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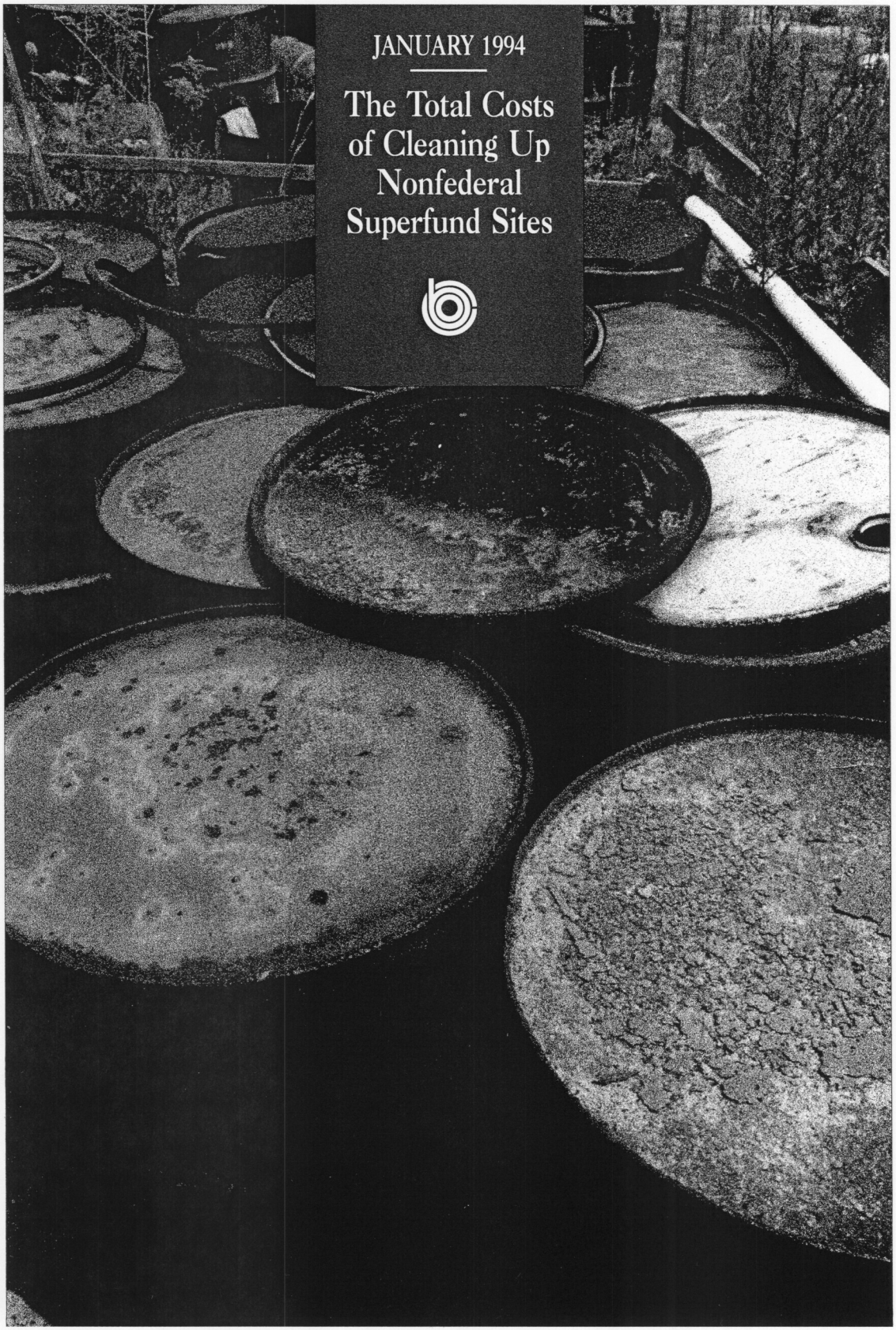
The Total Costs of Cleaning Up Nonfederal Superfund Sites



THE TOTAL COSTS OF CLEANING UP NONFEDERAL SUPERFUND SITES

The Congress of the United States
Congressional Budget Office

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NOTES

Numbers in the text and tables of this study may not add to totals because of rounding.

Except for references to legislation, all of the years referred to in this study are federal fiscal years.

Cover photo shows drums at an abandoned waste site in New Jersey that ranked high on Superfund's National Priorities List. (Photo by S.C. Delaney, Environmental Protection Agency.)

Preface

The federal Superfund program to clean up the nation's worst hazardous waste sites has been controversial since its creation in 1980. As the Congress begins to consider reauthorizing Superfund, which is due to expire on September 30, 1994, it is giving increased scrutiny to several aspects of the program, including the cost. This study, written at the request of the ranking Member of the House Committee on the Budget, analyzes the future costs to the public and private sectors that can be expected under Superfund's current policies. In keeping with the mandate of the Congressional Budget Office (CBO) to provide objective analysis, the study makes no recommendations.

Perry Beider of CBO's Natural Resources and Commerce Division wrote the study, under the supervision of Jan Paul Acton and Roger Hitchner. David Cooper, Dave Evans, Bruce Pumphrey, and many other staff members at the Environmental Protection Agency gave the author extensive cooperation with his research. Many valuable comments were made by Kim Cawley, Elizabeth Pinkston, Linda Radey, and Christopher Williams within CBO, and by William Colglazier, Dave Evans, Charles Openchowski, Kate Probst, and Bruce Pumphrey outside the agency.

Christian Howlett Spoor edited the manuscript. Gwen Coleman and Donna Wood typed the tables. Kathryn Quattrone, with the assistance of Martina Wojak-Piotrow, prepared the study for publication.

Robert D. Reischauer
Director

January 1994

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Summary

The cost of cleaning up the nation's hazardous waste sites is far greater than the Congress expected in 1980 when it passed the federal law governing such cleanup. The magnitude of remaining costs is an important issue as the Congress reviews the progress and prospects of the federal Superfund program, set to expire on October 1, 1994. This study seeks to inform the Congressional and public reauthorization debate by estimating Superfund's future costs under existing policies.

Unlike most federal environmental laws, which focus on reducing new emissions of hazardous substances, Superfund focuses on cleaning up sites that are already contaminated. The Environmental Protection Agency (EPA) has evaluated thousands of contamination problems and placed nearly 1,300 of the worst sites on the National Priorities List (NPL) for intensive cleanup. The differences in type and extent of contamination at NPL sites lead to a range of cleanup costs per site from the millions of dollars to the hundreds of millions. Under the Superfund law, certain "responsible parties" are liable for a site's costs; EPA can enforce this liability either by having the responsible parties perform the cleanup under its oversight or by conducting its own cleanup (with the government of the state in which the site is located paying a required share) and recovering the costs afterward.

Data gained from the first 12 years of Superfund's operation underpin the estimates reported in this study. Yet much remains uncertain--particularly the number of sites that will ultimately be identified as needing cleanup. Lesser sources of uncertainty in the estimates are the costs of evaluating and cleaning up each site and the public and private costs of administering the program, including the costs of establishing or contesting liability for cleanup. The Congressional Budget Office's (CBO's) analysis reflects these uncertainties by reporting estimates for three scenarios based on differing assumptions. None of the scenarios, however, incorporate major changes in policy or breakthroughs in cleanup technologies.

Estimates of Future Costs

CBO's base-case estimate is that Superfund cleanups will cost the public and private sectors about $75 billion from fiscal year 1993 onward. This figure includes all Superfund-related expenditures except those associated with cleaning up federal facilities and is in discounted, present-worth dollars--a measure that is useful in summarizing costs incurred over many years because it takes into account the time value of money. (For comparison, the estimated present worth of spending obligations from the beginning of Superfund through 1992 is less than $30 billion.) Estimated direct costs to the various payers, not including subsequent cost recoveries, are $43 billion (58 percent) to responsible parties, $28 billion (38 percent) to the federal government, and $3 billion (4 percent) to the states for required contributions to cleanups conducted by EPA. State

and local governments that are liable at specific sites will also pay some share of the responsible-party costs.

The present-worth estimate of about $75 billion assumes a real discount rate of 7 percent per year; the corresponding figure in real dollars (adjusted for inflation but not discounted) is roughly $230 billion. These costs are incurred through the year 2070; hence, annual costs over the entire 78-year period average $2.9 billion, which closely matches current combined public and private spending for Superfund. This simple average can be misleading, however, because some expenditures must precede others. Average costs before 2047, the year in which the last cleanup project is assumed to move into the operations and maintenance phase, are estimated to be $4.2 billion per year. Moreover, assuming no constraints on funding, annual spending could rise over the next decade to a peak of $9.1 billion in 2003.

Estimates other than the base-case figures were developed using alternative assumptions--the most important concerning the number of sites to be discovered and cleaned up. The base case assumes that EPA ultimately places 4,500 nonfederal sites on the NPL, a fourfold increase over the 1,149 such sites included by the end of 1992. This assumption comes from an extrapolation of the number of sites screened for the NPL so far and a rough estimate by EPA staff of the percentage of screening sites that may be placed on the NPL. Plausible variations in the assumptions about future screening sites and the placement rate lead to a total of 2,300 NPL sites in the low case and 7,800 sites in the high case. Total estimated costs in the low case are $42 billion in present-worth terms, of which the federal government's share is $17 billion. In the high case, the estimated total is $120 billion, including $43 billion spent by the federal government.

Site investigation and cleanup account for about 65 percent of future Superfund costs in all three scenarios. Costs for litigation, negotiation, and other activities associated with the liability system represent about 24 percent of the total. This share is consistent with CBO's analysis of expenditures through 1992, which does not support the common perception that most Superfund money has been spent on attorneys' fees. The remaining 10 percent to 12 percent of estimated future costs reflect federal costs for management, support, and research.

How Does This Study Differ from Previous Analyses of Superfund Costs?

The Environmental Protection Agency and a group of researchers at the University of Tennessee have both published partial estimates of Superfund's future costs. The CBO estimates differ from these predecessors in four ways.

- CBO's estimates are more comprehensive, including public and private administrative and legal costs and cleanup costs for sites not yet discovered.

- CBO's analysis separates NPL sites into three cost groups. The Superfund experience to date shows that some sites are hundreds of times more expensive than others; the base-case estimate of the average cost for a small minority of "mega-sites" is $169 million in cleanups conducted by EPA, compared with a $24 million average for all other sites. Evidence suggests that relatively fewer mega-sites have been discovered since the early years of the program, which leads CBO to expect a downward trend in average cleanup costs as time passes.

- The estimates consider the time path of Superfund expenditures in order to calculate their discounted present worth.

- The analysis of cleanup costs incorporates recent EPA data on the differences between initial estimates and final costs. It also allows for the possibility that private-sector cleanups may cost less than those performed by the government.

The wider coverage and the use of discounted dollars in CBO's analysis yield very different costs than the EPA and Tennessee estimates of $16 billion and $151 billion, respectively. The EPA figure is restricted to costs incurred by the federal government

during cleanup of the first 1,236 NPL sites; the Tennessee figure gives past and future costs of cleaning up 3,000 nonfederal NPL sites in undiscounted dollars, omitting administrative and legal costs. In terms of average cleanup costs per site, the CBO estimates are lower than comparable EPA and Tennessee figures, primarily because of the assumptions about the future incidence of mega-sites and the costs saved in private-sector cleanups.

Implications for Federal Cleanup Policy

CBO's analysis of future Superfund costs has several important implications for the federal government's cleanup policy.

- *Estimates of total Superfund costs depend strongly on the ultimate number of sites to be cleaned up--a number that remains highly uncertain.* The CBO scenarios assume that the total number of nonfederal NPL sites could be as low as 2,300 or as high as 7,800; largely as a result, present-worth costs vary by a factor of almost three between the low case and the high case. More extreme numbers of NPL sites are less likely than those assumed here, but they cannot be ruled out from the data now available.

- *Under any plausible assumptions, Superfund expenditures are not even halfway complete; thus, the Congress may be justified in considering policy changes that involve short-term transition costs but long-term benefits.* CBO's analysis implies that the funds obligated through fiscal year 1992 represent between 19 percent and 40 percent of the economic value of Superfund's total costs, measured in present-worth dollars. In undiscounted dollars, these obligations constitute only an estimated 5 percent to 17 percent of the ultimate total.

- *Required contributions by the states will remain a relatively small share of total costs, but they will rise dramatically from current levels.* The estimated state share of future costs is 4 percent to 5 percent in present-worth terms (8 percent to 9 percent in undiscounted dollars). The observed share to date is much lower--less than 1 percent--because state contributions are concentrated at the end of the cleanup process. EPA data and studies indicate that these contributions totaled about $0.1 billion through 1992, whereas the base-case estimate of future state costs is $3.3 billion in present-worth terms, or $19 billion in undiscounted dollars.

- *Under CBO's base-case and high-case assumptions, but not its low-case assumptions, EPA will need large increases in funding to avoid a growing backlog of sites awaiting study and cleanup.* The base case assumes that roughly 900 sites--14 percent of those in the final, "decision-pending" stage of EPA's screening process--were awaiting placement on the NPL at the end of 1992. Adding these sites to the list over a 10-year period while expeditiously cleaning up current NPL sites and processing new sites brought to EPA's attention would require federal Superfund spending to double by the year 2003. (Total public and private spending would triple.) Keeping pace with the site work load in the high case would require federal spending to triple (and total spending to increase almost fivefold).

When the current Superfund law was enacted, little information was available about the ultimate costs to the taxpayer and the economy. Now that the general order of magnitude of public and private Superfund obligations is becoming clearer, the program's balance of benefits and costs may warrant a second look.

The estimates described in this study do not evaluate policy alternatives that might be less costly than current law, but they do provide a baseline against which alternatives could be evaluated. Alternatives that have been discussed include narrowing the range of sites handled by the federal program, revising cleanup standards, reordering priorities among sites or within sites, giving local communities more say in decisions about cleanup, narrowing or eliminating the law's liability provisions, and encouraging or requiring EPA to make greater use of settlement tools available in the current law.

Chapter One

The Superfund Program and Its Types of Costs

The federal Superfund program to clean up the nation's worst hazardous waste sites was created by the Congress in 1980, partly in response to reported threats to human health and the environment at the Love Canal site in Niagara Falls, New York. The problem of cleaning up waste hazards has proved to be larger and more expensive than the Congress originally expected, and the end is not yet in sight. During its first 12 years, the Superfund program completed close to 2,500 removal actions, which include responses to emergencies such as chemical spills and leaking barrels and interim steps to eliminate the immediate threats posed by more complex hazards. The program also placed 1,275 sites on the National Priorities List (NPL) for longer and more extensive remedial cleanups. But despite public and private spending of more than $13 billion through 1992, only 149 of the 1,275 NPL sites had completed all construction work related to the cleanup remedies, and just 40 had been fully cleaned up. Furthermore, estimates of the ultimate number of NPL sites range between 2,100 and 10,000.[1]

The potential size of the Superfund program raises important questions about its likely costs and benefits. To shed some light on these questions, this study estimates the future costs to the public and private sectors of Superfund cleanups at all sites not owned by the federal government. (The costs of cleaning up federal facilities are borne not by the Superfund program but by the agencies that operate the sites--principally the Departments of Energy, Defense, and the Interior--and pose some different policy issues.)[2] This study does not try to estimate the benefits of cleanup; a 1991 report by the National Research Council suggested that reliable estimates of the benefits may not be possible given the present state of toxicological knowledge.[3]

Superfund in Brief

The Superfund law is the broadest federal statute governing cleanup of waste hazards--or, more formally, sites contaminated with hazardous sub-

1. See Milton Russell, E. William Colglazier, and Mary R. English, *Hazardous Waste Remediation: The Task Ahead* (Knoxville, Tenn.: University of Tennessee, Waste Management Research and Education Institute, 1991); and Office of Technology Assessment, *Coming Clean: Superfund Problems Can Be Solved . . .* (October 1989).

2. For example, the issue of permanent isolation as an alternative to cleanup has been raised for some remote and technically difficult sites in the Energy Department's nuclear weapons complex. Conversely, the controversies surrounding the Superfund liability system generally do not apply to federal sites. For analyses of cleanup problems at federal facilities, see Congressional Budget Office, *Cleaning Up the Department of Energy's Nuclear Weapons Complex* (forthcoming), "Environmental Cleanup Issues Associated with Closing Military Bases," CBO Staff Memorandum (August 1992), and *Federal Liabilities Under Hazardous Waste Laws* (May 1990); and Office of Technology Assessment, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production* (February 1991).

3. National Research Council, Committee on Environmental Epidemiology, *Environmental Epidemiology*, vol. 1, *Public Health and Hazardous Wastes* (Washington, D.C.: National Academy Press, 1991).

stances.[4] The program is administered by the Environmental Protection Agency (EPA), which evaluates the need for cleanup at sites brought to its attention, identifies parties liable for the costs of cleanup, and oversees site studies and cleanups conducted either by its own contractors or by the liable parties. Funding for these EPA activities comes primarily from specific business taxes earmarked for a trust fund, officially named the Hazardous Substance Superfund.

Superfund was created by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) to complement other federal environmental laws that emphasize reducing new emissions of hazardous substances or cleaning up narrower categories of sites (see Box 1). The Congress amended the program, greatly increasing the size of the trust fund, in the Superfund Amendments and Reauthorization Act of 1986 (SARA). In 1990, the Congress renewed Superfund for fiscal years 1992 through 1994 and extended its taxation authority through calendar year 1995.

What Does the Superfund Program Do?

The Superfund program focuses on two types of waste-hazard cleanups: removal actions and remedial actions. Removal actions include emergency responses to immediate threats (from spills or leaking barrels, for example) and limited, interim steps toward full cleanup (such as draining a surface lagoon). Under SARA, removals financed by the federal government are limited to one year and $2 million unless EPA finds that continued action is immediately necessary or is appropriate and consistent with its plans for subsequent remediation. (The ceilings on duration and cost do not apply to removal actions undertaken by liable private parties.) For many sites, removals are sufficient to complete the necessary cleanup.

Sites that are more costly to clean up and pose large enough threats to human health and the environment can be placed by EPA on the National Priorities List for remedial response. Examples of remedial cleanups include capping and monitoring landfills, excavating and disposing of river sediments, pumping and treating groundwater, and incinerating or biologically treating soils. A significant policy change introduced in SARA requires EPA to give preference to remedial treatments that permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, especially over remedial options that involve off-site disposal of untreated substances.

EPA selects sites for the NPL using a multistage screening process that culminates in a score under the Hazard Ranking System (HRS). Each site brought to EPA's attention--typically by a state or local government, site owner, or neighbor--first receives a preliminary assessment (PA), which includes a review of available documents and reconnaissance of the site. A site that is neither eliminated from further consideration after the PA nor referred to another cleanup program receives a site inspection (SI), which involves collecting and analyzing samples of soil and water, as appropriate. In some cases, the SI is supplemented by an expanded site inspection, which yields more data. Finally, EPA uses the collected data to assign the site an HRS score; in general, a site is placed on the NPL if it scores at least 28.5.[5]

The National Priorities List is itself a multistage process, commonly called a pipeline. Once a site is on the list, it passes through several major phases or milestones.

- The remedial investigation and feasibility study (RI/FS) maps out the nature and extent of a site's waste hazards and evaluates alternative responses.

4. The term "hazardous waste" is given a specific legal definition in the Resource Conservation and Recovery Act (42 U.S.C. 6903, 90 Stat. 2799). Superfund cleanups can be triggered by a broader class of substances, some of which can be considered products or feedstocks rather than wastes.

5. One site in each state may be placed on the NPL, regardless of its HRS score, by being designated the top priority of the state government. Also, a rarely used mechanism allows a site to be placed on the NPL if the Agency for Toxic Substances and Disease Registry issues a health advisory recommending that people be removed from the site. Some sites that would score above 28.5 are referred to another cleanup program (see Box 1) instead of being placed on the NPL.

Box 1.
Other Federal Laws Governing Cleanup

The Resource Conservation and Recovery Act of 1976 (RCRA), which amended the Solid Waste Disposal Act of 1965, established in its Title C a national program for tracking and managing hazardous wastes and a corrective action program requiring cleanup of such wastes released into the environment at treatment, storage, or disposal (TSD) facilities, which include many industrial plants. The corrective action program is defined more narrowly than the Superfund program, which covers a broader class of hazardous substances and is not limited to releases occurring at facilities; also, some TSD facilities are likely to end up as Superfund sites because their owners and operators are unable or unwilling to comply with the corrective action requirements. Nonetheless, the large number of TSD facilities potentially requiring cleanup may make total cleanup costs under RCRA higher than under Superfund.

The initial RCRA statute did not direct the Environmental Protection Agency (EPA) to regulate underground storage tanks containing chemical products as opposed to wastes; nor did the 1980 Superfund law authorize the agency to clean up leaks of petroleum and petroleum products (which are generally excluded from the Superfund definition of hazardous substances) from such tanks. These gaps in authorization were filled in 1984 and 1986. Among the many changes made to RCRA by the Hazardous and Solid Waste Amendments of 1984 were provisions requiring EPA to set standards for the design, operation, and cleanup of underground tanks containing petroleum or hazardous products. Authorization for EPA to clean up leaks from petroleum tanks was included in the 1986 amendments to Superfund, which also created a smaller Leaking Underground Storage Tank Trust Fund to finance such cleanups.

The Clean Water Act, formally the Federal Water Pollution Control Act Amendments of 1972, created the federal authority to regulate cleanup of oil spills that pose a threat to surface water. The Oil Pollution Act of 1990 authorized using the existing Oil Spill Liability Trust Fund to pay for cleanup, raised existing limits on spillers' federal liability, and authorized the Coast Guard to require that owners and operators of oil-related facilities and vessels have plans for containing and removing such spills in coastal areas.

The 1976 Toxic Substances Control Act (TSCA) authorized EPA to regulate both the use, labeling, and disposal of new and existing chemicals used in manufacturing and commerce and the cleanup of spills of polychlorinated biphenyls (PCBs). The Asbestos Hazard Emergency Response Act amended TSCA in 1986, adding requirements that EPA set standards for cleaning up asbestos in school buildings. Superfund cleanups must meet the TSCA standards where applicable or "relevant and appropriate."

The Surface Mining Control and Reclamation Act of 1977 established a permitting program in the Department of the Interior to require active coal-mining operations to meet environmental and reclamation standards. It also placed a tax on current coal production to fund reclamation of mines abandoned before 1977 or before enactment of the regulations implementing the law. The tax money, however, cannot be used to clean up mines for which a responsible former operator could pay; in such cases, cleanup can proceed only under Superfund or state authorization. Amendments passed in 1990 also prohibit this money from being used to clean up mines listed as NPL sites, even if no solvent operators exist.

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) directed the Department of Energy to clean up sandlike tailings left from uranium-processing operations at 24 specific inactive sites. These sites are excluded from the Superfund program, as are any releases of radioactive substances from nuclear power plants. Other radioactive wastes, including uranium tailings at milling sites not included in the UMTRCA list, can be cleaned up under either Superfund or the Atomic Energy Act of 1954, as amended.

- The record of decision (ROD) documents EPA's selection of a particular remedy.
- The remedial design (RD) develops the detailed engineering plan for carrying out the selected remedy.
- The remedial action (RA), which often includes "construction" and "operations and maintenance" phases, is the actual implementation of the remedy.

This description of the NPL pipeline requires two qualifications. First, many sites are divided into multiple "operable units" that correspond to different areas or media to be cleaned up and that undergo the RI/FS-ROD-RD-RA sequence separately. A site's surface soil and groundwater might constitute two operable units, for example. Second, a site or operable unit that has reached a given stage in the pipeline may return to an earlier stage as a result of further evaluation or new information.

Besides these screening, study, and cleanup efforts at individual sites--sometimes called direct response activities--many technical, legal, and managerial activities in both the public and private sectors are part of the Superfund program. The liability system, discussed next, spurs searches for liable parties and negotiation and litigation over cleanup work and cost allocation. Other activities include research and development, technology dissemination, laboratory analysis, community relations, technical assistance grants, contract management, policy development, and budget planning.

Who Pays for Superfund Cleanups?

CERCLA takes a two-pronged approach to the problem of who should pay to clean up hazardous waste sites: it makes four types of parties liable for the costs of cleanup, and it establishes the Superfund trust fund to finance responses at sites for which the liable parties cannot be found or lack sufficient resources. The four types of "responsible parties" (RPs) are a site's present owners and operators, its previous owners and operators from periods during which it received hazardous substances, the generators of such substances, and any waste transporters responsible for choosing the site.[6]

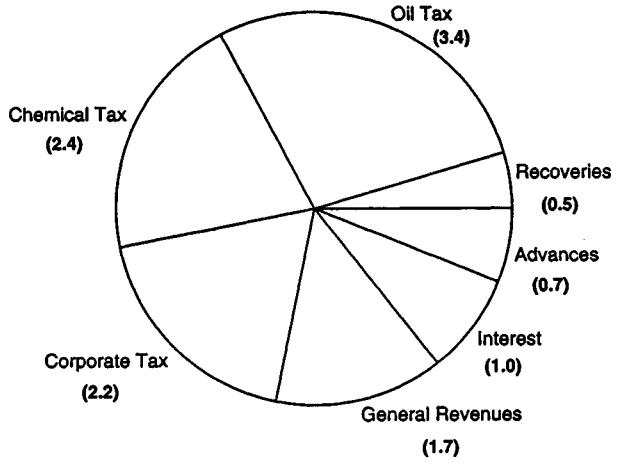
Liability under CERCLA is retroactive, strict, and joint and several. Strict liability places responsibility without regard to care or negligence; for example, a party cannot escape Superfund liability by showing that its waste disposal practices obeyed all laws and regulations that were in force at the time. Joint-and-several liability means that any responsible party can be assessed the total costs for a contaminated site (unless his or her contribution can be shown to have produced a separate, divisible result). This liability scheme serves two goals of Superfund's designers: it minimizes the ultimate burden on federal taxpayers, and it gives handlers of hazardous substances additional reason to avoid creating future hazards.

In administering the Superfund program, the Environmental Protection Agency can enforce the liability of responsible parties in either of two ways. It can have them perform the necessary cleanup directly, under government supervision; such "RP-lead" or "enforcement-lead" cleanups can occur either through a negotiated settlement or as a result of an administrative or judicial order. Alternatively, EPA can conduct the cleanup itself and then negotiate or sue to recover its costs from the responsible parties after the fact. Such cleanups are referred to as "fund-lead."

Fund-lead cleanups and other federal Superfund expenditures are financed with money appropriated from the trust fund, which receives most of its revenue from excise taxes on petroleum and certain chemicals and a tax on corporate income. In fiscal year 1992, these taxes brought in $1.2 billion; cumulatively, they account for $8 billion of the $12 billion in total Superfund receipts through 1992, or 67 percent (see Figure 1). Other sources of money to the trust fund are general Treasury revenues (14 percent of the total), interest on the fund balance (8

6. Because liability is often contested, the term "potentially responsible parties" is also commonly used. The present study follows the EPA style in referring to "RP-lead" cleanup and study projects; no confusion is intended with the definition of "responsible party" used in the Oil Pollution Act.

Figure 1.
Cumulative Trust Fund Resources, Fiscal Years 1981-1992 (In billions of dollars)



Total Receipts: 12.0

SOURCE: Congressional Budget Office based on data from the Department of Treasury.

percent), repayable advances from the general fund (6 percent), and recoveries, fines, and penalties from responsible parties (5 percent).

One important difference between fund-lead and RP-lead cleanups is that the state in which a site is located is required to share the cost of a fund-lead cleanup. States pay 10 percent of costs for the construction phase of a remedial action (50 percent or more for sites that were operated by the state or a local government during the disposal of hazardous substances) plus all maintenance of the remedy. In carrying out this provision of the law, EPA defines the first 10 years of pump-and-treat remedies (commonly used in cleaning groundwater) as long-term remedial actions, requiring only the 10 percent state contribution, rather than as maintenance.

EPA has de-emphasized the fund-lead option since 1989, when it adopted its "enforcement-first" policy. Under that policy, the agency seeks to maximize cleanups by responsible parties (thus minimizing demands on the trust fund and the need for cost recovery) by routinely issuing administrative orders to compel cleanup when settlements are not reached by the end of the statutory moratorium for negotiations. More recently, EPA has announced efforts to encourage settlements by increasing its use of some of the incentives and negotiating tools authorized in SARA.

Progress of Cleanups to Date

Although few NPL sites have been completely cleaned up in Superfund's first 12 years, the program's record of accomplishment is arguably better than its image would suggest. EPA has evaluated close to 24,000 nonfederal sites for possible inclusion on the NPL and has begun evaluating another 9,000 sites. Combined, these cases represent 94 percent of the nonfederal sites that had been brought to the agency's attention through fiscal year 1992. Together with cooperating responsible parties, EPA has finished 2,639 removal actions at 2,142 nonfederal sites--431 NPL sites and 1,711 non-NPL sites. Also, EPA has placed 1,149 nonfederal sites on the proposed or final NPL and has started one or more stages of the remedial pipeline at all but 56 of these sites. (The NPL also includes 126 federal sites, of which 116 have begun one or more stages of the remedial pipeline. Through 1992, 56 removal actions had been completed at 21 federal NPL sites.)

Measuring progress at sites once they have entered the NPL pipeline is complicated by the common EPA practice of dividing sites into operable units. Agency statistics typically report cleanup status in terms of the progress of each site's most advanced operable unit. Hence, reporting that 1,093 nonfederal NPL sites (95 percent of the total) were at or beyond the remedial investigation/feasibility study stage at the end of 1992 really means that 1,093 sites had started (if not completed) at least one RI/FS, but not necessarily all of the RI/FSs required for the site. Other EPA statistics as of the end of 1992 show that the most advanced operable unit

- had passed the record-of-decision stage at 766 sites (67 percent);
- had reached or passed the remedial design stage at 698 sites (61 percent); and

- had reached or completed the remedial action stage at 501 sites (44 percent).[7]

These statistics do not reveal how much of the work remains to be done at the 1,149 sites, however, because they do not indicate the number of operable units into which the sites will ultimately be divided.

One statistic on NPL progress that encompasses all of a site's operable units is the number of construction completions. EPA is still refining the definition of this term; it currently includes sites deleted from the list after the completion of all necessary response actions (other than routine operation and maintenance of the remedy), sites awaiting formal deletion, and sites at which all remedies are in place but long-term operations and maintenance are ongoing. (Pump-and-treat operations to clean groundwater, for example, may require 30 years or more to attain the cleanup goals.) At the end of fiscal year 1992, EPA counted 148 nonfederal sites as construction completions--up sharply from 63 the previous year but still less than 13 percent of the nonfederal NPL. Of these 148 sites, 40 have been deleted from the list, 83 are awaiting deletion, and 25 are undergoing long-term remediation.[8]

Controversies and Options

Since its inception, Superfund has been subject to many criticisms, not all of them consistent. Some of the more common criticisms, outlined below, reflect dissatisfaction with the program's overall ratio of benefits to costs; others primarily involve the distribution of the benefits and costs among affected parties.

Slow Pace of Cleanup. The view that NPL sites are not getting cleaned up fast enough can be argued by referring to the above figures on deleted sites and construction completions. Alternatively, critics can point to the durations of average cleanup projects, which have risen steadily in recent years. At the end of 1992, EPA estimated that the average operable unit takes nine years and four months from the start of its remedial investigation/feasibility study to the completion of its remedial action. This figure suggests that the average time per site between placement on the NPL and completion of cleanup construction at the last operable unit may be about 12 years.

Unfairness. Superfund's liability system has been criticized as unfair on various grounds. Some observers argue that the fundamental concept of retroactive liability (or retroactive liability for actions that are not negligent) is unjust. Others claim that retroactivity can be justified but that joint-and-several liability is unfair. A third position says that a basically fair liability scheme is being wrongly interpreted in cases involving specific types of parties--particularly local governments, lenders, or contributors of very small volumes of waste.

Litigiousness. Another criticism of the liability system focuses on the transaction costs incurred in assigning and allocating liability.[9] Among these are the costs of negotiations and litigation among a site's potentially responsible parties, between the parties and EPA, and between the parties and their insurers. EPA's efforts to identify and locate responsible parties and to gather site data suitable for use in litigation are also transaction costs; so are unofficial RI/FSs conducted by responsible parties as a check on EPA's own work and the additional layer of oversight involved when both RPs and EPA monitor the work of contractors performing RP-lead cleanups.

7. These pipeline statistics include sites at which an operable unit skipped over the indicated stage rather than passing through it. A few early sites went directly to remediation without going through the RI/FS and ROD steps. Other sites are counted as being past the remedial design stage because a "no-action" ROD for one of their operable units indicated that no further cleanup (and hence no design work) was necessary.

8. In addition, one federal NPL site awaits deletion. A recent review by the General Accounting Office reported that 23 of the 149 cases are sites that received neither removal nor remedial action because EPA found that they posed no threat to health or the environment and had been listed on the NPL in error (because of mistakes in sampling, for example). Another 28 NPL sites had reached construction completion based on removal actions alone. See General Accounting Office, *Superfund: Cleanups Nearing Completion Indicate Future Challenges* (September 1993).

9. Economists define transaction costs as those costs incurred in order to engage in a transaction (such as the costs of search time, bidding, and contracting) in contrast to the costs of the goods or services actually exchanged. The Superfund case stretches the term a bit: in this context, the "transactions" are not trades in the marketplace but legal assignments and allocations of liability.

Selection of Inappropriate Remedies. Several competing criticisms allege that too many of EPA's Superfund remedies are inappropriate. Some people fault the remedies primarily for insufficient thoroughness and permanence. Others argue that many remedies are excessively thorough and hence too expensive, sometimes because EPA's assumptions about human exposure to a site's hazardous substances are based on unrealistic scenarios for future land use. A third perspective focuses less on the results of the remedy selections than on the process, arguing that EPA's decisions should take more account of the desires of affected local communities.

Low Environmental Priority. The above criticisms regarding slow cleanups, litigiousness, and inappropriate remedies can be interpreted as arguments that Superfund's benefits are lower than they could be or that its costs are higher than necessary. Another criticism holds that even if the above issues were resolved, a more fundamental cost-benefit problem would remain. In this view, hazardous wastes represent a relatively low risk to humans and the environment (compared with other threats such as indoor radon exposure, pesticide residues on foods, non-point-source water pollution, and tropical deforestation) and should fall much lower on the nation's list of budget priorities.

These criticisms have led to a wide variety of proposals for reforming Superfund. Among the options under discussion are the following:

- narrowing the range of sites handled by the federal program, leaving more sites to the discretion of the states;
- revising the cleanup standards, perhaps to take explicit account of future land use;
- making greater use of priority-setting systems to defer work at some sites or operable units where cleanup is less urgent, thus reducing current funding needs;
- giving local communities more say in cleanup decisions;
- beefing up the trust fund and dropping retroactive liability;
- reducing the emphasis on joint-and-several liability, with increased government funding to pay the shares of liable parties who are bankrupt or cannot be identified; and
- capping liability for municipalities or eliminating liability for contributors of very small volumes of waste.

The estimates given in this study do not evaluate Superfund costs under any of these alternative policies, but they do provide a baseline against which the changes could be compared. The baseline itself can help to indicate whether the remaining Superfund problem is large enough to justify the near-term costs of disruption involved in changing to a new policy regime.

Types of Costs and Expenditures to Date

The Superfund costs included in this study are those incurred by the private sector and federal and state governments for both site cleanup work and ancillary activities. The Congressional Budget Office (CBO) estimates that nominal-dollar outlays (that is, actual spending) by private parties and state governments over Superfund's first dozen years were roughly $6.3 billion and $0.1 billion, respectively. Firmer figures indicate that the federal government spent $7.0 billion, excluding costs fronted or reimbursed by liable parties. Cumulative obligations--immediate or multiyear spending commitments--may be on the order of $20 billion for all payers combined.

As noted earlier, the figures considered here do not include the costs of cleaning up federal facilities. (In 1992, the environmental restoration programs of the Departments of Defense and Energy obligated on the order of $3 billion, roughly equaling the combined public and private Superfund obligations.) Two other types of costs that might be attributed to the program are also not covered: Superfund-induced spending on hazard prevention is excluded for lack of data, as are the economic costs of loans not made and properties not resold or reused because of concerns about potential Superfund liability.

Federal Expenditures

Total federal Superfund outlays over the program's first 12 years were $7.7 billion in nominal terms, or $8.6 billion in constant 1992 dollars (see Table 1). These totals include $0.5 billion (nominal) subsequently recovered from responsible parties and $0.2 billion funded by cash-out settlements, in which RPs settle their liability by paying in advance for cleanup work to be done by EPA.[10] Cumulative obligations were $10.5 billion and $11.9 billion in nominal and 1992 dollars, respectively. Both measures of costs grew sharply in the initial years after SARA, when the Congress authorized a fivefold increase in the size of the trust fund. In 1992, annual outlays and obligations reached new highs of $1.5 billion and $1.7 billion.[11]

The $1.7 billion in 1992 Superfund obligations represents roughly one-quarter of EPA's total budget. EPA addresses most other environmental problems through regulation rather than direct government action; accordingly, Superfund obligations greatly exceed the amounts spent by the agency on other problems. An EPA analysis of its 1992 budget request found $450 million targeted for air pollution, for example, $109 million for pesticide problems, and $28 million for indoor radon exposure. The Superfund budget was second only to the $2.1 billion for treatment of point-source water problems, most of which constituted grants to the states for constructing municipal wastewater treatment plants.[12]

If 1992 Superfund obligations are classified according to the categories used in this study for estimates of future costs, direct response costs account for 52 percent of the program's budget (see Table 2).[13] Total site-based costs are arguably as high as 59 percent when laboratory analysis, site mapping, compensation of EPA workers who oversee site cleanups, and services of the Army Corps of Engineers and Bureau of Reclamation are included.

Table 1.
Federal Superfund Outlays and Obligations, Fiscal Years 1981-1992
(In thousands of 1993 dollars)

	Outlays	Obligations[a]
1981	8,039	40,283
1982	79,576	180,114
1983	150,214	227,199
1984	285,471	453,818
1985	363,023	455,485
1986	442,352	359,927
1987	544,890	1,039,451
1988	832,870	1,456,350
1989	964,978	1,522,681
1990	1,160,459[b,c]	1,484,947[b,d]
1991	1,431,608[b,c]	1,589,557[b,d]
1992	1,466,507[b,c]	1,737,340[b,d]
Total	7,729,987	10,547,152
Approximate Total in 1992 Dollars	8,610,000	11,875,000

SOURCE: Congressional Budget Office based on data from the President's budget, various years.

NOTE: Figures were derived by subtracting from total outlays and obligations those related to contaminated federal facilities for which the Environmental Protection Agency was reimbursed by other agencies.

a. Net of recoveries of prior-year obligations not spent.

b. The reimbursements from other federal agencies that were subtracted in this case are CBO estimates.

c. Includes outlays for the Office of Inspector General from Treasury Department reports on the Superfund trust fund.

d. Includes obligations for the Office of Inspector General from the President's budget.

10. The totals exclude an estimated $0.1 billion in Superfund outlays reimbursed by other federal agencies for such activities as assistance in setting up data systems for hazardous waste sites. The figure of $7.0 billion in nominal federal outlays avoids double-counting by also excluding RP payments.

11. Table 1 shows 1992 obligations of $1.737 billion, well above the 1992 appropriation of $1.615 billion. This high-water mark was reached with the aid of a high level of cash-out settlements, which appear as offsetting collections in the budget and are not subject to the appropriation process.

12. Environmental Protection Agency, Office of Policy, Planning, and Evaluation, "Environmental Problem Area Profiles" (July 20, 1991).

13. The data in Table 2, based on an internal EPA management report, yield higher total obligations than those shown in Table 1, primarily because they do not subtract funds recovered by canceling previous obligations.

Table 2.
Superfund Obligations in Fiscal Year 1992

Type of Cost	Millions of Dollars	Percentage of Superfund Budget
Direct Response		
Screening	81.9	5
Removals	199.8	11
Remedial investigations/feasibility studies	70.5	4
Remedial designs[a]	62.8	3
Remedial actions[a]	515.0	29
Subtotal	930.0	52
Response Support		
OSWER salaries, excluding enforcement[b]	68.0	4
Remedial support[b,c]	75.2	4
Removal support[b,d]	54.1	3
Laboratory analysis	44.8	2
Other EPA support[e]	9.5	f
Supporting federal agencies[g]	65.3	4
Subtotal	317.0	18
Enforcement		
Oversight of RP-lead RDs and RAs[a]	36.7	2
Office of Waste Programs Enforcement	124.7	7
EPA Offices of Enforcement, General Counsel[h]	77.4	4
Department of Justice[i]	32.3	2
Subtotal	271.1	15
Research and Development		
EPA research and development	68.0	4
National Institute of Environmental Health Sciences[b]	51.1	3
Subtotal	119.1	7
Management and Administration		
OSWER management[b,j]	43.1	2
General administration[k]	100.8	6
Office of Inspector General[l]	13.2	1
Subtotal	157.1	9
Total	1,794.3	100

SOURCE: Congressional Budget Office using data from the Environmental Protection Agency's (EPA's) final 1992 Superfund budget, except where noted.

NOTE: OSWER = EPA Office of Solid Waste and Emergency Response; RP = responsible party; RD = remedial design; RA = remedial action.

a. Obligations for oversight of RP-lead projects were estimated by applying percentage shares from EPA's 1993 budget justification to the 1992 totals.

b. Estimated by combining final 1992 figures with percentage shares from the earlier 1992 operating plan.

c. Includes administrative costs of cleanup contractors, services from the Army Corps of Engineers and Bureau of Reclamation, technical assistance grants to local communities, state grants, contractor services for mapping and for support of policy development, and so on.

d. Includes contractor services for technical assistance, support of policy development and waiver requests, and so on.

e. Includes the EPA Offices of Water, Air, and Radiation; Policy, Planning, and Evaluation; and the Administrator.

f. Less than 0.5 percent.

g. Includes the Agency for Toxic Substances and Disease Registry, Coast Guard, National Oceanic and Atmospheric Administration, Federal Emergency Management Agency, Department of the Interior, and Occupational Safety and Health Administration.

h. Includes an estimated $33 million (2 percent) for the EPA Office of Federal Facilities Enforcement.

i. Taken from the 1992 operating plan in EPA's 1993 budget justification.

j. Includes contractor services, computer time, and equipment purchases for training, budgeting, planning, dissemination of new technologies, emergency preparedness, and so on.

k. Includes rent, utilities, financial management, contract management, computer services, and so on.

l. Actual 1992 obligations from the President's 1994 budget request.

Enforcement costs account for 15 percent of the total, including 2 percent for oversight of RP-lead remedial designs and remedial actions. As noted before, the additional level of oversight involved in RP-lead projects is one source of transaction costs resulting from the enforcement system.

Most of the Superfund budget is spent outside EPA; the agency relies extensively on external contractors to supplement its own work force. All of the costs shown in Table 2 for direct response, remedial support, removal support, laboratory analysis, oversight of RP-lead RDs and RAs, and Office of Solid Waste and Emergency Response (OSWER) management are dollars spent on external services and purchases, as are the majority of funds for the OSWER Office of Waste Programs Enforcement. These external costs account for an estimated $1.3 billion, or 91 percent of the OSWER Superfund total of $1.4 billion. Taking EPA's Superfund budget as a whole (including the non-OSWER costs for general administration, research and development, enforcement, and support), the 1992 appropriation guaranteed that external costs would be at least 84 percent of the total by capping internal costs at roughly 16 percent.

State and Private Expenditures

State and private-sector Superfund spending is easier to classify than federal spending but harder to estimate. State costs related to the federal program are largely the required contributions for remedy construction and operations and maintenance (O&M) at fund-lead sites, and EPA does not directly monitor the O&M costs. The estimate of $0.1 billion in state costs to date comes from a 1991 EPA estimate of $40 million (in 1990 dollars) for cumulative O&M costs through 1992 plus the observed $76 million (in nominal dollars) paid to the agency as matching shares of construction costs. (Many states also have their own cleanup programs, which incur a full range of legal and administrative expenses. The costs of these programs are not included here.) EPA spent $2.6 billion on remedial actions over the same period, according to agency data, including roughly $0.1 billion to $0.2 billion for oversight of RP-lead actions; the $76 million in state matching contributions therefore represents only 3 percent of total public spending on construction of fund-lead RAs. The gap between this 3 percent and the statutory 10 percent requirement is explained by EPA's willingness to negotiate multiyear or deferred payment plans with the states.

Total Superfund costs to the private sector include three components:

- payments made to the government for fines, penalties, cash-out settlements, and recoveries of fund-lead expenditures;
- costs of RP-lead cleanup studies and actions; and
- transaction costs incurred by responsible parties and their insurers in efforts to minimize their individual liability.

EPA does not directly observe the second and third types of costs. The agency estimates the value of RP cleanup commitments but does not require RPs to report how closely actual spending matches its estimates; nor does it track private transaction costs. The directly observed costs for fines, penalties, cash-out settlements, and cost recoveries represent only the tip of the iceberg of total private Superfund costs. Moreover, these costs are mere "transfer payments"--in that they do not reflect additional costs to the economy as a whole but only a shift of funds from the private sector to the government--and thus are irrelevant to an analysis of total Superfund costs.

The rough figure of $6.3 billion in private-sector costs to date comes from an observed $0.5 billion in cost recoveries and estimates of approximately $3.7 billion in RP-lead cleanup projects and $2.0 billion in transaction costs. The $3.7 billion figure for cleanup costs was derived by assuming that EPA's estimated value of almost $7.5 billion in responsible-party work commitments accurately predicts dollar outlays--in effect, assuming that any cost savings from private-sector efficiencies balance any increases from underestimating the scope of the cleanup

problems--and that half of the commitments remain to be spent over the next five years.[14]

The estimate of $2.0 billion in transaction costs was extrapolated from data in a recent RAND study of five large industrial RPs and four property/casualty insurers.[15] The RAND study found that 17 percent of the dollars spent through 1989 by the responsible parties at sites with total expenditures over $100,000 were transaction costs. CBO assumed that this ratio applies to expenditures by all RPs through 1992; with estimated RP spending on non-transaction costs totaling $4.1 billion (including payments to EPA but excluding cleanup work funded by RPs' insurers), their estimated transaction costs are $4.1*0.17/(1 - 0.17) = $0.8 billion.[16]

The RAND study also estimated that the insurance industry as a whole spent $410 million in 1989 on transaction costs at all hazardous waste sites. Of this total, an estimated 40 percent was sparked by NPL sites and 60 percent by non-NPL sites, including Superfund removal sites. Also, 21 percent of costs resulted from claims for bodily injury and property damage rather than claims for cleanup costs under CERCLA. CBO assumed that 1989 costs represented one-seventh of the total between 1981 and 1992 (because costs in the early years were relatively low) and that NPL and Superfund removal sites together accounted for $210 million in 1989 insurer transaction costs--roughly half of the total. Subtracting the costs related to injury and damage claims, this yields $0.21*7*(1 - 0.21) = $1.2 billion.

14. Given the time required for engineering design before a remedy can be carried out, the following five-year spendout pattern was assumed: zero the first year, 20 percent each in the second and third years, and 30 percent each in the fourth and fifth years.

15. Jan Paul Acton and Lloyd S. Dixon, *Superfund and Transaction Costs* (Santa Monica, Calif.: RAND, 1992).

16. A follow-up study restricted to 18 NPL sites suggests that smaller firms might have higher shares of transaction costs and that the national average might be 32 percent. See Lloyd S. Dixon, Deborah S. Drezner, and James K. Hammitt, *Private-Sector Cleanup Expenditures and Transaction Costs at 18 Superfund Sites* (Santa Monica, Calif.: RAND, 1993).

Other Groups' Estimates of Superfund Costs

The EPA and a group of researchers at the University of Tennessee have also produced estimates of future Superfund costs. These estimates are not comparable with each other, however, nor are they as comprehensive as the ones presented here.

In its annual report to the Congress on Superfund for 1990 (the most recent available), EPA projected funding requirements of $16.4 billion in fiscal years 1993 and beyond and a cumulative total since 1981 of $27.2 billion. These estimates are restricted to costs incurred by the federal Superfund budget and exclude costs for cleaning up future NPL sites (that is, sites not listed at the end of fiscal year 1990).

The University of Tennessee researchers released reports in December 1991 that contained a "best-guess" estimate of $151 billion for cumulative costs to clean up 3,000 nonfederal NPL sites.[17] The Tennessee studies examined the implications of alternative cleanup policies, estimating that greater use of containment methods could reduce future costs to $90 billion, and that greater reliance on treatment methods could raise them to $352 billion. These figures cover a different set of costs than does the smaller EPA estimate: they include state and private remediation costs for NPL sites as well as federal costs, but they omit expenditures on non-NPL removal sites and EPA's enforcement and management activities.

The present CBO study seeks to improve on its EPA and Tennessee predecessors in four ways. First, it covers a broader range of costs, including state and private-sector cleanup expenditures and the costs associated with future NPL sites (excluded from the EPA estimate), federal implementation costs (not

17. See Russell, Colglazier, and English, *Hazardous Waste Remediation*; and E. W. Colglazier, T. Cox, and K. Davis, *Estimating Resource Requirements for NPL Sites* (Knoxville, Tenn.: University of Tennessee, Waste Management Research and Education Institute, 1991).

covered in the Tennessee study), and private transaction costs (omitted from both). Second, because a relatively few "mega-sites" have had a major impact on Superfund costs to date, CBO's estimate incorporates possible trends in the average characteristics of future NPL sites. Third, cumulative future expenditures are reported in discounted, present-worth dollars, which take into account the time value of money and thereby provide a more useful measure of the expenditures' cost to the economy. Fourth, CBO's analysis of average cleanup costs incorporates recent EPA data on the differences between initial estimates and final costs and allows for the possibility that private-sector cleanups may cost less than those performed by the government.

Chapter Two

Estimates of Future Superfund Costs

The Congressional Budget Office analyzed three scenarios for Superfund costs after 1992, reflecting present levels of uncertainty about the size of the remaining cleanup problem. The base-case estimate is $74 billion in discounted, present-worth dollars; the low-case and high-case estimates are $42 billion and $120 billion, respectively. Annual undiscounted costs in the base case peak at $9.1 billion in 2003 and average $2.9 billion per year through 2070.

A major factor in these estimates is the assumed number of sites on the National Priorities List; the assumptions of 2,300 nonfederal NPL sites in the low case, 4,500 in the base case, and 7,800 in the high case explain most of the differences in estimated costs. Other assumptions that have a major impact on costs are those regarding the average cleanup costs per NPL site and the discount rate. The cost estimates are less sensitive to assumptions about removal actions, site studies, administrative activities, and legal costs.

Overview of the Methods for Estimating Costs

CBO's estimates of future Superfund costs include site-based costs for study and investigation, cleanup, and enforcement combined with federal nonsite costs for program administration and private transaction costs. To reflect the time value of money and important uncertainties about the determinants of future costs, the estimates are given in discounted, present-worth dollars and for three scenarios based on alternative sets of assumptions.

The basic idea underlying the estimates can be expressed in a simple formula:

Total costs = [(number of sites) x (average cleanup cost + average investigation and study cost + average enforcement cost)] + private transaction costs + federal program costs.[1]

Because different types of sites have vastly different average costs, however, it is useful to extend this formula by distinguishing between NPL sites, non-NPL removal sites, and sites evaluated for possible inclusion on the NPL. This extension avoids the use of a single, overall per-site cost that could be unreliable as a basis for extrapolating into the future. As discussed later in this chapter, vastly different costs can also be found within the set of NPL sites; accordingly, CBO further distinguishes three cost categories of NPL sites--"mega-," "major," and "minor" sites--to explore possible changes in the mix of sites and their implications for average cleanup costs.

1. Private transaction costs and federal program costs could also be analyzed in terms of average costs per site. As explained later in the chapter, however, the CBO analysis treats transaction costs as a markup on other responsible-party costs rather than as a fixed cost per site, and it models program costs as a mixture of per-site costs, annual costs, and markup rates.

The CBO analysis also goes beyond the simple formula in taking account of the year in which a cost is incurred, so as to permit the calculation of discounted, present-worth costs. In measuring the overall impact of a multiyear stream of benefits or costs, economists view dollars spent or gained in the future as less valuable than present dollars, for two reasons that correspond to supply and demand factors. First, later dollars are easier to supply, in that one dollar can be invested now to return more than one dollar in the future. Second, present dollars are in greater demand, in that individuals generally prefer not to delay gratification, all other things being equal. Accordingly, the estimates reported here use an annual discount rate to roll back the entire stream of future costs into an equivalent 1993 present worth.[2]

The CBO estimates reflect a mix of data and informed opinion. Where possible, CBO based its assumptions on regularities and trends identified in the Superfund program to date that seem likely to apply to the future. Because data on the many categories of site-specific and non-site-specific costs are often scarce or unreliable, however, many assumptions could only be based on subjective judgments reached in consultation with informed sources.

The necessity of subjective judgments prompted CBO to develop alternative scenarios in which it could vary key assumptions. The low and high cases are intended to represent plausibly optimistic and pessimistic scenarios of Superfund costs, capturing between them most of the relevant range of uncertainty. Although the resulting estimates do not provide a statistical 90 percent confidence interval, CBO believes that future costs are unlikely to lie far outside their span.

The Cost Estimates

The CBO estimates of future Superfund costs are $42 billion in the low case, $74 billion in the base case, and $120 billion in the high case.[3] These present-worth estimates are calculated using a 7 percent annual discount rate, and they exclude the costs associated with cleaning up federal facilities. They also assume no major changes in policy or breakthroughs in technology; estimates that reflected those additional sources of uncertainty would span a wider range.

The present-worth estimates depend not only on the total dollars spent but also on the pattern of spending over time. In the absence of funding constraints, the base and high cases project that annual costs will rise severalfold through the year 2003 and then decline more gradually. The sharp increases reflect both timely progress of existing NPL sites through the cleanup process and a tripling or quadrupling of the size of the NPL, partly driven by an assumed backlog of sites in the last stage of the Environmental Protection Agency's screening process. Estimated spending increases in the low case are much more moderate and short-lived.

Responsible parties pay more than half of total costs in all three scenarios; the federal government's share is between 36 percent and 40 percent of the total, and the state share does not exceed 5 percent. By spending category, site studies and cleanup account for most of the costs, with remedial actions at NPL sites alone accounting for half of the total. Enforcement and transaction costs together represent just under one-quarter of total costs.

Nationwide Costs in Total and Over Time

The base-case estimate of $74 billion is closer to the low-case figure of $42 billion than to the high case's $120 billion. This reflects a comparable asymmetry in the assumed numbers of ultimate NPL sites--4,500 in the base case compared with 2,300 in the low case and 7,800 in the high case. (See Appendix A for a summary of the different assumptions underlying the cases.) As discussed later in the section about site

2. For a more detailed discussion of discounting, see Robert C. Lind, "A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options," in Robert C. Lind, ed., *Discounting for Time and Risk in Energy Policy* (Washington, D.C.: Resources for the Future, 1982).

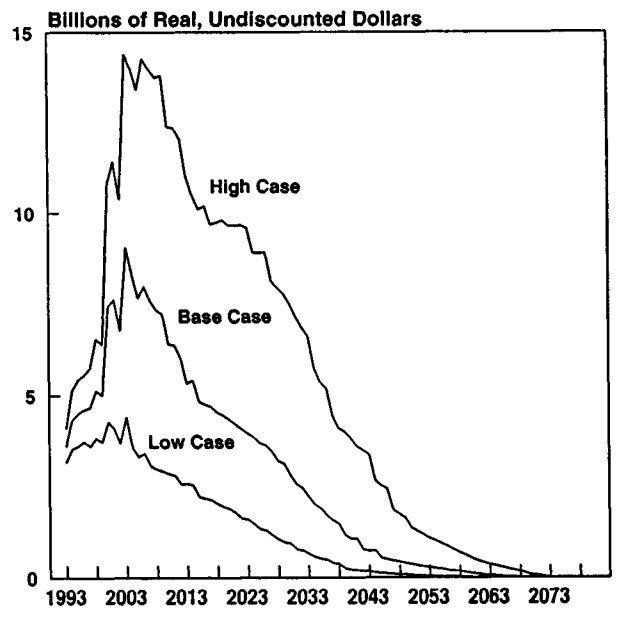
3. As used in this study, future "costs" (or "spending" or "expenditures") generally refer to obligations--that is, funding commitments made at the beginning of a one-year or multiyear project. The only ongoing outlays resulting from obligations before 1993 that are included in the estimates of future costs are those for operations and maintenance of site cleanup projects. Because of their 24-year duration, O&M costs are tracked as outlays in CBO's analysis.

assumptions, the range of plausible numbers of NPL sites is less clearly defined at the high end than at the low end; this greater uncertainty warrants an asymmetrically high number of NPL sites in the high case.

Annual spending in real (that is, inflation-adjusted) but undiscounted dollars peaks in the year 2003 in all three scenarios, as shown in Figure 2. The height of the peak varies dramatically, however--from $4.4 billion in the low case to $9.1 billion in the base case and $14.4 billion in the high case. (For comparison, 1992 obligations were roughly $3 billion.) The paths shown in Figure 2 assume that funding is not constrained; the consequences of constraints on the growth of Superfund are considered in Chapter 3.

The rapid growth in estimated spending in the base and high cases is largely fueled by rapid growth in the National Priorities List, which adds 2,181 new nonfederal sites by the year 2003 in the base case and 3,378 new sites in the high case. Roughly one-third of the additions represent sites brought to EPA's attention for screening after 1992; the other two-thirds are drawn from the 11,000 sites that began but did not finish the screening process by the end of 1992, of which 6,400 were in the final, "decision-pending" stage. The assumptions of the base and high cases imply that the decision-pending group includes substantial backlogs of sites--roughly 900 and 1,400, respectively--awaiting placement on the NPL.[4] Given adequate funding for cleanup work at both new and existing sites, the number of projects rises sharply. The average number of remedial investigations/feasibility studies started annually from 1993 through 2003 is estimated to be 339 in the base case and 490 in the high case, whereas the actual average between 1990 and 1992 was 115. Over the same period, the average number of new remedial actions reaches 243 a year in the base case and 291 in the high case, compared with 109 in the 1990-1992 period.

Figure 2.
Total Superfund Expenditures, Fiscal Years 1993-2075



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

Cumulatively, the costs shown in Figure 2 total $106 billion in undiscounted dollars in the low case, $228 billion in the base case, and $463 billion in the high case. Costs are incurred through 2062, 2070, and 2075, respectively; hence, average annual costs in undiscounted dollars are $1.5 billion, $2.9 billion, and $5.6 billion. These averages have only limited significance: because of the necessary sequencing of cleanup activities, total future costs cannot be paid out in equal yearly installments. Averages excluding the final 24 years of spending (during which all remaining cleanup projects are assumed to be in the operations and maintenance phase) are roughly 40 percent to 50 percent higher--$2.3 billion, $4.2 billion, and $7.7 billion, respectively.

Costs by Payer and Category

CBO estimates that responsible parties will pay 58 percent of total present-worth costs in the base case (roughly $43 billion out of $74 billion), with the government paying 38 percent ($28 billion) and the

4. No significant backlog exists in the low case; as discussed in the next section, this case assumes a lower value for the percentage of screening sites ultimately placed on the NPL.

states paying 4 percent ($3 billion), as shown in Table 3. These figures reflect costs as initially paid; subsequent cost recoveries that would increase the RP share further and decrease the federal share are not estimated here. Also, the estimated costs to state governments cover only their required contributions to "fund-lead" cleanup projects (those performed by EPA); state or local government contributions to "enforcement-lead" cleanups (those performed by responsible parties) resulting from liability for individual Superfund sites are included in the estimate for costs to liable parties.

These shares vary only a few percentage points in the other scenarios. In the high case, two factors increase the share paid by responsible parties to 60 percent and decrease the federal share to 36 percent. First, the larger number of NPL sites makes cleanup costs a larger fraction of overall spending, and these cleanup costs are concentrated among the responsible parties. Second, as discussed later in the chapter, CBO's analysis assumes that private cleanups cost less than those conducted by the government, but the assumed advantage is smaller in the high case than in the base case. Conversely, the same two factors also explain why the RP share falls to 55 percent in the low case.

When base-case costs are measured in undiscounted dollars, the responsible parties pay 61 percent of the total, the federal government 31 percent, and the states 8 percent. The state share of total costs in undiscounted dollars is twice the present-worth figure because discounting has a larger impact on costs that are more distant in time and state costs are primarily for operations and mainte-

Table 3.
Future Superfund Costs, by Initial Payer (In present-worth and undiscounted dollars)

	Base Case		Low Case		High Case	
Payer	Billions of Dollars	Percent	Billions of Dollars	Percent	Billions of Dollars	Percent
			Present Worth, Discounted at 7 Percent			
Responsible Parties	42.5	58	23.2	55	72.4	60
Federal Government	28.1	38	16.9	40	42.8	36
State Governments[a]	3.3	4	2.1	5	5.0	4
Total	73.9	100	42.2	100	120.1	100
			Undiscounted			
Responsible Parties	139.1	61	61.2	58	295.8	64
Federal Government	69.9	31	35.0	33	130.2	28
State Governments[a]	19.2	8	9.8	9	36.8	8
Total	228.3	100	106.0	100	462.9	100

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

a. State contributions to fund-lead cleanups only. Contributions to RP-lead cleanups at sites where state or local governments share direct liability are included in the figures for responsible parties.

nance, which occur at the end of the cleanup process. RP expenditures are similarly back-loaded, although not to the same extent, and therefore also represent a larger share of the total in undiscounted dollars.

By expenditure category, base-case costs of removal and remedial cleanup plus site investigation and study represent about 64 percent of future Superfund costs in present-worth dollars (with remedial action alone accounting for 53 percent); enforcement and transaction costs account for 24 percent; and federal costs for support activities, research, and general management make up the remaining 11 percent (see Table 4). The share

Table 4.
Future Superfund Costs, by Category (In present-worth and undiscounted dollars)

Category	Base Case Billions of Dollars	Base Case Percent	Low Case Billions of Dollars	Low Case Percent	High Case Billions of Dollars	High Case Percent
Present Worth, Discounted at 7 Percent						
Site Studies and Cleanups						
Remedial actions	39.1	53	22.4	53	65.6	54
Other	8.5	11	4.4	11	13.8	12
Subtotal	47.6	64	26.8	64	79.4	66
Enforcement	4.5	6	2.5	6	6.6	5
Transaction Costs	13.4	18	7.7	18	21.6	18
Support Activities	3.7	5	2.6	6	4.9	4
Research and General Management	4.7	6	2.6	6	7.7	6
Total	73.9	100	42.2	100	120.1	100
Undiscounted						
Site Studies and Cleanups						
Remedial actions	134.0	59	61.1	58	281.3	61
Other	17.9	8	7.8	7	35.3	7
Subtotal	151.9	67	68.9	65	316.6	68
Enforcement	10.7	5	4.9	5	19.5	4
Transaction Costs	43.8	19	20.2	19	88.3	19
Support Activities	10.4	5	6.7	6	15.8	3
Research and General Management	11.4	5	5.3	5	22.7	5
Total	228.3	100	106.0	100	462.9	100

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

accounted for by enforcement and transaction costs does not support the belief that most Superfund money is being devoted to negotiation and litigation, but is consistent with CBO's analysis of spending through 1992.[5]

The share of costs going to study and cleanup is slightly greater in the high case--again, because the number of sites is larger and average cleanup costs per site are higher--or when measured in undiscounted dollars, which give greater weight to O&M costs. The share of study and cleanup costs is lower in the low case than in the base case when costs are measured in undiscounted dollars, but the two are essentially equal in present-worth dollars, despite the smaller number of NPL sites in the low case. These facts reflect the timing of the various expenditures. Because fewer sites are added in the future, the existing NPL sites--many of which have already passed the study and investigation stages--take on greater relative importance. On average, therefore, cleanup costs occur earlier in the stream of overall costs in the low case than in the base case.

Assumptions About Numbers of Sites

The ultimate numbers of NPL sites, non-NPL removal sites, and screening sites are highly uncertain. The significance of this uncertainty lies in the fact that the number of NPL sites is a key determinant of Superfund's long-run costs. Accordingly, this study reports estimates based not only on a base case of 4,500 nonfederal NPL sites--almost four times the current level of 1,149 sites--but also on alternative scenarios of 2,300 sites and 7,800 sites (twice and roughly seven times the current level).

CBO derived these figures by combining estimates of the number of screening sites brought to EPA's attention as candidates for cleanup with estimates of the fraction of these sites accepted by the NPL screening process. In each scenario, a second rate was applied to the same pool of candidate sites to estimate the number whose contamination problems will be found not to warrant placement on the NPL but to be serious enough to require removal action.

Other assumptions determined the incidence of future NPL mega-sites (defined here as those for which the records of decision estimate cleanup costs of $50 million or more) and distributed sites between the fund-lead and RP-lead categories. These assumptions influence the estimates of average cleanup costs per site--in the latter case, because the analysis also assumes that the private sector has some efficiency advantage over the government in performing cleanups.

Number of Screening Sites

CBO's base case assumes that 25,394 new sites will be brought to EPA's attention for screening, in addition to the 36,814 sites already known to the agency at the end of fiscal year 1992. The low and high scenarios assume 15,151 and 50,000 additional screening sites, respectively.

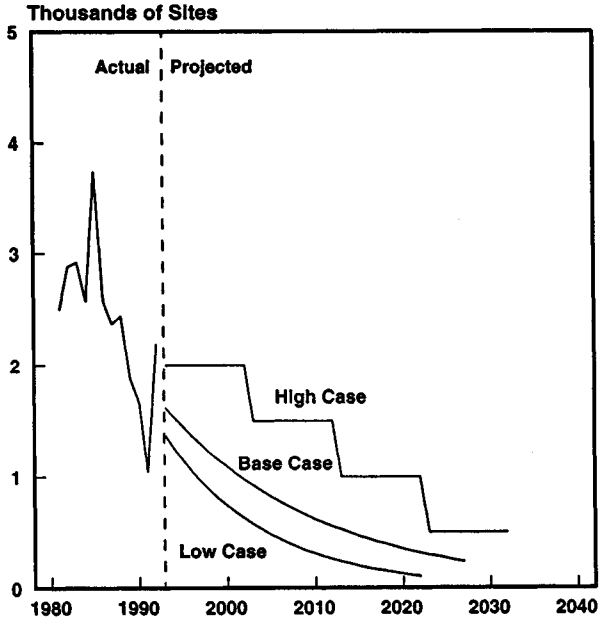
These assumptions are based on alternative interpretations of the Superfund experience to date. Annual additions to the screening inventory between 1981 and 1992 ranged from a high of 3,737 in 1985 to a low of 1,043 in 1991 (see Figure 3).[6] The evidence suggests an overall downward trend--particularly when the 1981-1986 additions are compared with those from 1987 to 1992--but its strength cannot be reliably determined from the handful of data points.

5. EPA data suggest that enforcement spending accounted for roughly $0.9 billion through 1992. As noted in Chapter 1, CBO estimates that private-sector transaction costs over the same period were $2.0 billion. Hence, total enforcement and transaction costs were on the order of $2.9 billion, or 22 percent of the estimated $13.4 billion spent by the public and private sectors.

The enforcement and transaction costs considered here include most but not all of the out-of-pocket costs resulting from Superfund's liability system. Not included are certain of EPA's nonenforcement expenses, such as the extra costs it incurs to obtain litigation-quality data in its site studies.

6. EPA also had 8,000 sites in its screening inventory at the end of fiscal year 1980. CBO does not know why additions to the inventory were so high in 1985 or so low in 1991; explanations would have to be sought at the level of the state governments, the primary channels through which EPA becomes aware of new sites.

Figure 3.
Actual and Assumed Additions to the Superfund Screening Inventory



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

The base-case estimate of 25,394 additional screening sites was derived by fitting a curve to the 1981-1992 data and extrapolating it to the year 2027.[7] The cutoff point in 2027 was chosen as a subjective correction for the indefinitely long "tail" of the curve; it can also be interpreted as a year by which the flow of new sites will be small enough to be handled by something other than the present Superfund program. The low-case figure of 15,151 sites resulted from fitting a similar curve to the data from the latest six years (1987 to 1992) and extrapolating it to the year 2022. The rationale behind this alternative is that the more recent data may better indicate the program's likely future course. Finally, the high case assumes a slower decline in screening sites (in a stepwise pattern chosen for simplicity), with 50,000 new sites added to the inventory by the year 2032. This case implies a total of 86,814 sites, counting those already identified, which is roughly consistent with a draft EPA analysis that estimated a total of 91,000 sites most likely to need evaluation.[8]

The number of screening sites is important to the estimate of total Superfund costs primarily because of its impact on the assumed numbers of NPL and removal sites. As discussed in the section about cost assumptions, screening costs themselves are assumed to be relatively minor in this analysis, averaging less than $46,000 per site. Consequently, a 10 percent increase in the number of future screening sites alone, holding constant the NPL and removal sites, would add less than 0.1 percent to total present-worth costs in any of the three scenarios.

Number of NPL Sites

Converting the size of the screening inventory to the size of the National Priorities List requires estimating the fraction of screening sites that will ultimately be placed on the NPL. According to a rough estimate from knowledgeable Superfund staff, the future placement rate will be in the neighborhood of 5 percent to 10 percent. Unfortunately, existing data are not useful in refining this estimate. EPA revised its screening criteria in March 1991, and too few data have accumulated since then to allow the estimate to be confirmed or narrowed.

The results under the original screening criteria are not useful either. First, the revised criteria may not yield the same overall acceptance rate as their predecessors. Second, the data on the performance

7. With the data smoothed using a three-year moving average, the resulting exponential-decay curve was 1,714*exp(-0.056593*[t - 1992]), where t indicates the year. The result in the low scenario, discussed next, was 1,497*exp(-0.087737*[t - 1992]); data smoothing was not required for a good fit in this case.

8. Environmental Protection Agency, Office of Emergency and Remedial Response, Hazardous Site Evaluation Division, "The Superfund Universe Study: Interim Report" (September 30, 1991). The estimate includes 58,000 sites in the "Focused Screening Universe," defined as those sites in categories representing "the highest priority for possible site discovery and screening efforts," and roughly 33,000 sites already in the inventory as of February 1991. An additional 9,000 sites thought to be of low hazard potential bring a more general "Superfund Evaluation Universe" to an estimated total of 100,000 current and future sites.

of the original criteria are distorted because EPA deferred final decisions on thousands of sites during the transition to the new system. As of the end of 1992, 3.5 percent of all sites that had entered the inventory were listed on the NPL, but another 18 percent were in the decision-pending stage, having survived the earlier preliminary assessment and site inspection phases, and 15 percent awaited either the PA or SI.

In the absence of firmer information, CBO chose placement rates of 8 percent in the base case, 5 percent in the low case, and 10 percent in the high case. All three scenarios assume that federal facilities, whose costs are excluded from the analysis, continue to represent 10 percent of all NPL sites. Multiplying these placement rates by the above projections of total screening sites, subtracting 10 percent for federal facilities, and rounding to the nearest hundred sites yields the estimates of 4,500 nonfederal NPL sites in the base case, 2,300 in the low case, and 7,800 in the high case.[9]

The difference in assumed NPL size between the low case and base case (2,200 sites) is notably smaller than the difference between the high case and base case (3,300 sites), reflecting the fact that the range of possible sizes is more clearly defined at the low end than at the upper end. It is relatively easy to argue that the ultimate number of nonfederal NPL sites is unlikely to be much below 2,300. Observed acceptance rates suggest that even if no more sites were added to the screening inventory, the National Priorities List would reach 2,400 sites just on the basis of the 11,000 incomplete sites in the inventory at the end of 1992.[10]

The estimates of total present-worth costs are highly sensitive, though not strictly proportional, to the numbers of NPL sites; a 10 percent increase in the assumed level implies cost increases of roughly 7 percent in all three scenarios. The main reason that estimated costs rise less than 10 percent is an issue of timing: the increase in ultimate NPL sites shifts the "center of gravity" of Superfund expenditures farther into the future (since near-term costs include those for sites already on the NPL), thus reducing the impact on present-worth costs.[11]

The variation in assumed size of the NPL is the main cause of the differences in the scenarios' estimated costs. Modifying the base case by adopting the NPL size assumptions from the low case would reduce its estimated present-worth costs by $25 billion--80 percent of the difference between the two scenarios. Similarly, substituting the high-case NPL would raise base-case costs by $38 billion, eliminating 81 percent of the difference in present worth. The assumed differences in average cleanup costs and ancillary activities account for the remaining differences in estimated costs.

NPL Sites by Cost Category

To varying degrees, each of the three scenarios assumes that the average costliness of remedial cleanups falls as more sites are added to the NPL. The rationale for this downward trend is the theory that a disproportionate number of the worst problems were discovered and listed in the early years because of their obviousness and that the program will increasingly be "scraping the bottom of the barrel" as additional sites are listed.[12]

9. The base-case calculation yields (36,814 + 25,394)*0.08*0.90 = 4,479 ≈ 4,500; the low scenario gives (36,814 + 15,151)*0.05*0.90 = 2,338 ≈ 2,300; and the high scenario gives (36,814 + 50,000)*0.10*0.90 = 7,813 ≈ 7,800.

10. Focusing on nonfederal sites, 8,903 sites had reached the site inspection stage and completed the screening process by the end of 1992, of which 1,149, or 12.9 percent, were placed on the NPL. Applying this percentage to the 9,040 sites awaiting the SI and those in the post-SI decision-pending stage yields 1,167 new NPL sites. Counting the sites that never received a site inspection because they were screened out at the preliminary assessment stage, the overall acceptance rate through 1992 was 4.8 percent (1,149 NPL sites out of 24,119 final decisions); applying this rate to the 2,064 sites awaiting the PA yields an additional 98 NPL sites.

11. In undiscounted dollars, which are unaffected by timing, the increase ranges from 9.2 percent to 9.4 percent in the three scenarios. The other factors contributing to the divergence from strict proportionality are that the costs of screening and removals at non-NPL sites are unaffected by the change in NPL size; that some EPA support costs rise less than proportionately; and that the added sites have lower average cleanup costs than their predecessors as a consequence of the "barrel-scraping effect" discussed in the next section.

12. An extension of this argument would suggest that all NPL-caliber contamination problems, not just the worst of the worst, should get scarcer over time, and thus that the rate at which screening sites are

Assumptions about the strength of this barrel-scraping effect can have a significant impact on estimates of long-run costs. If the base case had assumed a fixed distribution of NPL sites by cost category, its present-worth estimate would have been $84 billion; hence, the arguably conservative level of barrel scraping actually used in the scenario lowers costs by 12 percent. Plausible steeper trends in the distribution of sites would have larger impacts.

The key fact that makes the barrel-scraping effect an important issue is that some Superfund NPL sites can be hundreds of times more "super" than others in terms of their cleanup costs (see Box 2). Indeed, evidence suggests that the most expensive 10 percent of sites have accounted for 50 percent of all cleanup costs, and the least expensive half of sites have represented only 10 percent of total costs.[13] If this wide distribution of NPL cleanup costs is likely to continue relatively unchanged, then estimates of future costs need only extrapolate from the average per-site cost observed so far. If not, however, then changes in the composition of the NPL also must be taken into account.

The available data suggest that the distribution of NPL sites is changing. In particular, the incidence of so-called mega-sites appears to be declining. Defining a mega-site as one with cleanup costs of $50 million or more (as estimated in the records of decision), EPA staff know or expect 44 of the 711 nonfederal sites proposed for the NPL through October 1984 to be mega-sites, a ratio of 6.2 percent. The same can be said of only 0.9 percent (4 of 438) of the nonfederal sites proposed since 1984.

The significance of the apparent drop in the incidence of mega-sites is hard to determine now, for three reasons. First, part of the fall could be illusory, if some recent sites have not yet received enough attention for EPA staff to know of their true costliness, or if changes in EPA policies have divided some potential mega-sites into multiple pieces for listing purposes. Second, the net impact on future cleanup costs of any barrel-scraping trend could be reduced by a possible second effect acting in the opposite direction. This second effect assumes that early "false-positive" mistakes in the screening process led to the listing of a comparatively high number of inexpensive sites not containing NPL-caliber problems and thus artificially lowered the average costs observed to date. Third, a current barrel-scraping effect could conceivably be reversed in the future if a category of mega-sites is newly discovered or gets increased attention. Large areas contaminated with mining wastes may prove to be such a category.[14]

Although conclusive data are not available, CBO considers it likely that a significant barrel-scraping effect is reducing average cleanup costs and will continue to do so. In light of the current uncertainty, the three scenarios analyzed here employ different assumptions about the strength of the effect, with all three erring on the conservative side by assuming less barrel scraping than the limited data suggest. The analysis distinguishes three cost categories of sites on the NPL: mega-, major, and minor sites, defined as those with estimated present-worth costs of $50 million or more, between $20 million and $50 million, and less than $20 million, respectively.

The assumed decline in mega-sites and major sites occurs most rapidly in the low case and most

placed on the NPL should fall. If there exists a large pool of "lesser" potential NPL sites that are no more obvious than the average site with less-than-NPL-caliber contamination, however, then any such reduction in the placement rate might be delayed for many years or be of limited magnitude.

13. This pattern is observed in two partly overlapping samples of NPL sites: one sample, developed by EPA, mixes partial and complete estimates of construction costs at 253 nonfederal sites; the other, developed by researchers at Resources for the Future, includes complete estimates of inflation-adjusted cleanup costs (including operations and maintenance costs) at 168 sites. Outside the Superfund context, EPA also found 10 percent of sites accounting for one-half of total costs in an analysis of 79 waste treatment and disposal facilities subject to corrective action cleanups under the Resource Conservation and Recovery Act; see Environmental Protection Agency, "Draft Regulatory Impact Analysis for the Final Rulemaking on Corrective Action for Solid Waste Management Units" (March 1993), p. ES-12.

14. A recent Congressional report indicated that the Department of the Interior has just begun surveying its lands for mining sites needing cleanup or reclamation; see House Committee on Natural Resources, Subcommittee on Oversight and Investigations, "Deep Pockets: Taxpayer Liability for Environmental Contamination," Majority Staff Report (July 1993). The report said that the number of abandoned mine sites on Interior lands may be in the hundreds of thousands, but it did not estimate the number needing significant cleanup or the average cost per site. Such sites contribute to the total national bill for cleanup but not the Superfund bill, since their costs are borne by the Interior Department and responsible private parties.

Box 2.
Examples of Mega-, Major, and Minor Sites

Mega-site: The 22-acre Whitmoyer Laboratories site in Jackson Township, Pennsylvania, is in a largely agricultural area. Portions of the site are in the 100-year floodplain of the Tulpehocken Creek, and an estimated 20 residences in the vicinity use the underlying aquifer for drinking water.

Whitmoyer produced organic compounds containing arsenic on the site between 1957 and 1964. In 1964, widespread groundwater contamination was discovered, leading the owners to place concentrated wastes in a concrete vault and start a pump-and-treat operation to clean the groundwater. Sludge from the groundwater treatment was placed in on-site lagoons in 1977. In 1986, the Environmental Protection Agency (EPA) discovered arsenic contamination in nearby wells and began providing residents with bottled water. The last owners abandoned the site in 1987.

EPA divided the cleanup work at the site into three operable units. The first dealt with 69,000 gallons of concentrated liquid wastes in tanks and pipes near the creek; the second addressed roughly 29,000 cubic yards of vault and lagoon wastes and miscellaneous chemicals remaining on the site, plus contaminated buildings and equipment; and the third focused on 116,000 cubic yards of contaminated soil and sediment and the contaminated groundwater. The remedies selected by EPA involved demolition, excavation, off-site thermal or biological treatment, on-site incineration and fixation, groundwater treatment (physical, chemical, and possibly biological), capping, and off-site and on-site disposal. Estimated present-worth costs for the three operable units totaled $124 million, which qualifies the site as a mega-site for purposes of the Congressional Budget Office's (CBO's) analysis.

Major site: The Northside Landfill occupies 345 acres in a mixed residential and agricultural area of Spokane, Washington. One-third of the site lies over a large aquifer that serves the Spokane-Coeur d'Alene area.

The landfill began accepting residential and light commercial refuse from the city of Spokane and other public and private haulers in the 1930s, and it was still in use when EPA completed its record of decision in 1989. Investigations in 1981 and 1983 revealed the presence of volatile organic compounds beneath the site and in residential wells northwest of it. The city responded by supplying the 19 affected residences with bottled water and then extending municipal water lines to the area.

The remedy EPA selected for the site included closing and capping the landfill's four disposal areas, pumping and treating the groundwater until closure of the landfill reduces contamination below target levels, and implementing institutional controls to restrict access to the site and prevent construction of wells that would draw on contaminated water. The cost estimate for this remedy was $30 million, placing the site in CBO's "major" cost category.

Minor site: The Vogel Paint and Wax site is a two-acre disposal area, part of an 80-acre tract outside Maurice, Iowa. Adjacent land use is primarily agricultural. An aquifer beneath the site supplies private wells and the Southern Sioux County Rural Water System.

Paint sludge, resins, solvents, and other wastes from paint manufacturing were disposed of at the site between 1971 and 1979. Records indicate that roughly 43,000 gallons of organic chemicals and 6,000 pounds of metal wastes were buried in trenches during this period. The owner covered the disposal area with a clay cap in 1984.

EPA's chosen remedy for this site included either biological or thermal treatment of 3,000 cubic yards of contaminated soil; off-site incineration, recycling, or disposal of the wastes themselves; groundwater pumping and treatment using air stripping; and monitoring of the air and groundwater. With an estimated cleanup cost of less than $1.9 million, this site is a minor site in CBO's classification.

SOURCE: Adapted from Environmental Protection Agency, *ROD Annual Report*, various years.

gradually in the high case (see Table 5). Nonetheless, the low case has the highest overall proportion of mega-sites because the smaller number of NPL sites in that scenario gives the barrel-scraping effect less of an opportunity to take hold.

The three scenarios also differ in the proportions of major and minor sites among the first 711 nonfederal NPL sites. Cost estimates for many of these sites remain incomplete, making it impossible to know exactly how many will end up in each category. (Estimates for many early mega-sites are also incomplete, but the greater notoriety of these sites allows their number to be specified more precisely. All scenarios assume that mega-sites constitute 6.5 percent of the first 711 sites, or 46 sites in all,

Table 5.
Assumed Distribution of NPL Sites, by Cost Category (In percent)

	Mega-Site	Major Site	Minor Site
	Base Case		
First 711 Sites	6.5	18.7	74.8
Next 989 Sites	4.0	13.0	83.0
Next 1,200 Sites	2.0	8.0	90.0
Next 1,600 Sites	2.0	6.0	92.0
All 4,500 Sites	3.1	10.1	86.8
Total Number of Sites	141	454	3,905
	Low Case		
First 711 Sites	6.5	14.0	79.5
Next 789 Sites	4.0	10.0	86.0
Next 800 Sites	2.0	6.0	92.0
All 2,300 Sites	4.1	9.9	86.0
Total Number of Sites	94	227	1,979
	High Case		
First 711 Sites	6.5	23.3	70.2
Next 1,189 Sites	5.0	20.0	75.0
Next 1,600 Sites	3.5	16.5	80.0
Next 4,300 Sites	2.0	12.0	86.0
All 7,800 Sites	3.2	15.2	81.7
Total Number of Sites	247	1,184	6,369

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are $50 million or more; for major sites, between $20 million and $50 million; and for minor sites, less than $20 million.

See Appendix A for the differences in assumptions underlying the three cases.

NPL = National Priorities List.

thereby building in a small cushion of two additional cases on top of the 44 already identified.) Based on data on 273 cleanup projects at 253 nonfederal sites, the base case here assumes that 20 percent of the non-mega-sites (or 18.7 percent of all sites) in these early cohorts will be major sites; the low and high cases use 15 percent and 25 percent for this ratio, respectively.

Non-NPL Removal Sites

All three scenarios assume that 7 percent of the sites in the screening inventory ultimately become nonfederal non-NPL removal sites (those requiring limited or emergency, but not long-term, cleanup). This assumption is an extrapolation of experience to date. Of all sites that had begun the screening process, the fraction that were nonfederal non-NPL sites with one or more removals started was 5.8 percent in 1992, up from 5.4 percent in 1991 and 4.8 percent in 1990.[15] The upward trend in recent years suggests that the ultimate percentage of non-NPL removal sites may exceed 7 percent; however, many of the sites included in the current 5.8 percent may later be reclassified as NPL sites.

The reason for using the same assumption in all scenarios is not that this percentage is known with precision, but that the uncertainty is relatively unimportant to the estimates of total costs. A 10 percent increase in the number of future non-NPL removal sites would add no more than 0.3 percent to projected present-worth costs in any of these scenarios.

The use of NPL placement rates of 5 percent to 10 percent, compared with an assumption of 7 percent for non-NPL removal sites, does not imply that the national total of "modest" waste problems that could be handled through EPA's removal authorities is similar to, or even less than, the number of NPL-caliber problems. Many of the simpler problems are resolved by private voluntary action or by state agencies rather than through the federal Superfund program.

Sites by Lead Party in Cleanup

This analysis also classifies cleanup projects at NPL and non-NPL sites as RP leads or fund leads--that is, as performed (and paid for) by the responsible parties under EPA supervision, or directly by EPA. The division of projects by lead party obviously affects the distribution of costs between the public and private sectors; it may also affect the cost total if, as many observers believe, the private sector can perform the same work less expensively than EPA.[16]

The distributions of lead parties assumed in this analysis vary by type of cleanup or study project, but they do not vary by scenario. Based on the results observed in the first three years of EPA's enforcement-first policy, CBO's analysis assumes that responsible parties will take the lead in 25 percent of future removal projects at non-NPL sites, 40 percent of removals at NPL sites, 50 percent of remedial investigations/feasibility studies, and 70 percent of remedial designs and remedial actions. Total costs in the three scenarios are not strongly sensitive to these percentages. Raising the RP-lead share for RDs and RAs from 70 percent to 75 percent reduces costs by 1.5 percent in the low case, where the assumed private-sector cost advantage is the largest, and less in the other cases--provided that private transaction costs do not change as a result of the increase in RP leads. Depending on the relative contentiousness of RP-lead cleanups and of cost-

15. More precisely, 2,031 non-NPL sites other than federal facilities had started one or more removals by the end of 1992, and 34,793 federal and nonfederal sites had received at least a preliminary assessment (the first stage of the screening process) or a prescreening removal.

16. A report released after CBO completed its analysis provides some support for this belief. The report, commissioned by the Department of Energy, compared 58 "environmental restoration" (ER) cleanups conducted by the department with 233 other public and private cleanup projects. Statistical analysis correcting for differences in such factors as volume of waste, contaminated media, and cleanup technology indicated that the ER projects cost 15 percent more than the other government cleanups (including fund-lead Superfund cleanups) and 32 percent more than the private cleanups. These findings imply that private-sector costs are 13 percent lower than those in the (non-ER) public sector, within the range of the CBO assumptions given in Table 8. See Department of Energy, Office of Environmental Restoration and Waste Management, "Project Performance Study" (prepared by Independent Project Analysis, Inc., Reston, Va., November 1993), pp. iii-v.

recovery efforts after fund-lead cleanups, changes in transaction costs could supplement, reduce, or even reverse the direct savings.

The share of remedial actions undertaken by EPA is a key determinant of future costs to the states. As noted in Chapter 1, state governments provide 10 percent of the capital costs of all fund-lead RAs and bear all the associated costs for operations and maintenance (except the first 10 years of costs for a pump-and-treat remedy for groundwater).[17] CBO's assumptions about the types, costs, and durations of O&M projects imply that states pay 54 percent of the public sector's present-worth costs for O&M (using a 7 percent discount rate), or 72 percent of the costs measured in undiscounted dollars. The present-worth share is lower because discounting gives greater weight to the front-loaded federal contributions.

Assumptions About Direct Response Costs

Estimated costs for direct response--that is, for site-specific screening, study, and removal and remedial action--constitute the lion's share of total Superfund costs in all scenarios, with the share ranging from 64 percent in the low case to 66 percent in the high case. In turn, costs for remedial action (major cleanup) at NPL sites represent the large majority of all direct response costs--82 percent or more in the three cases. Consequently, assumptions about average RA costs are second in importance only to those about the number of NPL sites in terms of their impact on total estimated costs.

The analysis described below led CBO to assume that costs for fund-lead remedial actions in the base case are $169 million for each mega-site, $50 million for each major site, and $21 million for each minor site, with RP-lead cleanups costing 20 percent less for all three types of sites (see Table 6).[18] These assumptions yield an average cost of $25 million for the 4,500 NPL sites (or roughly $28 million, before the 20 percent RP-lead savings). Several factors make these estimates uncertain. In recognition of this uncer-tainty, the low and high scenarios make alternative assumptions that, when coupled with the distributions of site types shown in Table 5, result in average costs per site of $23 million in the low case and $29 million in the high case.

The estimates of total Superfund costs are sensitive to the assumptions about average RA costs. For example, a 10 percent increase in the assumed RA costs for major NPL sites would raise total costs by 1.4 percent in the base case, as shown in Table 7, and an increase in the private-sector efficiency advantage from 20 percent to 25 percent of EPA costs would reduce total expenditures by 3.6 percent.

The average costs per site for non-RA cleanup and study are both less uncertain (because the data are more plentiful and less variable) and less important to an estimate of overall Superfund costs (because non-RA costs are small relative to RA costs). Consequently, CBO's analysis used the same cost assumptions for non-RA response activities in all three scenarios:

Site Screening	
Preliminary assessments	$10,000 per site
Site inspections	$65,000 per site
Removals	$600,000 each
Remedial Investigations/ Feasibility Studies	$1.2 million each
Remedial Designs	$1 million each

17. Based on data from EPA and researchers at Resources for the Future, CBO assumed that 47 percent of remedial actions involve contaminated groundwater; that present-worth O&M costs for groundwater remedies average 4.7 times those for other cleanups (at the 10 percent discount rate commonly used in EPA's records of decision); and that O&M continues for 30 years in groundwater cases and 20 years in all others.

18. These average costs appear inconsistent with the cost ranges used to define major sites (between $20 million and $50 million) and minor sites (below $20 million). The definitions are based on cleanup costs as estimated in EPA's records of decision; the averages used in this analysis incorporate information on cost growth after the ROD estimates.

These costs apply to fund-lead activities; enforcement-lead removals, RI/FSs, and remedial designs cost less, sharing the same private-sector efficiency advantage assumed in each scenario for remedial actions.

Estimating the Costs of Remedial Action

Cleanup has been completed at too few NPL sites for observed costs to provide a good indication of average remedial action costs. Accordingly, CBO's analysis began instead with the estimated costs given in the records of decision that EPA issues for its remedial cleanups. In using the RODs to explore average costs at NPL sites, three problems had to be addressed.

- The ROD estimates are not always calculated on a consistent basis and often understate the actual costs that are ultimately incurred.
- Many RODs only discuss cleanup of an operable unit (subsite), leaving the cost picture incomplete for the site as a whole.
- The ROD estimates do not attempt to incorporate any private-sector efficiencies that would

Table 6.
Average Present-Worth Costs per Site for Fund-Lead Remedial Action, by Site Type (In millions of dollars)

	Base Case	Low Case	High Case
Mega-Sites			
Capital	107.6	102.6	112.7
Operations and maintenance[a]	61.6	58.9	65.0
Total	169.2	161.5	177.7
Major Sites			
Capital	33.0	28.9	37.0
Operations and maintenance[a]	16.9	14.8	19.0
Total	49.9	43.7	56.0
Minor Sites			
Capital	14.0	14.0	14.0
Operations and maintenance[a]	6.9	6.9	6.9
Total	20.9	20.9	20.9
Memorandum:			
Average Total Cost for All NPL Sites, Before Private-Sector Efficiency Advantage	28.5	28.9	31.2
NPL Average After Private-Sector Advantage	24.7	23.3	29.1

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are $50 million or more; for major sites, between $20 million and $50 million; and for minor sites, less than $20 million.

See Appendix A for the differences in assumptions underlying the three cases.

NPL = National Priorities List.

a. Operations and maintenance costs are discounted at 7 percent.

Table 7.
Sensitivity of Present-Worth Cost Estimates to Assumptions About Remedial Action Costs (In percent)

	Base Case	Low Case	High Case
Effect of a 10 Percent Increase in Remedial Action Costs			
Mega-site	1.4	1.7	1.5
Major site	1.4	1.2	2.2
Minor site	4.2	4.3	3.7
All sites	7.0	7.2	7.4
Effect of a 5-Percentage-Point Increase in the Private-Sector Cost Advantage[a]	-3.6	-3.9	-3.3

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. Estimated present-worth costs for mega-sites are $50 million or more; for major sites, between $20 million and $50 million; and for minor sites, less than $20 million.

See Appendix A for the differences in assumptions underlying the three cases.

a. This change affects the cost of enforcement-lead removals and studies, as well as remedial actions.

lower the costs of cleanups led by the responsible parties.

The starting point for CBO's analysis was the data set EPA uses to underpin its projections of future costs to Superfund. This data set contains estimates of capital costs from 273 RODs (not counting duplicate entries or those for federal facilities). However, problems of reliability and comprehensiveness limited the usefulness of the entries on mega- and major sites.[19] For these sites, CBO relied instead on a review of individual RODs for all known or suspected mega-sites and a set of 34 major sites, updated with information from knowledgeable EPA staff.

Whenever possible, CBO obtained operations and maintenance costs for major and mega-sites from individual RODs. Where information on O&M costs was lacking, average shares of O&M costs in total costs, obtained from those RODs with complete detail, were applied as default values. These default shares were calculated for different cost categories and ranged from 14 percent (for RODs with estimated capital costs above $30 million) to 35 percent (for those with capital costs below $20 million). For minor sites, a fourth ratio was derived from a data set developed by researchers at Resources for the Future; this ratio was based on the 184 RODs with capital costs below $15 million. In all cases, O&M spending was assumed to occur in equal installments over 24 years, the average duration seen among all 214 RODs in the data set.

Because actual cleanup costs commonly exceed those estimated in a ROD, CBO analyzed preliminary data from an EPA survey of post-ROD changes in capital costs and gathered site-specific information from EPA staff. The survey of 226 cases found that the largest percentage increases in costs tended to occur at cleanup projects with the least expensive RODs: whereas the dollar-weighted average increase for the whole sample was 44 percent, RODs with estimated capital costs under $13 million showed an

19. When CBO began its review in the summer of 1992, the data set included duplicate entries, entries that double-counted the costs of RODs covering two sites, entries that included the costs of operating and maintaining the remedy as well as the capital costs, and many entries obtained from unreliable preliminary sources. (EPA has since taken steps to correct these problems.) Moreover, the limited sample did not provide complete data on the mega-sites, whose costs are particularly important to the overall average.

Table 8.
Scenario-Specific Assumptions About Remedial Action Costs (In percent)

	Base Case	Low Case	High Case
Default Scaling Assumptions Used for Sites with Cleanup Projects Not Yet Estimated			
Mega-sites over $150 million	120	110	130
All other mega-sites	135	110	160
Major sites	160	120	200
Efficiency Advantage of Private Sector	20	30	10

SOURCE: Congressional Budget Office.

NOTES: Site types are defined by cleanup costs as estimated in the records of decision. For mega-sites, the estimated present-worth cleanup costs are $50 million or more; for major sites, between $20 million and $50 million.

See Appendix A for the differences in assumptions underlying the three cases.

average increase of 80 percent.[20] This latter rate was assumed to apply to all RODs for minor sites. Where specific information was not available at the more costly sites, default values of 26 percent, 34 percent, and 12 percent were derived for projects with estimated capital costs above $44 million, between $20 million and $44 million, and below $20 million, respectively.[21] In all cases, post-ROD growth of O&M costs was assumed to be half that of capital costs.

As noted earlier, sites may be divided into operable units that receive separate RODs; in fact, EPA estimates that the average site receives 1.8 RODs. CBO's analysis uses this ratio to convert from costs per ROD to costs per site at minor NPL sites. At the more expensive sites, however, evidence suggests that costs are not distributed evenly among a site's RODs and thus that smaller scaling factors should be applied to incomplete sites that already have a very expensive ROD. (Among 19 mega-sites with complete sets of RODs, the first ROD with costs in the mega-site range--or if none, the most expensive ROD--accounts for an average of 70 percent of total estimated capital costs.) The default scaling assumptions vary widely among scenarios, reflecting the great uncertainty surrounding this factor (see Table 8). Nonetheless, since the assumptions are used only where site-specific information is not available, they do not result in large differences in average RA costs or total Superfund expenditures.[22]

Each scenario also assumes a cost advantage for private-sector studies and cleanups (see Table 8). Such advantages are widely thought to exist; various observers argue that responsible parties employ more

20. Because of the inverse correlation between a ROD's initial cost estimate and its subsequent percentage cost growth, the simple case-by-case average for the whole sample is 157 percent, much higher than the dollar-weighted average of 44 percent. These figures must be considered preliminary; at present, for example, the data contain both intermediate updates of estimated costs and actual observed costs.

Note that post-ROD cost growth is of interest here only in calculations of average actual cleanup costs. Additional experience might lead EPA to raise its ROD estimates in the future and thus reduce average cost growth, but that would have no effect on actual cleanup costs per site.

21. The apparent inverse relationship between ROD estimates and post-ROD cost growth is violated by the 12 percent average growth observed for RODs with estimated capital costs between $13 million and $20 million. This deviation from the pattern may result from small sample size: the data set of 226 cases included only 17 in the $13 million to $20 million range.

22. Default values were used for 12 of 46 mega-sites and 9 of 34 major sites. Adopting the high-case assumptions in the base case would raise average present-worth costs from $24.7 million to $25.4 million per site and increase total discounted Superfund costs by 2.5 percent.

experienced project managers who can respond more creatively to situations encountered during cleanup, that government procurement regulations lead to costly delays or award jobs to low bidders who may be less efficient, and that certain efficient contractors choose not to bid on government projects. Although individual cases can be identified in which a private-sector cleanup cost as little as half the amount of a similar fund-lead project, no significant data are available on the overall impact of these advantages. In the absence of usable data, CBO identified savings rates of 10 percent to 30 percent as plausible estimates after consulting with experienced cleanup contractors, RP representatives, and EPA staff. As noted in Table 7, raising the assumed savings rates by 5 percentage points would reduce estimated present-worth costs for the program by 3.3 percent to 3.9 percent. Conversely, eliminating the 20 percent advantage assumed in the base case would increase total estimated costs by 14 percent.

Other Direct Response Costs

Direct costs for screening, removals, studies, and engineering designs account for 11 percent to 12 percent of discounted Superfund costs in the three scenarios. A 10 percent increase in any of the assumed unit costs would add no more than 0.6 percent to total costs in the base case.

Screening Costs. As noted earlier, CBO's analysis assumes an average of roughly $46,000 per site in screening costs. This average has two components: each site placed in the inventory incurs $10,000 in costs for a preliminary assessment, which is primarily a review of available documents concerning the site's history; and 55 percent of the sites are assumed to go on to receive a site inspection, involving collection and analysis of samples, at an average cost of $65,000. Thanks to the large numbers of sites EPA has already screened, these unit costs are subject to less uncertainty than others in this study.

Removal Costs. Fund-lead removal actions at NPL and non-NPL sites are both assumed to cost $600,000 each. Although this estimate is higher than EPA's budget-planning figure of $525,000, EPA staff regard it as a reasonable estimate of future costs, given that average costs have risen over time as more ambitious projects have been handled as removals rather than remedial actions. (EPA data show that the average fund-lead removal over the 1987-1992 period cost $440,000, but that the average cost for 1992 alone was $700,000.) Based on rough extrapolations of the evidence to date, CBO's analysis assumes that 45 percent of NPL sites receive at least one removal action and that 85 percent of these sites eventually get two. Also, 20 percent of non-NPL removal sites are assumed to get a second removal action.

Study Costs. The unit cost used in CBO's analysis for each fund-lead remedial investigation/feasibility study is $1.2 million. This figure was derived by assuming that the typical RI/FS costs $1 million and that 5 percent of cases (in all scenarios) are "mega-RI/FSs" that cost $5 million. The EPA budget-planning estimate for a standard RI/FS is $750,000; EPA staff note, however, that actual costs often exceed this target. The average NPL site is assumed to get 1.8 RI/FSs; this is essentially a restatement of the EPA estimate of 1.8 RODs per site, since every ROD except an amended one marks the completion of an RI/FS.

Remedial Design Costs. The unit cost used here is $1 million per fund-lead remedial design--again, somewhat higher than EPA's budget-planning estimate of $800,000, in recognition of increases in actual costs since the passage of the Superfund Amendments and Reauthorization Act in 1986. Major and minor sites receive an average of 1.8 designs per site; mega-sites, however, are assumed to receive 2.67 designs (and subsequent remedial actions) on average, based on an analysis of projects started or expected at 43 existing mega-sites. The latter assumption introduces a minor inconsistency: in principle, mega-sites should average 2.67 RI/FSs if they receive that number of designs.[23] Resolving the inconsistency would require tracking the mega-sites separately at the RI/FS stage. Given the relatively small number of such sites and the relatively

23. Another consequence of the assumption of 2.67 remedial projects per mega-site is that the NPL as a whole averages slightly more than 1.8 per site. The number of projects per major and minor site could be marginally reduced to attain an average of exactly 1.8 for the current NPL as a whole, but there is no reason to treat the rough EPA estimate with that level of precision.

minor cost of each RI/FS, the increase in complexity would have no noticeable impact on the results.

Assumptions About Transaction and Enforcement Costs

CBO estimates that the share of transaction and enforcement costs in total future spending will be 23 percent to 24 percent in the three scenarios, with private transaction costs (paid by responsible parties and their insurers) representing 18 percent (see Table 4 on page 17). These estimates assume that transaction and enforcement costs continue to maintain their current relationships to response costs; arguments could also be made for a wide variety of alternative assumptions.

For the private sector, CBO assumes that transaction costs add 23 percent to responsible parties' direct costs for studies and cleanups, and that insurers' transaction costs nationwide are tied to those of the RPs in fixed proportions--1 to 1 in the base case, 1.15 to 1 in the low case, and 0.85 to 1 in the high case. The figures used in these assumptions come from the RAND data on five very large industrial firms and four insurance companies.[24] As noted in Chapter 1, the RAND study estimated that transaction costs represented 17 percent of the dollars spent by the five RPs at sites with costs exceeding $100,000; subtracting the 8 percent of RP costs estimated to be repayments of government expenditures, the ratio of transaction costs to RP-lead cleanups and studies is 17/(100 - 17 - 8), or 23 percent.

CBO calculated the proportionality factors that relate insurer and RP transaction costs by dividing an estimated $163 million in insurer transaction costs related to Superfund cleanups in 1989 (based on the RAND data) by estimated RP transaction costs in 1989. In turn, the RP transaction costs were calculated using the unit costs of the three scenarios for RP-lead cleanups and studies and an assumption that the 23 percent ratio of transaction costs to response costs is the nationwide average for all responsible parties.[25]

Alternative assumptions are certainly possible, though difficult to quantify with current data. For example, a higher rate of RP transaction costs could be chosen on the theory that smaller firms not represented in the RAND study have relatively higher legal costs. The theory suggests that legal expenses have a high fixed component and thus that the transaction costs incurred by a smaller firm whose cleanup liability is $200,000 may not be much less than those of a larger firm facing a liability of $2 million. Conversely, lower rates could be chosen on the grounds that the RP data to date are biased because transaction costs occur earlier in the cleanup process. The assumptions about insurer transaction costs used here might turn out to be too low if new categories of litigation (such as insurer-versus-insurer or insurer-versus-reinsurer) become important; they might also be too high, if the courts gradually clarify the applicability of insurance policies to Superfund liabilities.

CBO's analysis modeled federal enforcement costs in more detail, assigning unit costs to site-level activities for RP searches and cost-recovery efforts and to project-level activities for negotiations and oversight. Site-level costs were estimated separately for fund-lead and RP-lead NPL sites and removal-only sites, and specific project-level costs were calculated for fund-lead and RP-lead removals, RI/FSs, and RAs (see Table 9). (Fund-lead projects do not incur enforcement costs for oversight, but many of them are preceded by negotiations between EPA and responsible parties over possible RP-lead

24. Jan Paul Acton and Lloyd S. Dixon, *Superfund and Transaction Costs* (Santa Monica, Calif.: RAND, 1992).

25. The RAND estimate of 1989 insurer transaction costs related to waste-hazard sites is $410 million. The $163 million used here subtracts 21 percent of the total for costs related to claims for bodily injury and property damage rather than cleanup and assumes that half of the remainder reflects costs for sites being addressed under state or federal programs other than CERCLA, or voluntarily. Taking into account the private-sector advantages in efficiency, the assumptions of the low, base, and high cases imply RP response costs in 1989 of $623 million, $734 million, and $853 million, respectively--which in turn yield estimated RP transaction costs of $143 million, $169 million, and $196 million.

responses.) EPA enforcement activities not included in these categories, such as developing policy and maintaining data bases, were viewed as indirect costs and modeled as fixed markups on the direct costs.

CBO's analysis broke down enforcement costs by federal office, including both headquarters and regional costs. The unit costs for the Office of Waste Programs Enforcement, the largest of the four sources, are based on EPA's budget-planning estimates, as are the RD/RA oversight costs of the Office of Emergency and Remedial Response. Costs for the Office of Enforcement were derived from expected outputs, work years, and subaccount budget totals in the 1993 operating plan. The Department of Justice costs are based on rough estimates obtained from department staff. None of these figures are known with great precision; however, their relatively small contribution to total Superfund costs makes the uncertainties of secondary importance. For the same reason, moderate gains in efficiency resulting from the recently announced reorganization of EPA's enforcement activities would not have a major impact on total costs.

Assumptions About Federal Program Costs

Federal program costs--those for activities other than direct response and enforcement--constitute the remaining 11 percent of estimated future costs in the

Table 9.
Assumed Unit Enforcement Costs, by Source (In thousands of dollars)

Site or Activity Category	EPA Office of Waste Programs Enforcement	EPA Office of Emergency and Remedial Response	EPA Office of Enforcement	Department of Justice	Total
Removal Site					
Fund-lead	56	n.a.	33	15	105
RP-lead	18	n.a.	5	n.a.	24
National Priorties List Site					
Fund-lead	503	n.a.	235	150	888
RP-lead	327	n.a.	97	60	484
Removal Action					
Fund-lead	2	n.a.	4	n.a.	7
RP-lead	74	n.a.	17	n.a.	91
Remedial Investigation/ Feasibility Study					
Fund-lead	53	n.a.	18	n.a.	72
RP-lead	604	n.a.	28	n.a.	632
Remedial Design/ Remedial Action					
Fund-lead	64	n.a.	56	10	131
RP-lead	134	500	109	240	983

SOURCE: Congressional Budget Office.

NOTE: EPA = Environmental Protection Agency; n.a. = not applicable; RP = responsible party.

base case, 12 percent in the low scenario, and 10 percent in the high scenario (see Table 4 on page 17). These costs cover a wide spectrum of support, research, and management activities: some are closely related to site-level cleanup, and others are highly centralized and administrative in nature.

Although data on current spending for program costs are readily available, assumptions about their future evolution are unavoidably speculative because the connection between such costs and the flow of sites through the Superfund pipeline is indirect. In some cases, CBO's analysis assumes that these costs rise or fall in strict proportion to certain measures of program activity. The remaining costs are assumed to be totally independent of other program activity--that is, they are fixed, real-dollar amounts over the life of the program.[26] These assumptions of full or zero proportionality are not intended to be individually accurate but merely simple rules of thumb whose biases partially compensate for each other.

Using unit costs based on EPA's budget-planning estimates or on extensions of recent experience, CBO makes several assumptions about program costs.

- Annual personnel costs for EPA's nonenforcement staff are assumed to equal $68,000 per NPL site, excluding sites at which remedial construction is complete. (With 1,500 "active" NPL sites in a given year, for example, total salary costs would be $102 million.)

- Removal support costs, including contracts for technical assistance and support of policy development, are assumed to be $250,000 per fund-lead removal action.

- Annual remedial support costs are assumed to equal $750,000 per fund-lead RA started in that year plus a fixed component of $40 million. Such costs include administrative costs of cleanup contractors, technical assistance grants to local communities, state grants, contracts for mapping and support of policy development, and services of the Army Corps of Engineers and the Bureau of Reclamation.

- Response management is assumed to cost $44 million per year for services and equipment related to training, budgeting, planning, data management, policy development, dissemination of information on new technologies, and emergency preparedness.

- General administration (including financial management, rent, and utilities), research and development, and interagency costs (primarily for the Agency for Toxic Substances and Disease Registry and the National Institute of Environmental Health Sciences) are assumed to be a fixed markup on all other federal costs except operations and maintenance costs. (O&M costs were excluded as a matter of convenience to avoid the need for separate spreadsheet columns for federal and state costs.) General administration expenses are both larger and harder to predict than the other types of program costs. Consequently, the markup factor varies among scenarios, from 20 percent in the low case to 22 percent in the base case and 24 percent in the high case.

Assumptions About the Discount Rate

Because the Superfund program can be expected under present policies to continue for many decades, the present values of its costs and benefits are sensitive to the assumed annual discount rate.[27] For

26. For this purpose, the end of the program is defined as the point at which remedial construction is complete at all NPL sites. Costs for operations and maintenance would continue to be incurred for another 24 years.

27. As noted earlier, CBO's analysis assumes that sites are added to the screening inventory for another 30 years in the low scenario, 35 years in the base case, and 40 years in the high scenario, and that operations and maintenance of each remedy last for 24 years. The time between a site's inclusion in the screening inventory and its proposed listing on the NPL is assumed to be four years, and the time it spends on the NPL before beginning its last O&M project is assumed to be 9, 12, or 15 years, depending on whether it receives one, two, or three remedial actions. Consequently, Superfund expenses continue for as many as 83 years (through 2075) in this analysis.

Table 10.
Present-Worth Costs at Alternative Discount Rates (In billions of dollars)

Discount Rate	Base Case	Low Case	High Case
10 Percent	52	32	80
7 Percent	74	42	120
4 Percent	112	59	197
2 Percent	156	78	292
0 Percent	228	106	463

SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

example, at a discount rate of 10 percent, the present worth of estimated costs in the base case would be $52 billion rather than the $74 billion obtained at 7 percent; in contrast, a 2 percent discount rate would imply present-worth costs of $156 billion (see Table 10). Although economists agree that future effects should be discounted in policy analyses, there is less agreement about the proper discount rate to use in a given case.

Much of the ambiguity surrounding the choice of a discount rate arises because income from capital is taxed, which implies that private-sector investments must provide a before-tax rate of return higher than the rate at which investors are willing to trade present and future gratification in their consumption patterns (called the pure rate of time preference). Because of this tax wedge, the discount rate used to analyze a particular policy should ideally be higher the more the policy is financed at the expense of private-sector investment rather than household consumption. In practice, however, the ultimate incidence of the policy's costs is generally unknown, and a simpler rule of thumb must be used.

The 7 percent real discount rate chosen here is the standard rate used by executive branch agencies in analyzing regulations and public investments. In support of this policy, the Office of Management and Budget (OMB) argues that 7 percent "approximates the marginal pretax rate of return on an average investment in the private sector in recent years."[28] The argument most commonly made against the OMB policy is that some share of the funds used for a public policy is likely to come out of consumption rather than investment and thus that the 7 percent rate is too high.

CBO analyzed the sensitivity of present-worth costs in the base, low, and high cases to alternative discount rates between zero and 10 percent--a range chosen to span the set of plausible values (see Table 10).[29] Base-case costs vary from $52 billion at 10 percent to $228 billion at zero percent (that is, without discounting); similarly, the low-case estimates vary from $32 billion to $106 billion, and the high-case costs range from $80 billion to $463 billion.

Although using a 7 percent discount rate results in a much lower estimate of present-value costs than would be obtained at zero or 2 percent, it does not suggest that Superfund is a better "bargain"--if anything, the argument cuts the opposite way. A thorough cost-benefit analysis of the program re-

28. Office of Management and Budget, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," Circular A-94, revised (October 29, 1992), p. 9.

29. The 10 percent rate was the OMB standard before October 1992. At the other end of the range, the zero rate provides a useful benchmark in undiscounted dollars and can be defended as a plausible estimate of the consumer rate of time preference, given the real interest rates now being paid on savings accounts. The 2 percent rate is based on the real interest rate on Treasury securities; in recent years, CBO's analyses of public investments have used this rate, on the basis of macroeconomic evidence that government spending was crowding out neither consumption nor investment in the short term, but rather leading to increased borrowing abroad. Finally, the 4 percent rate is included simply as a point between 2 percent and 7 percent, equally far below the primary assumption of 7 percent as 10 percent is above it.

The present study follows OMB's rule of thumb rather than CBO's on the grounds that in the incidence of its costs, Superfund is more like a pure regulation than a standard public investment. Over half of the estimated costs (before discounting) are incurred directly by the private sector. Moreover, most of the federal costs are funded from dedicated taxes on business that might not be retained if the Congress were to cancel the program and whose incidence, again, is probably closer to that of typical regulatory costs than that of the average federal dollar.

quires that its benefits also be discounted, after they are converted to dollar equivalents.[30] To the extent that the benefits of cleanup are spread over a longer period of time than the costs are, a higher monetary discount rate tends to reduce the present value of benefits more sharply, leading to a lower ratio of benefits to costs. In general, higher discount rates favor less investment, whether public or private, and more consumption.

30. Such an analysis might assume that the dollar equivalents of the benefits increase over time, on the theory that continued economic growth will raise the monetary value that individuals place on good health and a clean environment, but the assumed rate of increase would be the same for any discount rate.

Chapter Three

Comparisons with Other Estimates and Implications for Policy

Estimates by the Congressional Budget Office of future Superfund costs are very different from earlier estimates developed by the Environmental Protection Agency and the University of Tennessee. The main factors that explain the differences are CBO's broader coverage of costs and use of discounted dollars, different average cleanup costs per site, and different numbers of sites on the National Priorities List. The CBO estimates of average cleanup costs are lower than the EPA and Tennessee figures, primarily because of the assumed private-sector cost advantage and barrel-scraping effect.

The estimates presented here have four main implications for Superfund policy. First, future costs will remain highly uncertain until the ultimate number of sites to be cleaned up is known more precisely. Second, the cleanup job is far from over. Third, costs to the states will rise dramatically from current levels, though they will remain a relatively small share of total Superfund costs. Fourth, under the assumptions of the base case and high case, large increases in federal and private spending will be required over the next decade to avoid a growing backlog of sites awaiting cleanup.

CBO's analysis provides a baseline estimate that assumes no significant policy changes. Two administrative changes that are being carried out or discussed by EPA now are unlikely to have major effects on total costs. Many other policy changes have been proposed, some of which would have larger cost implications. Given adequate data, the costs of these alternatives could be estimated using the same methods employed in Chapter 2.

Why Do the CBO, EPA, and Tennessee Estimates Differ?

The CBO, EPA, and University of Tennessee estimates of Superfund costs--$74 billion, $16 billion, and $151 billion, respectively--are not directly comparable and rely on many different assumptions and analyses.[1] A handful of key factors explain most of the differences, however.

Two factors make direct comparisons of the estimates inappropriate. One is the different coverage of types of costs. The CBO figure includes all future public and private Superfund expenditures (including private transaction costs), but the EPA figure covers only costs to the federal government, and the Tennessee estimate covers public and private costs for study and cleanup at NPL sites--including costs before 1993--omitting administrative and legal expenses and the costs of screening and removals at non-NPL sites. The other comparability issue is that

1. See Environmental Protection Agency, Office of Emergency and Remedial Response, *Progress Toward Implementing Superfund: Fiscal Year 1990* (February 1992), pp. 33-38; and E. W. Colglazier, T. Cox, and K. Davis, *Estimating Resource Requirements for NPL Sites* (Knoxville, Tenn.: University of Tennessee, Waste Management Research and Education Institute, 1991).

the CBO estimate is in present-worth dollars, but the EPA and Tennessee figures are in undiscounted dollars.

The estimates also differ in their assumptions and analyses of the number of sites to be cleaned up, the average cleanup costs, and the costs of activities other than cleanup. For example, the CBO base case assumes 4,500 nonfederal NPL sites, the EPA figure covers only the 1,120 sites listed through 1990, and the Tennessee estimate assumes 3,000 sites. Average cleanup costs per NPL site, measured using a common 10 percent discount rate for operations and maintenance costs, are $21 million in the CBO base case, $29 million in the EPA estimate, and $32 million in the Tennessee analysis.[2] The Tennessee study also assumes $1 million per site in "preremedial costs"; the comparable figure in the CBO analysis, covering removal actions, remedial investigations/feasibility studies, and remedial designs, is roughly $4 million.

The importance of each of these factors can be seen in a closer comparison of the CBO and Tennessee cost estimates. In undiscounted dollars, CBO's estimate is not $74 billion but $228 billion, reversing the apparent difference from Tennessee's figure of $151 million. Scaling up the Tennessee estimate from 3,000 to 4,500 nonfederal NPL sites yields a cost of $226 billion, almost entirely closing the gap. The story does not end there, however. The CBO estimate for only the site-specific costs, past and future, of studies and cleanup at NPL sites is $161 billion (of which $12 billion is costs before 1993). The difference between $161 billion and $226 billion is the result of the Tennessee study's higher remedial action costs and lower preremedial costs. In percentage terms, the discounting factor accounts for 200 percent of the original gap between the CBO and Tennessee estimates, the assumptions about NPL size for negative 97 percent, the cost-coverage factor for negative 87 percent, and the difference in average site costs--mostly remedial action costs--for 84 percent.

This examination of the gap between the CBO and Tennessee estimates raises the question of why CBO's cleanup costs are lower. Assumptions about two factors--the efficiency of private-sector cleanups and future trends in the costliness of sites--explain most of the difference. Eliminating the 20 percent efficiency advantage assumed for private-sector cleanups would raise CBO's estimate of average costs per site, measured at a 10 percent discount rate, from $21 million to $24 million. Also eliminating the assumed downward trend in site costliness (the barrel-scraping effect) would bring the CBO estimate as high as $31 million--between the EPA and Tennessee figures of $29 million and $32 million per site.[3] The remaining gaps are attributable to differences in data on the costs of individual cleanup projects: all three studies combine cost estimates from records of decision with data on post-ROD cost overruns, but the sets of projects sampled in the three analyses, though overlapping, are not identical.

The key CBO assumption of a downward trend in site costliness receives some support from the fact that EPA has recently reduced its own estimate of average cleanup costs per site. The addition of data on recent cleanups, coupled with corrections to flawed older data, has led EPA to lower its estimate of average remedial action costs from $29 million per site, the figure used in its projection of future federal costs, to $26 million.[4] This revised estimate is close to the $24 million average estimated by CBO in the absence of private-sector cost savings--or equivalently, for cleanups funded by the federal government.

2. See *Federal Register*, June 23, 1992, p. 34022; and Colglazier, Cox, and Davis, *Estimating Resource Requirements*, Figure 4.13. The $25 million figure for the CBO base case given in Chapter 2 discounted O&M costs at 7 percent.

3. CBO's highest figure, $30.6 million, is obtained under the strictest interpretation of "eliminating the downward trend." In this version, all sites are assumed to be distributed among the mega, major, and minor categories in the same proportions as were the first 711 sites proposed for the NPL. Alternatively, average costs for future cleanups could be assumed to equal those observed through 1992. This interpretation would yield a somewhat lower estimate, because the average through 1992 is already reduced by the lower incidence of mega-sites among sites listed in later cohorts.

4. Environmental Protection Agency, Office of Emergency and Remedial Response, "Overview of the Outyear Liability Model," fact sheet (December 1993).

Implications for Federal Cleanup Policy

Four main policy implications can be derived from CBO's estimates of future Superfund costs despite the significant uncertainty represented by the difference between the low and high scenarios. That uncertainty itself is the focus of the first implication.

Superfund Costs Depend on the Size of the Cleanup Problem, Which Remains Unknown

Some uncertainty is unavoidable in any attempt to estimate costs decades into the future. Given the unpredictability of changes in technology and policy, such estimates cannot be regarded as forecasts but at best as extrapolations based on currently observable trends.

In the case of Superfund, however, so little is known about the ultimate size of the problem that estimates of the remaining costs are conditional not only on technology and policy but also on the number of sites to be cleaned up. The assumed numbers of NPL sites in CBO's low and high cases range from 49 percent below the base-case assumption to 73 percent above it--and more extreme possibilities cannot be ruled out. This variation in numbers of NPL sites is the main reason why estimated present-worth costs range almost threefold between the low and high cases (and undiscounted costs more than fourfold).[5] As noted in Chapter 2, applying the low-case or high-case NPL assumptions to the base case eliminates 80 percent of the respective differences in present-worth costs.

One key reason that the ultimate number of NPL-caliber cleanup problems is so uncertain is that EPA has not conducted a comprehensive site-discovery effort. Instead, it has relied primarily on reports from state and local governments, site owners, and other individuals. Possible alternatives to this passive approach have been discussed by the Office of Technology Assessment, which suggested that historical aerial photographs could provide the cornerstone of an active federal site-discovery program.[6] EPA's main argument for not making site discovery a higher priority has been that the passive approach is already bringing in enough cleanup work to absorb the current level of funding.

Does the ultimate number of sites matter for policy purposes? On the one hand, larger numbers of sites presumably increase the benefits of a cleanup program as well as the costs. Arguably, therefore, the uncertainty about ultimate NPL sites is less important for Superfund policymaking than is the level of average costs per site (including the appropriate share of overhead costs). On the other hand, the same inefficiency or inequity seen as regrettable but not worth the trouble to address in a small or short-lived program may be totally unacceptable at a larger scale. For example, setting priorities so that sites with the worst health effects do not languish at the back of the queue is presumably more important when the queue is longer.

Much of the Superfund Job Remains To Be Done

Despite the uncertainty in the number of sites to be cleaned up, there is good reason to believe that the end of the Superfund program is by no means around the corner. According to the CBO base case, public and private obligations incurred through 1992 represent less than 30 percent of the total economic value of Superfund costs, measured in present-worth dollars, and less than 10 percent of total inflation-adjusted but undiscounted dollars. The federal government's obligations through 1992 represent 35 percent of its share of cumulative costs in present-

5. Cost estimates in the three scenarios do not vary in strict proportion with the number of NPL sites because of assumed economies of scale in administrative costs, unit-cost assumptions that differ among scenarios (including assumptions about the barrel-scraping effect), and discounting.

6. Office of Technology Assessment, *Coming Clean: Superfund Problems Can Be Solved . . .* (1989), p. 94. The EPA region covering Alaska, Idaho, Oregon, and Washington has used historical business lists and geographic information systems in an active site-discovery effort; see Environmental Protection Agency, *The Superfund Program: Ten Years of Progress* (June 1991), p. 11.

worth dollars and 14 percent in undiscounted dollars.[7]

More optimistically, the low scenario suggests that the economy may be 40 percent of the way through Superfund's present-worth costs (though only 17 percent finished in undiscounted dollars). At the other end of the spectrum, the high scenario suggests that 19 percent of the present-worth costs (and less than 5 percent of the undiscounted costs) have so far been incurred.

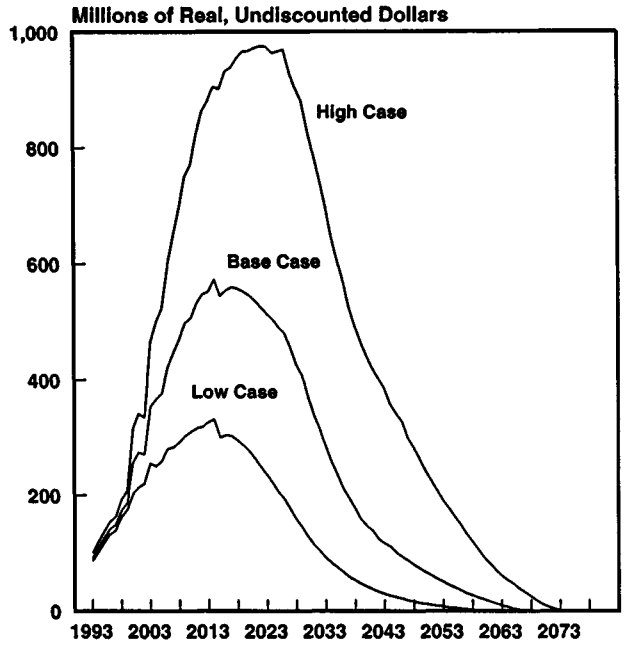
The larger the amount of cleanup work yet to be done, the greater the potential benefits from improving Superfund policies, compared with the disruption costs that might be incurred in adopting new policies. The CBO estimates suggest that the end of the cleanup problem may be distant enough to justify some policy changes involving long-term benefits but short-term costs.

Costs to the States Will Rise Dramatically

The finding that much of the Superfund job lies ahead is even more true for the required state contributions to fund-lead cleanups, which are concentrated at the back end of the cleanup process, than for total national spending. The low, base, and high estimates of $2.1 billion, $3.3 billion, and $5.0 billion in future present-worth costs to the states imply that the obligations incurred through 1992 are 15 percent, 10 percent, and 7 percent of the total, respectively.[8]

The percentage of cumulative state costs that were incurred through 1992 is lower in undiscounted dollars--between 1 percent and 3 percent, given estimated future costs ranging from $9.8 billion to $36.8 billion. The contrast between the present-worth and undiscounted results is sharper for state costs than for total national spending, another consequence of the back-loading of the state contributions. Whereas yearly national costs reach their peak in 2003 in CBO's analysis (see Figure 2 on page 15), the state costs rise more gradually and do not peak until 2014 or 2022 (see Figure 4). The trajectories of state costs shown in Figure 4 should be considered illustrative; because of the importance of operations and maintenance costs in total state expenditures, a more detailed analysis would require better data on the average duration of groundwater and nongroundwater O&M efforts.[9]

Figure 4.
Required State Contributions to Superfund, Fiscal Years 1993-2075



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

7. Total obligations between 1981 and 1992 were $19.9 billion in nominal dollars, $21.7 billion in real 1991 dollars, and $28.3 billion in 1991 dollars discounted forward to the start of 1993. (The use of 1991 rather than 1992 as the index year for real dollars allows a more accurate comparison between past and future costs because the data underlying CBO's estimates of future costs reflect a mix of prices from different years.) The federal obligations to date of $10.3 billion in nominal dollars (excluding offsetting collections) are equivalent to $11.4 billion in real dollars and $15.1 billion in discounted dollars.

8. Including state commitments for capital costs not yet paid to EPA, obligations through 1992 are roughly $0.3 billion in real 1991 dollars and $0.4 billion in 1991 dollars discounted forward to the start of 1993.

9. In the absence of adequate data on the duration of O&M costs, CBO's analysis did not directly model the EPA policy of paying for the first 10 years of a groundwater pump-and-treat remedy, but instead assigned the agency a constant share of each year's costs for all fund-lead O&M. This simplification causes the state cost trajectory to peak a few years earlier than it would otherwise.

State costs for contributions to fund-lead cleanups are estimated to remain a modest share of the national total, despite their high growth in relative terms. These costs represent 4 percent to 5 percent of the present-worth total, and 8 percent to 9 percent of total undiscounted costs, in the CBO scenarios.

Current Funding Levels May Constrain the Pace of Cleanup

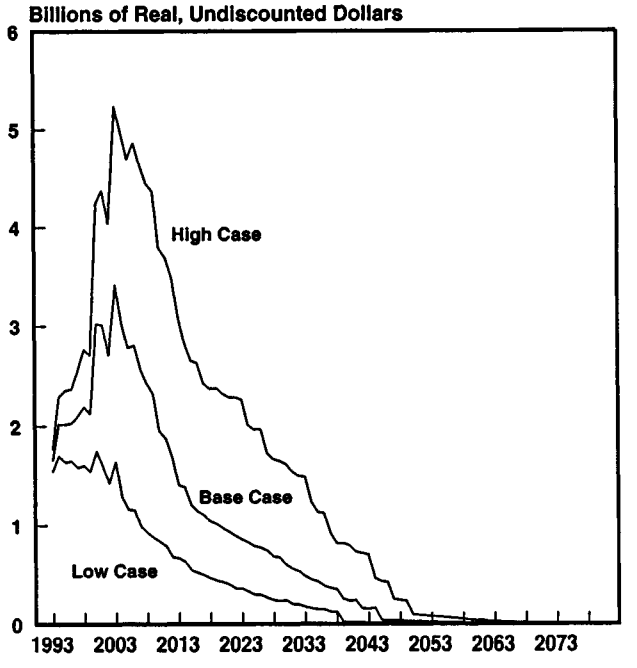
As noted in Chapter 2, the assumptions of the base and high cases imply that a substantial backlog of sites await placement on the NPL. Current levels of public and private Superfund spending are too low to simultaneously drain this backlog over the next 10 years, keep pace with new sites brought to EPA's attention, and move present sites expeditiously through the cleanup pipeline.

The growth in total spending necessary to keep pace with site work loads in the base and high cases is shown in Figure 2 on page 15; Figure 5 shows a similar pattern for the federal component of the total. Federal costs peak at $3.4 billion in the base case and $5.2 billion in the high case, roughly double or triple the highest level observed to date ($1.7 billion in 1992). This growth in federal costs cannot be avoided by additional emphasis on enforcement-lead cleanups: since most new projects are already being undertaken by responsible parties, the potential for further cost shifting of this type is limited.

Of course, high growth in spending can always be avoided by stretching the costs out over more years; in the context of Superfund, a funding stretchout would have several effects on long-term costs. Natural dispersion and decay of hazardous substances would make some cleanups cheaper--or even unnecessary--and others more expensive. Total costs would probably rise in undiscounted dollars because a stretched-out program would have more years of overhead costs. Total present-worth costs, however, might fall because of the additional years of discounting.

Regardless of the impact on long-term costs, stretching out the program unambiguously delays cleanup and its attendant benefits. One way to illustrate the magnitude of the possible delays is to contrast the results of CBO's low case, in which federal and total spending levels remain relatively flat over the next decade, with those of the base and high cases. The average annual number of remedial investigations/feasibility studies started from 1993 through the peak cost year of 2003 is 151 in the low case, 339 in the base case, and 490 in the high case. Over those 11 years, new remedial actions average 173, 243, and 291 per year in the low, base, and high cases. Consequently, applying the activity levels funded in the low case to the site work loads of the base case would allow only 45 percent of the ready RI/FS projects and 71 percent of the potential remedial cleanups to begin by 2003, leaving backlogs of more than 2,000 RI/FSs and close to 800 RAs. Similarly, only 31 percent of the RI/FS starts and 59 percent of the RA starts would occur if low-case activity levels were applied to high-case needs, and backlogs of roughly 3,700 RI/FSs and 1,300 RAs would accumulate by the end of 2003.

Figure 5.
Federal Superfund Expenditures, Fiscal Years 1993-2075



SOURCE: Congressional Budget Office.

NOTE: See Appendix A for the differences in assumptions underlying the three cases.

Superfund Costs Under Alternative Policies

Given that the CBO estimates assume a static policy environment, it is useful to consider how changes in Superfund policies might affect future costs. Two current EPA initiatives are unlikely to have a major impact on total long-run costs but could shift their distribution by payer and over time. Other proposed changes could affect total costs as well as their distribution.

EPA's current initiatives are the Superfund Accelerated Cleanup Model (SACM) and state deferral of potential NPL sites. The SACM seeks to eliminate downtime in the screening process, institute presumptive remedies for common contamination problems, and speed risk reduction (as distinct from environmental restoration) at NPL sites as well as non-NPL removal sites. The state deferral policy, now being developed, would allow EPA to delegate to qualified states the responsibility for addressing certain "low- or medium-priority NPL-caliber sites, i.e., sites that EPA would not be able to address for several years."[10]

Although both of these initiatives may represent significant change in other respects, their impact on Superfund's total costs may be minor. The streamlining called for in the SACM could result in some cost savings, but the main effect will be to shift some of the existing costs forward in time (and perhaps to defer others) in order to speed up the benefits of reduced risks to health and the environment. Similarly, state deferral could conceivably reduce overall administrative costs--if the cooperating state programs are more efficient than EPA's--but the primary emphasis of the initiative is on speeding up cleanup by spreading costs, not on reducing costs.

To the extent that either of these policy changes succeeds in increasing the pace of cleanup, present-worth costs could actually rise, since earlier expenditures have a higher economic value. A thorough cost-benefit analysis, however, would also show present-worth benefits rising as a result of the earlier cleanups. In the absence of enough data on benefits to allow such an analysis, undiscounted dollars may provide a more useful measure of the cost effects of alternative policies.

Other proposed changes in Superfund policies could have more significant cost implications. For example, changes in cleanup standards could raise or lower average cleanup costs (for one or more types of sites), with secondary effects on administrative and transaction costs. A shift from the present liability system to a public-works financing scheme would eliminate enforcement and transaction costs at many sites, but it would also eliminate the savings from any private-sector advantage in efficiency. The cost effects of these and other alternatives could be estimated using the framework employed in Chapter 2, given adequate data on the nature of the policy changes.

The nonfederal sites addressed under the Superfund program, which are the focus of this study, are only one component of the overall national effort to clean up hazardous wastes. The full universe of sites includes federally owned facilities, sites being addressed under the Resource Conservation and Recovery Act and other federal laws, and sites being cleaned up under state programs or voluntary private efforts. Ideally, attempts to maximize the net benefits of the nation's waste cleanups should take this broader context into account.

10. Environmental Protection Agency, "Superfund Administrative Improvements: Final Report" (June 23, 1993), p. 34.

Appendixes

Appendix A

A Summary of the Different Assumptions Used in the Three Scenarios

Table A-1 summarizes the differing assumptions that underlie the three Congressional Budget Office scenarios analyzed in this study. The table includes all of the primary assumptions--those not derived from more fundamental, underlying assumptions--and some of the key secondary (derivative) assumptions.

Table A-1.
Assumptions of the Three Cases

	Base Case	Low Case	High Case
Sites Added to the Screening Inventory	25,376	15,151	50,000
Percentage of Screening Sites Placed on the NPL	8	5	10
Total Nonfederal NPL Sites[a]	4,500	2,300	7,800
Percentage Distribution of Sites (Mega/major/minor)			
First 711 sites	6.5/18.7/74.8	6.5/14.0/79.5	6.5/23.3/70.2
Next 789 sites	4.0/13.0/83.0	4.0/10.0/86.0	5.0/20.0/75.0
Next 200 sites	4.0/13.0/83.0	2.0/6.0/92.0	5.0/20.0/75.0
Next 200 sites	2.0/8.0/90.0	2.0/6.0/92.0	5.0/20.0/75.0
Next 400 sites	2.0/8.0/90.0	2.0/6.0/92.0	3.5/16.5/80.0
Next 600 sites	2.0/8.0/90.0	n.a.	3.5/16.5/80.0
Next 600 sites	2.0/6.0/92.0	n.a.	3.5/16.5/80.0
Next 1,000 sites	2.0/6.0/92.0	n.a.	2.0/12.0/86.0
Next 3,300 sites	n.a.	n.a.	2.0/12.0/86.0
All sites	3.1/10.1/86.8	4.1/9.9/86.0	3.2/15.2/81.7
Default Cost-Scaling Factors Used for Sites with Cleanup Projects Not Yet Estimated (Percent)			
Mega-sites greater than $150 million	120	110	130
All other mega-sites	135	110	160
Major sites	160	120	200
Costs per Site for Fund-Lead Cleanups (Millions of dollars)[b]			
Mega-sites			
Capital	107.6	102.6	112.7
Operations and maintenance	61.6	58.9	65.0
Total	169.2	161.5	177.7
Major sites			
Capital	33.0	28.9	37.0
Operations and maintenance	16.9	14.8	19.0
Total	49.9	43.7	56.0
Efficiency Advantage of Private Sector (Percent)	20	30	10
Average Cleanup Costs for All Sites (Millions of dollars)[c]	24.7	23.3	29.1
Federal Markup for General Administration, Research, and Non-EPA Costs (Percent)	22	20	24

SOURCE: Congressional Budget Office.

NOTES: NPL = National Priorities List; n.a. = not applicable; EPA = Environmental Protection Agency.

a. Secondary assumption, derived from the total screening inventory (existing sites and assumed additions) and the assumed acceptance rate of the screening process. (See Chapter 2 for details.)

b. Secondary assumption, derived from site-specific data and the assumed cost-scaling factors for incomplete sites. (Operations and maintenance costs are discounted at 7 percent per year.)

c. Secondary assumption, derived from fund-lead costs by site type, the assumed distribution of sites, and the assumed private-sector efficiency advantage.

Appendix B

A Glossary of Superfund Terms

Many of the definitions given below are adapted from Environmental Protection Agency, *The Superfund Program: Ten Years of Progress* (June 1991).

cash-out settlement: An agreement in which a responsible party settles its liability by paying the Environmental Protection Agency (EPA) a certain amount toward cleanup work to be done later. It differs from a cost recovery, in which EPA collects money to reimburse the Superfund trust fund for previous expenditures.

enforcement-first policy: A policy introduced in 1989 under which EPA attempts to maximize the number of cleanups conducted by responsible parties.

enforcement-lead cleanup: A cleanup conducted by some or all of a site's responsible parties with EPA oversight; same as **RP-lead cleanup**. Compare with **fund-lead cleanup**.

fund-lead cleanup: A cleanup conducted by EPA using money from the trust fund.

Hazard Ranking System (HRS): The system EPA uses to score potential risks to human health and the environment from releases or threatened releases of hazardous substances. In general, a hazardous waste site must score at least 28.5 on the HRS to be placed on the National Priorities List for extensive cleanup.

joint-and-several liability: A legal rule under which any liable party may be held fully responsible for a situation resulting from the actions of multiple liable parties. In the context of Superfund, joint-and-several liability means that any subset of a site's responsible parties can be required to pay for the entire cleanup of the site (although such parties are free to seek contributions or reimbursement from the other liable parties).

major site: In the Congressional Budget Office's analysis, a site contaminated with hazardous substances whose total cleanup costs are expected to be between $20 million and $50 million, as estimated in one or more records of decision. Compare with **mega-site** and **minor site**.

mega-site: A site whose estimated cleanup costs exceed $50 million.

minor site: A site with estimated cleanup costs of less than $20 million.

National Priorities List (NPL): EPA's list of sites eligible for long-term remedial response using money from the trust fund.

operable unit: An element of an overall site cleanup. EPA may choose to divide a site into multiple operable units to be cleaned up separately or to treat it as a single unit. Multiple units generally correspond to different areas or media, such as soil and groundwater.

preliminary assessment (PA): The first stage of EPA's screening process for investigating suspected waste sites, generally involving review of available documents and site reconnaissance. Followed by a site inspection, when necessary.

record of decision (ROD): A public document in which EPA identifies the cleanup alternative to be used at an operable unit of a site on the National Priorities List.

remedial action (RA): The actual construction or implementation phase of cleanup at an operable unit of a site on the National Priorities List.

remedial design (RD): The engineering work that follows a record of decision to develop the technical drawings and specifications that will guide subsequent remedial action.

remedial investigation and feasibility study (RI/FS): Related studies that gather data to determine the type and extent of contamination at an NPL site (or operable unit), establish cleanup criteria, and analyze the feasibility and cost of alternative cleanup methods.

removal or **removal action:** An action of short duration (generally under one year) taken to control immediate threats to people or the environment from a release or threatened release of hazardous substances. Removals may be undertaken at sites not on the National Priorities List.

responsible party (RP): An individual, business, or other organization legally liable for cleaning up a site. The four types of responsible parties are a site's present owners and operators, its previous owners and operators from periods during which it received hazardous substances, the generators of such substances, and any waste transporters responsible for choosing the site. Because liability is often contested, the term "potentially responsible party" is also commonly used.

RP-lead cleanup: Same as **enforcement-lead cleanup**.

site inspection (SI): The second stage of EPA's screening process, which involves collecting and analyzing samples of soil and water, as appropriate.

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