinated biphenyls; PRP = potentially responsible party; EPA = Environmental Protection Agency.

all nonfederal sites in their percentage of slow sites, but are less likely to be fast and more likely to be in the remaining "intermediate or unknown" duration category.

As for the types of contamination involved at a site, the distribution by duration category of the 47 sites at which some contamination was caused by disposal to a lake or river is tilted sharply toward slow sites and away from fast sites compared with the national average. The data do not show any significant correlations between the presence of dioxins or PCPs and a site's duration category; the same is true for asbestos, PCBs, and metals in general. Sites involving lead contamination appear somewhat less likely to be slow.[17]

Another marked correlation exists between the distribution of durations and the number of potentially responsible parties. Sites with more than 10 PRPs are half again more likely to be slow and 40 percent less likely to be fast than sites with zero to 10 PRPs. Orphan sites--that is, sites with no identifiable PRPs capable of contributing to the cost of cleanup--show the strongest tilt away from slow durations and toward fast durations of any group of sites examined in the table. The number of potential *de minimis* parties does not seem, however, to have a distinct effect: sites at which more than 10 PRPs each contributed less than 1 percent of the waste show roughly the same distribution as all sites with more than 10 PRPs.

Finally, the RPMs in EPA's Region 1 (New England) expect a much higher fraction of slow cleanups at their sites than do all RPMs nationwide (39 percent as against 25 percent) and a much lower fraction of fast cleanups (19 percent as against 40 percent).[18] This correlation could be an artifact of the data, if Region 1's sites are atypical in other ways that affect duration or if its RPMs simply took a less optimistic view of Superfund's future progress.

Interestingly, however, Region 1 reported a disproportionate number of funding and staffing constraints. The region accounts for less than 7 percent of all nonfederal NPL sites but 20 percent of the sites at which RPMs cited these constraints as a factor leading to slow cleanup (16 cases out of a total of 82) and 43 percent of the sites for which RPMs identified either constraint as the primary factor (3 of 7 funding problems and 6 of 14 staffing problems).

---

17. One characteristic not reported in Table 6 is the presence of groundwater contamination. Because such contamination is so common, having been identified at 81 percent of all nonfederal sites, it has little power to explain why some sites take longer than average.

18. For all other regions, the share of long sites was 31 percent or less. At the other end of the spectrum from Region 1, Region 6 (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas) and Region 7 (Iowa, Kansas, Missouri, and Nebraska) reported 15 percent and 14 percent long sites and 65 percent and 68 percent short sites, respectively, on the basis of 66 and 56 total sites.

Without the nine slow sites involving primary funding or staffing problems, the share of slow sites in Region 1 would be similar to the national average.

Effects on Intrinsic Site Difficulties. EPA's cleanup managers frequently cited intrinsic site difficulties, such as size and complexity, as factors contributing to slow site cleanups. As Table 7 shows, the RPMs identified such difficulties as primary or secondary explanations at 45 percent of all 282 slow nonfederal NPL sites, and as primary explanations at 31 percent.

Two site characteristics that were shown above to be correlated with slow cleanups are nonetheless not positively associated with the perceived difficulty of slow sites. Slow sites proposed for the NPL between 1981 and 1983 are no more likely to be judged difficult than their later counterparts. This result suggests that site difficulty per se is at best part of the reason why a higher share of early sites have long cleanup times; again, other possible reasons include EPA inexperience and start-up problems in the program's initial years and underestimation by RPMs of the length of sites added after 1983. As Table 7 also shows, slow sites in EPA's Region 1 are distinctly less likely to be considered difficult than those in other regions; this result is expected, since Region 1 RPMs attributed more of their slow sites to funding and staffing problems.

In the remaining cases, the expected pattern generally prevails: physical and technical site characteristics that were found to be strongly correlated with slow cleanups are also correlated with a slow site's perceived difficulty. Slow sites with three or more operable units are much more likely to be considered intrinsically difficult, as are those with more than 200 acres or 50,000 cubic yards of waste. Site difficulty is either a primary or secondary explanation at *all* slow sites involving dry cleaners and mining, and a primary explanation in almost all the cases. Again, however, the samples of sites included in these categories are small. A larger sample suggests that chemical manufacturing is correlated with the difficulty of slow sites, not just with site duration itself. Conversely, mixed-waste landfills, which are not associated with slow cleanups, also show no association with the difficulty of slow sites.

Site difficulty is almost uniformly considered a primary or secondary explanation for slow cleanups in the relatively few cases involving waste disposal to a lake or river. Two other indicators of surface-water hazards are introduced here: the presence of widespread sediment contamination is strongly correlated with the difficulty of slow sites, but the more general existence of an impact on surface water is not. The small number of slow sites with contamination by dioxins or PCP are more likely than the average slow site to be difficult, even though these substances did not show a major

TABLE 7. CORRELATIONS BETWEEN INTRINSIC DIFFICULTY AND SELECTED CHARACTERISTICS OF SLOW SITES

	Number of Sites	Percentage with Intrinsic Difficulties	Percentage with Primary Intrinsic Difficulties
All Slow Nonfederal Sites	282	45.0	30.9
Proposed During 1981-1983	221	44.8	30.3
Proposed During 1984-1992	61	45.9	32.8
Three or More Operable Units	70	80.0	60.0
Site Area			
More than 200 acres	42	85.7	71.5
Not more than 200 acres	219	36.1	21.9
Waste Quantity			
More than 50,000 cubic yards	50	60.0	48.0
Not more than 50,000 cubic yards	174	36.8	22.4
Past or Current Site Use Includes			
Dry cleaners, laundries	14	100.0	85.7
Chemical manufacturing	59	67.8	45.8
Metal mining	10	100.0	90.0
Mixed-waste landfills	34	38.2	29.4
Contamination Included Lake/River Disposal	20	95.0	70.0
Widespread Sediment Contamination	14	85.7	50.0
Surface Water Impacts	181	44.8	31.5
Contamination Includes			
Dioxins, PCP	16	62.5	56.3
Asbestos	12	41.7	33.3
PCBs	58	41.4	27.6
Metals	169	43.8	30.2
Lead	79	44.3	26.6
Located in Region 1	30	33.3	23.3

SOURCE: Congressional Budget Office.

NOTES: PCP = pentachlorophenol; PCBs = polychlorinated biphenyls.

correlation with site duration itself. The presence of asbestos, PCBs, metals in general, or lead has no bearing on a slow site's perceived difficulty.

Effects on Enforcement and Legal Problems. Enforcement problems are cited nearly as often as intrinsic site difficulties as primary explanations at slow nonfederal NPL sites (29 percent of the time), and even more often as primary or secondary explanations (57 percent of the time). As Table 8 shows, many factors appear to predispose slow sites to having enforcement problems: the existence of more than 10 PRPs (or even more so, more than 50 PRPs), more than 10 PRPs that contributed less than 1 percent of the site's waste, the share of waste from off-site orphan parties exceeding 12 percent, past or current land use including mixed-waste landfills or chemical manufacturing, municipal solid waste exceeding 50 percent, and expected PRP costs exceeding $15 million. Dry cleaning and mining land uses have little bearing on the probability that a slow site has significant enforcement problems and a negative impact on the likelihood that such problems are the primary explanation. This result is expected, given that intrinsic difficulties are often identified as the primary explanation at these sites.[19]

The characteristics examined in Table 8 highlight the limitations of single-factor analysis, in that many of the investigated characteristics are likely to be correlated with each other. For example, sites with many PRPs are more likely to have many PRPs who contributed small shares of waste, and sites with a majority of municipal solid waste are likely to be mixed-waste landfills. Given such correlations, multivariate regression techniques are required if analysis is to distinguish the truly causal factors from the indirect proxies.

Multiple Regression Analysis of Site Duration

In essence, regression analyses attempt to find the mathematical line or curve of a given type that best fits the given data. By examining multiple explanatory factors at the same time, such analyses can estimate the independent effects of each individual factor when all other factors remain constant. CBO has conducted only the most preliminary regression analysis. Nonetheless, the available results do offer some qualified support for the findings of the single-variable correlations and suggest some potentially important topics for further study.

---

19. Waste type and quantity, among the characteristics examined in previous tables, are omitted here on the theory that they are unlikely to affect a site's contentiousness except through their impact on cleanup costs.

dichotomous data.[20] Other regressions analyzed estimated durations themselves, using the ordinary least squares (OLS) technique. The two measures of duration are not fully consistent: 66 of the 282 slow nonfederal sites identified by the RPMs appear to fit the definitions of medium or fast sites, based on the available listing dates, completion dates, and numbers of operable units. Time constraints precluded a site-by-site reconciliation of the two types of data.

Most of the factors that were shown in Table 6 to be individually correlated with the distribution of sites by duration also appear to be statistically significant--that is, to be very likely to have non-zero impacts--in one or both types of regression analysis (see Table 9). Both the OLS and logit regressions indicate that orphan sites tend to be faster and that sites proposed early, divided into several operable units, large in area, or involving dry cleaning or chemical manufacturing land uses are more likely to be slow. Again, because of the limited sample, the results on sites involving dry cleaning should be considered particularly tentative. The OLS analysis also suggests that larger waste volumes and the presence of more than 10 PRPs increase a site's duration, and the logit analysis suggests that the presence of widespread sediment contamination increases a site's chance of being slow.

One finding of note is that sites proposed for the NPL through 1983 and those with several operable units still appear significantly different in duration, even after correcting for site area, waste quantity, existence of surface water contamination, number of PRPs, and other factors. This finding has three possible explanations, one of which applies to the NPL proposal year but not to the number of operable units.

First, these two characteristics could still be serving as proxies for other factors or combinations of factors not included in the regressions.[21] Second, as discussed above, the connection with the proposal year could be an artifact of the data, resulting from the PRPs' underestimating the difficulties facing Superfund in the future. Third, a site's year of proposal and number of units could truly have direct impacts on its cleanup duration. To the extent that dividing a site into several operable units itself lengthens the time required to reach construction completion, the tension between EPA's current strategy

---

20. That many of the explanatory variables considered in CBO's analysis, like the slow/not-slow outcome variable, are also dichotomous suggests that discriminant analysis might produce better estimates than those from the logit regressions. Further research is necessary to answer this question.

21. When the variable indicating whether a site's proposal year is "early" or "late" is removed from the equation, the variable indicating the presence of contaminated surface water becomes more significant. This result suggests that many early sites had surface water problems, but does not explain why earliness itself appears to be a better predictor of long cleanup duration.

of dividing cleanup into short-term response work and long-term remediation, on the one hand, and the goals of reducing cleanup duration and achieving site completions, on the other hand, may be greater than expected.

Two variables that are individually correlated with the distribution of site durations--disposal to a lake or a river as a source of contamination and mining as a past or current land use--do not appear to be significant in the multivariate regressions. The lack of impact of the mining variable suggests that it was serving as a proxy for site size in the individual correlations.

TABLE 9. REGRESSION RESULTS ON CLEANUP DURATION

OLS Regressions on Duration in Years	Logit Regressions on Probability That Site Is "Slow"
Characteristics Found to Be Significantly Associated with Long Cleanups	
Early Proposal Year	Early Proposal Year
Several Operable Units	Several Operable Units
Large Size (Acreage)	Large Size (Acreage)
Large Waste Volume	
	Widespread Sediment Contamination
Land Use Including Dry Cleaning	Land Use Including Dry Cleaning
Land Use Including Chemical Manufacturing	Land Use Including Chemical Manufacturing
More Than 10 PRPs	
Viable PRPs (Not orphan site)	Viable PRPs (Not orphan site)
Characteristics Generally Found Not to Be Significant	
Waste Disposal to Lake or River	
Contamination Affecting Surface Water	
Land Use Including Mining	
Many PRPs Contributing Less Than 1 Percent of Waste	
Large Estimated Orphan Share from Off-Site Parties	

SOURCE: Congressional Budget Office.

NOTES: OLS = ordinary least squares; PRP = potentially responsible party.

The regressions investigated the differences between each EPA region and Region 10 (arbitrarily chosen as the default category) rather than the difference between each region and the national average. In qualitative terms, both OLS and logit results suggest that sites in Regions 1, 4, and 5 (corresponding roughly to the New England, southeastern, and Great Lakes states) take longer than average, while sites in Regions 6, 7, and 8 (the south-central, central plains, and Rocky Mountain and Dakota states) take less time than average. CBO cannot identify which of these differences, if any, are statistically significant.

Further research into the explanations of cleanup duration could benefit from the use of other statistical techniques, more variables, and a closer scrutiny of the underlying data. Such research would help not only to confirm or refute the present qualitative findings of significance, but also to quantify the size of the effects. Additional analysis could also help clarify the characteristics that make a site slow because of intrinsic difficulties or enforcement problems.