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SUPERFUND

Cost Growth on Remedial Construction Activities

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Resources, Community, and
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The Honorable Thomas A. Luken
Chairman, Subcommittee on Transportation,
Tourism, and Hazardous Materials
Committee on Energy and Commerce
House of Representatives

The Honorable James J. Florio
House of Representatives

As you requested, this report reviews the extent of cost growth for cleanup activities at Superfund sites with the highest expenditures and also compares this growth with that experienced in the construction industry.

Unless you publicly release its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of the report to appropriate congressional committees; the Administrator, Environmental Protection Agency; and the Director, Office of Management and Budget.

Major contributors to this report are listed in appendix II.

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Executive Summary

Purpose

The Environmental Protection Agency (EPA) faces the task of cleaning up perhaps thousands of hazardous waste sites located throughout the United States. The costs of cleaning up these sites come largely from a special federal fund called Superfund. But excessive cost growth for Superfund-financed cleanups currently underway at Superfund sites could reduce the funds available for future cleanups. At the request of the Chairman, Subcommittee on Transportation, Tourism, and Hazardous Materials, House Committee on Energy and Commerce, GAO reviewed the extent of cost growth for cleanup activities at Superfund sites with the highest expenditures and compared this growth with that experienced in the construction industry.

Background

The Superfund program, enacted with the passage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, provided EPA with $1.6 billion to remove hazardous substances, clean up contaminated land or groundwater, or initiate legal action to secure cleanup or cost recovery from responsible parties. The 1986 Superfund Amendments and Reauthorization Act (SARA) provided an additional $8.5 billion.

Superfund resources are used to clean up those hazardous waste sites that are included on the national priorities list. The list specifies those hazardous waste sites posing the most serious threats to public health and the environment and requiring long-term cleanup activities. As of November 1987, there were 951 sites included on, or proposed for, this list.

Superfund site cleanups typically involve construction activities designed to remedy or alleviate dangers from hazardous wastes. Some of these activities involve well-defined, routine construction tasks, such as building barriers to control the seepage of wastes into groundwater. Other tasks, such as excavating contaminated soil, are considered nonroutine because they involve uncertainties in scope, safety and health hazards, or technologies. When unforeseen site conditions are encountered during either routine or nonroutine construction, the contracted cleanup activities may need to be modified in response to the changed conditions. These modifications, in turn, frequently result in construction cost growth because they alter construction schedules or tasks.

Results in Brief

While Superfund construction cost growth at 25 sites with the highest construction expenditures ranged from a decrease of about 13 percent to an increase of about 99 percent, the average cost growth (12 percent) was within the 2- to 25-percent range that construction industry officials told GAO they experience. In the future under SARA, however, overall Superfund construction cost growth is likely to rise, according to EPA officials, as new or alternative technologies are employed to clean up hazardous waste sites.

Principal Findings

Cost Growth on Cleanup Activities

Using January 31, 1987, EPA data, GAO reviewed the construction contract bid awards, contract modifications, and the final construction costs for 30 Superfund long-term cleanup activities with expenditures over $1 million. Twenty-five national priority sites were involved; several involved more than one cleanup activity. Construction expenditures for the 30 activities represented about $94 million, or nearly 87 percent, of the $108 million GAO identified as Superfund long-term cleanup construction costs since the program began.

Using the EPA and construction industry officials' descriptions, GAO categorized the 30 activities as routine or nonroutine construction. Construction costs for the nine activities categorized as routine increased an average of 5 percent over the original construction contracts, within the construction industry's 2- to 12-percent range for routine activities. Individually, the cost growth for these routine projects ranged from a decrease of about 7 percent to an increase of about 17 percent. For example, the construction of the Sylvester treatment plant in Nashua, New Hampshire, had an original contract price of $5.4 million, but the final construction cost was $5.6 million—a cost growth of about 3 percent. The 17 nonroutine construction activities increased an average of 19 percent, also within the construction industry's range of up to 25 percent for nonroutine construction. Individually, the cost growth for these nonroutine projects ranged from a decrease of about 7 percent to an increase of about 99 percent. For example, the excavation of contaminated soil at the Krysowaty Farm, Hillsborough, New Jersey, site had an original contract price of $3.4 million. The total construction cost, however, was $3.9 million—a cost growth of about 16 percent.

Four of the 30 activities did not fit either the routine or the nonroutine description. Three of the four had negative cost growth. The four ranged from a decrease of about 13 percent to an increase of about 26 percent, with the average cost growth about 8 percent.

Future Cost Growth Under SARA

Superfund cleanup activities may also be characterized as permanent or nonpermanent. Many of the cleanup activities initiated under the original 1980 Superfund legislation were nonpermanent cleanups designed to contain contamination onsite or move the hazardous materials from one location to another. SARA places greater emphasis on cleanup activities that permanently or significantly reduce the volume, toxicity, or mobility of the contamination. According to EPA Superfund officials, these cleanups often cost more because they involve more uncertainties from the use of new or alternative technologies that may not have been proven under similar site conditions. Also, more unforeseen site conditions are likely to be encountered.

Because SARA emphasizes employing permanent cleanup technologies at hazardous waste sites, more of EPA's cleanup actions are likely to use new or alternative technologies than in the past. Cleanups using new or alternative technologies will likely experience greater cost growth than cleanups performed so far with traditional technologies, according to EPA officials. Depending on the extent of future cost growth, EPA may need to analyze the reasons for cost growth to determine if actions are needed to control it.

Recommendations

This report provides GAO's review of the extent of cost growth in the Superfund cleanup construction program; it contains no recommendations.

Agency Comments

As directed, GAO did not obtain agency comments on a draft of this report. However, during the review, GAO did discuss the report's contents with responsible EPA officials, and their comments have been incorporated where appropriate.

Contents

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EPA	Environmental Protection Agency
GAO	General Accounting Office
NPL	national priorities list
RCED	Resources, Community, and Economic Development Division
SARA	Superfund Amendments and Reauthorization Act of 1986

Introduction

The cost of cleaning up the nation's hazardous waste sites continues to grow as more sites are identified. With the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, the Congress gave the Environmental Protection Agency (EPA) a broad mandate and a $1.6 billion fund to clean up hazardous sites and to respond to emergency releases of hazardous substances. Through September 1986, EPA cleaned up 14 sites and responded to 716 emergencies. To continue cleanup efforts, the Congress, in October 1986, enacted the Superfund Amendments and Reauthorization Act (SARA), which provided an additional $8.5 billion and extended Superfund another 5 years. For the first time, SARA set mandatory schedules for beginning site cleanup work.

Cleanup of hazardous waste sites involves developing and implementing remedies to alleviate the dangers of hazardous waste. Typically, implementing a remedy through construction is the most expensive portion of the Superfund program. As with most activities involving construction, some degree of cost growth is accepted as normal within the construction industry.[1] According to construction industry officials, even in the most routine activities, despite prior planning, unforeseen conditions occur, such as inclement weather, that can alter construction contracts and lead to cost increases. However, cost growth for Superfund activities can reduce funds available for other site cleanups. This report examines the extent of cost growth in the construction phase of Superfund-financed hazardous waste cleanups and how it compares with cost growth experienced by the construction industry.

New Legislation Will Increase Superfund Cleanups

SARA made various changes to the original law (CERCLA). SARA provided an additional $8.5 billion to continue cleanup work through 1991 and established a schedule for initiating hazardous waste site cleanup work. SARA also mandated that EPA begin cleanup work at 375 sites within the next 5 years. Work must begin at 175 sites in the next 3 years and at another 200 sites in the following 2 years. According to the EPA Administrator, the Agency will exceed the SARA schedule for initiating cleanup work.

SARA also established standards for selecting the type of cleanup work conducted at each site. CERCLA and the implementing regulations had placed greater emphasis on selecting remedies that were proven and

[1] Construction cost growth is the difference between the original contract bid award and final construction costs.

cost-effective (but which may not be permanent cures) than on new or alternative technologies that permanently clean up the hazardous substances. Our July 1986 report showed that EPA often did not select permanent technologies because they were more costly or had not yet been proven.[2] The discovery that disposal sites containing Superfund waste were also leaking led to a change in the law. Under SARA (section 121), remedies protecting human health and the environment that are cost-effective and employ permanent and alternative technologies, including resource recovery, are to be selected to the maximum extent possible.[3] These remedies are favored because they are designed to reduce permanently and significantly the volume, toxicity, or mobility of the hazardous substances.

Superfund Remedial Cleanup and Construction Program

There are two basic types of Superfund-financed cleanup actions—removal and remedial actions. Removal actions are short-term responses to address immediate and significant threats at any hazardous waste site, but are not necessarily final solutions. Remedial actions are long-term efforts to mitigate or permanently eliminate conditions at hazardous waste sites that are considered serious, but not immediate, dangers to the public. Some remedial actions may be accomplished with proven technology; others require new or alternative technology. EPA ranks the severity of sites with environmental hazards and places the worst sites on its national priorities list (NPL) for cleanup under Superfund. As of November 1987, the NPL contained 802 sites, with an additional 149 proposed for inclusion.

To ensure that appropriate remedial cleanup actions are taken, a remedial investigation and a feasibility study are conducted for each site to identify the types and quantities of hazardous wastes present and the strategies for mitigating the hazards caused by the wastes. The selected remedy is documented in an EPA record of decision, and a design for implementing the remedy is developed. A remedial action may involve cleaning up the entire site or treating a portion of the problem at a time. NPL sites often have multiple remedial actions because multiple sources of contamination must be cleaned up. Whether whole or partial efforts, remedial actions involve implementing the selected remedy.

[2] Hazardous Waste: EPA's Consideration of Permanent Cleanup Remedies (GAO/RCED-86-178BR, July 7, 1986).

[3] Permanent treatment technologies consist of any technologies that are alternatives to land disposal or containment, the purpose of which is to permanently change or destroy the hazardous composition of waste through chemical, biological, thermal, or physical means.

Implementing the remedial action is commonly known as the cleanup or construction phase because the actions involve various construction-related cleanup activities. Typical Superfund construction activities have included building pumping stations and groundwater treatment plants, capping hazardous sites with waterproof clay, and installing drains or liners to contain polluted materials. Historically, construction activities have been the most expensive portion of EPA's work at the site because the activity must be tailored to each individual site and modified as unforeseen site conditions occur. According to EPA data, from the program's inception to January 31, 1987, there have been 90 separate Superfund-financed remedial construction cleanup activities at 68 sites totaling about $108 million.[4]

EPA's remedial project managers, located in EPA regional offices, have overall responsibility for managing sites, maintaining community relations, controlling costs, and ensuring that work performed at sites, including contract modifications, complies with environmental and contractual requirements. As discussed below, EPA delegates management and supervision of the construction to other organizations, and these organizations, in turn, contract with private sector contractors to perform the construction.

EPA currently provides for such construction management services in three ways. Construction management can be delegated to (1) the states through cooperative agreements with the states' environmental protection agencies, (2) the U.S. Army Corps of Engineers (Corps) through interagency agreements, and (3) private sector architectural and engineering firms under direct contract with EPA. Typically, the construction manager advertises and awards the construction contract and provides site supervision. The construction manager is responsible for managing, monitoring, and approving the construction contractor's daily activities. The construction manager's onsite inspectors (1) conduct routine inspections to ensure that the cleanup work meets contract specifications; (2) review and approve payments to the contractor to ensure the accuracy and appropriateness of the payment requests; and (3) review and approve contract modifications.

Construction contracts are usually competitively awarded to the lowest responsive bidder for a firm-fixed price per unit of work. In a few instances, construction contracts can be noncompetitively awarded, such

[4]This information was developed by GAO, using EPA headquarters data. More recent data were not readily available at the time of our review.

as when a public emergency exists or a required item is available from only one source. The final construction costs, however, may exceed the accepted bid award or original contract amount. The difference is referred to as construction cost growth or cost escalation. The construction manager uses contingency funds to pay for these increased costs. Contingency funds are percentages of the contract awards that are set aside for the construction manager's use to meet unforeseen site conditions and problems. The cost increases resulting from changing site conditions and problems are usually paid for as change orders and claims out of the contingency fund.

Change orders are written orders that authorize additions, deletions, or revisions of work, cost, or time to meet the construction contract's specifications. Change orders need not be competitively awarded. Instead, change orders are usually negotiated between the construction manager and the construction contractor for the additional work desired and the contractor's proposed time, material, and labor costs to perform the tasks. Claims, on the other hand, are contractor requests for time or cost changes that the construction manager originally rejected. Claims become change orders when the construction manager and the construction contractor reach agreement on the disputed amounts through negotiation, or the amount is set through litigation or arbitration.

Objectives, Scope, and Methodology

In a June 16, 1986, letter from the Chairman of the Subcommittee on Commerce, Transportation, and Tourism, House Committee on Energy and Commerce, we were asked to survey the economy and efficiency of EPA's Superfund remedial cleanup process.

In a February 27, 1987, briefing with the Subcommittee's staff, we were asked to limit the review to remedial construction cost growth at some of the larger NPL sites. Specifically, we were asked to determine the extent of cost growth at the 25 or so NPL sites with the largest construction expenditures. Additionally, we compared Superfund cost growth with the cost growth experienced by the construction industry.[5]

[5] At the time of the initial request, June 1986, James J. Florio was Chairman of the Subcommittee on Commerce, Transportation, and Tourism, House Committee on Energy and Commerce. That Subcommittee is now named the Subcommittee on Transportation, Tourism, and Hazardous Materials, chaired by Thomas A. Luken.

Using EPA data, we identified those NPL sites with remedial construction activity. As of January 31, 1987, the latest report of information available at the time of our review, we found 90 remedial construction activities at 68 NPL sites.[6] From this data base, we identified 30 construction activities at 25 NPL sites with Superfund-financed remedial action expenditures of $1 million or more. These 30 activities accounted for nearly $94 million, or about 87 percent, of the total $108 million that we identified as Superfund remedial construction costs since the program's inception. Appendix I contains a detailed description of the methodology we used to develop the data base, select the largest construction activity expenditures for review, and determine the extent of cost growth. We discussed this methodology with EPA headquarters and regional officials and they agreed with the reasonableness of our approach.

We obtained information on the cost growth experienced in the construction industry by interviewing various construction industry officials and reviewing data developed by the American Society of Civil Engineers. Specifically, we interviewed officers and members of the American Society of Civil Engineers, officials of private sector architectural and engineering firms, and the Corps to obtain their expert opinions on cost growth in various types of construction endeavors. We also reviewed the American Society of Civil Engineers' Manual No. 45, "Consulting Engineering - A Guide for the Engagement of Engineering Services" (1975) containing data on engineers' construction estimates.

In performing our review, we contacted officials in EPA's Office of Solid Waste and Emergency Response, which is responsible for the Superfund program, and officials in all 10 EPA regional offices. We also visited and reviewed site files and interviewed officials at EPA region II in New York, New York; region V in Chicago, Illinois; the U.S. Army Corps of Engineers' Philadelphia Construction District in Philadelphia, Pennsylvania; the New York State Department of Environmental Conservation in Albany, New York; and CH2M Hill, a private architectural and engineering firm, at its office in Herndon, Virginia.

We performed our work from March 1987 through September 1987. As requested by the Chairman's office, we did not obtain official agency comments on a draft of the report. We did, however, discuss the report's contents with EPA headquarters and regional officials responsible for the

[6] As stated earlier, some NPL sites have more than one remedial construction activity because of the number of hazards contaminating the site. Forty-nine of the 68 NPL sites we identified had only one remedial construction activity. However, 16 of 68 sites had 2 remedial construction activities, and 3 of the 68 sites had 3 activities.

Superfund program and have incorporated their views into the report where appropriate. We performed our review in accordance with generally accepted government auditing standards.

Superfund Remedial Construction Cost Growth Falls Within Industry Ranges

Construction cost growth for 30 Superfund-financed remedial construction activities, each of which had expenditures exceeding $1 million, averaged about 12 percent. The cost growth ranged from a decrease of 13 percent from the original construction price, to an increase of 99 percent. According to U.S. Army Corps of Engineers and construction industry officials, construction costs may increase from 2 percent to 25 percent over the original contract amount, depending on the type of work performed and circumstances encountered. Based on these officials' experience and expertise regarding cost growth, the average cost growth for the 30 Superfund remedial construction activities we reviewed falls within the ranges experienced by the construction industry. The Superfund construction activities that had clearly defined tasks and were considered fairly routine by the construction industry, averaged slightly less than 5 percent cost growth. Cost growth was higher, however, for nonroutine Superfund construction activities involving uncertainties in the quantities and/or types of hazardous materials to be handled. These averaged nearly 19 percent cost growth.

The 30 remedial construction activities we reviewed generally involved technologically proven and cost-effective remedies favored under the 1980 Superfund legislation—and not new or alternative technologies. However, EPA anticipates using new or alternative technologies to achieve the permanent remedies preferred under SARA. As we reported in 1986, these remedies frequently have higher initial construction costs and involve many more uncertainties than routine remedial construction activities. Consequently, as new or alternative technologies are used, construction cost growth is also likely to increase above the current 12 percent average.

Cost Growth for Routine and Nonroutine Construction

Our review of the American Society of Civil Engineers' Manual No. 45 showed that undisclosed site conditions can increase construction costs. Corps officials and members of the American Society of Civil Engineers said that in their experiences, construction cost growth may range between 2 percent and 25 percent, with nonroutine construction having the highest growth. These officials said that routine construction costs may increase an average of 2 percent to 12 percent over the original contract amount due to slight delays or changes in contract specifications. Routine construction has a clearly defined scope, has average health and safety concerns, and involves tasks that have been proven and performed a number of times. Therefore, final construction costs for routine activities should closely approximate the original contract award. EPA and Corps officials said that while Superfund construction inherently involves a number of uncertainties, some routine types of construction are still used.

Constructing slurry walls, for example, is a routine process that has been used in the United States for about 40 years. These walls are underground barriers that control the lateral flow of groundwater and other fluids, including hazardous waste. Similarly, building water treatment plants and laying water lines are common to both the construction industry and to the Superfund program. Air strippers, according to regional EPA officials, are also relatively routine Superfund remedial construction activities. Air strippers are commonly used to extract pollutants from contaminated water by pumping the water to the top of a tower. As the water cascades down, the toxic substances are forced, by air or some other method, out of the water and into retention tanks.

Nonroutine construction activities, according to EPA, Corps, and private industry officials, have uncertainties in the scope or magnitude of the required work, present greater than usual health and safety hazards for those working onsite, or may involve technologies that either have not been proven or have not been tried under similar site conditions. As a result, nonroutine construction activities often have higher cost increases than routine activities because of the unanticipated events encountered during construction. According to industry and Corps officials, the final construction costs for nonroutine activities may average as much as 25 percent over the original contract price.

Some of the remedial activities meeting the characteristics of nonroutine construction include excavating contaminated soil, barrels, or other hazardous materials from abandoned landfills or dump sites; decommissioning contaminated lagoons; extracting pollutants from the soil; and using permanent treatment technologies such as incineration. These activities involve uncertainties in the quantity of hazardous substances handled, the types of contaminants present, and the possible consequences to the environment or the workers from the construction activity. Therefore, changes in nonroutine contract specifications are likely to cost more than changes in routine construction contracts.

Average Superfund Construction Cost Growth Is Within Reported Industry Ranges

Overall, construction costs for 30 remedial construction activities we reviewed grew about $10.4 million. This represents an average cost growth of 12 percent, which is within the cost growth range provided by industry officials. We reviewed the cost growths of these 30 activities using January 31, 1987, EPA data and categorized the activities into routine and nonroutine construction. Using EPA and industry officials' descriptions, we classified 9 of the 30 activities as routine construction, 17 as nonroutine, and 4 as "other" because they did not fit either description. Table I.1 (see app. I) shows the overall totals for the 30 remedial construction activities we reviewed.

Cost Growth for Routine Activities

The nine Superfund routine construction activities averaged about 5 percent cost growth over the original contract awards, within industry's estimated range of 2 percent to 12 percent for routine construction. The nine activities included constructing water treatment plants and slurry walls, laying water lines, and building an air stripper. With the exception of the Pollution Abatement site in table 2.1, the nine routine activities generally involved well-defined construction tasks and few uncertainties.

Table 2.1: Routine Construction Activities

Dollars in thousands

EPA region	Activity name	State	Description of activity	Original construction price	Total construction cost	Cost growth (decrease)	Percentage cost growth[a]
I	Sylvester	N.H.	Construct slurry wall/cap	$2,222	$2,431	$209	9.41
I	Sylvester	N.H.	Construct treatment plant	5,375	5,550	175	3.26
II	Lipari Landfill	N.J.	Construct slurry wall/cap	2,144	2,204	60	2.80
II	Price Landfill	N.J.	Relocate well field	3,159	3,257	98	3.10
II	Pollution Abatement	N.Y.	Construct slurry wall/cap	2,963	3,475	512	17.28
III	Matthews	Va.	Construct water lines	1,466	1,359	(107)	−7.30
V	Charlevoix Municipal	Mich.	Construct intake system	2,877	2,996	119	4.14
V	Verona Well Field	Mich.	Construct air stripper	1,724	1,697	(27)	−1.57
IX	Stringfellow	Calif.	Construct treatment plant	4,189	4,449	260	6.21
Total				**$26,119**	**$27,418**	**$1,299**	**4.97**

[a]Percentages were calculated by dividing the cost growth by the original construction price.

The Pollution Abatement site involved several routine activities such as building a perimeter slurry wall, installing a containment cap and liner to cover the contaminated area, and grading and seeding the site to enhance the site's physical appearance. Although we categorized it as routine, the site's contract specifications also called for one nonroutine construction task. The contractor was to remove an estimated 30 to 430 drums containing hazardous waste. The actual number of drums found on the site, however, exceeded 1,150. Following this and several smaller unforeseen incidents, final construction costs increased by $511,694, or 17 percent, over the original contract amount.

Cost Growth for Nonroutine Activities

The 17 Superfund nonroutine construction activities included primarily excavating contaminated soil, barrels, and other hazardous materials and decommissioning or lowering levels in contaminated lagoons. As shown in table 2.2, the 17 nonroutine construction activities averaged nearly 19 percent cost growth over the original contract awards. This growth was within the estimated construction industry range of up to 25 percent for nonroutine construction. Seven of the 17 activities, however, had cost increases above 25 percent.

Table 2.2: Nonroutine Construction Activities

Dollars in thousands

EPA region	Activity name	State	Description of activity	Original construction price	Total construction cost	Cost growth (decrease)	Percentage cost growth[a]
I	Re-solve Incorporated	Mass.	Excavate soil	$4,561	$5,093	$532	11.66
I	Keefe Environmental Services	N.H.	Excavate barrels	795	1,156	361	45.41
II	Syncon Resins	N.J.	Excavate barrels	1,573	1,938	365	23.20
II	Love Canal	N.Y.	Excavate/ containment cap	3,900	5,188	1,288	33.03
II	Bridgeport	N.J.	Lower lagoon level	1,133	1,446	313	27.63
II	Burnt Fly Bog	N.J.	Excavate main lagoon	2,183	3,200	1,017	46.59
II	Pollution Abatement	N.Y.	Excavate barrels	1,492	1,497	5	0.34
II	Krysowaty Farm	N.J.	Excavate soil	3,367	3,891	524	15.56
III	Lehigh Electric-Phase II	Pa.	Excavate soil	2,551	2,641	90	3.53
III	Bruin Lagoon	Pa.	Excavate lagoon	2,167	2,841	674	31.10
III	Enterprise Avenue	Pa.	Excavate soil	3,017	2,948	(69)	−2.29
III	Lehigh Electric-Phase I	Pa.	Excavate transformers	1,052	1,006	(46)	−4.37
IV	PCB Spills	N.C.	Excavate soil	2,544	2,364	(180)	−7.08
IV	Miami Drum	Fla.	Excavate soil	1,100	1,626	526	47.82
VII	Aidex	Iowa	Excavate soil	6,939	7,421	482	6.95
IX	Mountain View Globe	Ariz.	Excavate asbestos site	1,871	1,871	0	0.00
IX	Jibboom Junkyard	Calif.	Excavate soil	1,985	3,949	1,964	98.94
Total				**$42,230**	**$50,076**	**$7,846**	**18.58**

[a]Percentages were calculated by dividing the cost growth by the original construction price.

Construction costs for the Jibboom Junkyard site, for example, nearly doubled when twice as much contamination was found than specified in the contract award. Originally, the contract required excavating and removing 6,000 tons of contaminated soil from the site. During the course of work, an additional 5,900 tons of contaminated soil and buried concrete structures were discovered. The tonnage of contaminated materials excavated nearly doubled, and construction costs increased by $1,963,554, or nearly 99 percent.

The Keefe Environmental Services site is another example of uncertainties causing increased construction costs. Contract specifications called for 4,000 barrels of hazardous waste to be excavated and removed from the site. However, once work began, 2,000 additional barrels were found, thus increasing construction costs by slightly more than $361,000, or 45 percent.

In a third example, the Miami Drum construction contract specified that the contractor would excavate and transport contaminated soil to an approved facility, treat the contaminated groundwater, and remove various hazardous materials and building structures from the site within 21 days. The contract also specified that the contractor would be paid based on unit prices and the number of days onsite. The amounts (units) of soil, water, and level of contamination encountered exceeded the amounts in the original contract, and the contract was extended for 21 days. This led to the contract costs increasing by $526,292, or nearly 48 percent.

Four Activities Did Not Fit Either Description

Four other activities did not clearly meet either description of routine or nonroutine construction. The four averaged nearly 8 percent cost growth due to changing conditions at the sites.

Table 2.3: Other Construction Activities

Dollars in thousands

EPA region	Activity name	State	Description of activity	Original construction price	Total construction cost	Cost growth (decrease)	Percentage cost growth[a]
II	Love Canal	N.Y.	Hydraulic clean out	$3,343	$2,925	$(418)	−12.50
VI	Tar Creek	Okla.	Clear/plug wells	2,648	2,383	(265)	−10.01
VI	Tar Creek	Okla.	Divert Tar Creek	1,694	1,524	(170)	−10.04
IX	McColl	Calif.	Air monitoring/site prep	7,974	10,062	2,088	26.19
Total				**$15,659**	**$16,894**	**$1,235**	**7.89**

[a]Percentages were calculated by dividing the cost growth by the original construction price.

At the McColl remedial construction activity in EPA region IX, for example, construction costs increased by about $2.1 million, or about 26 percent. The original contract price for this project was $16.9 million, but because of a court order, work was halted after $10.1 million had been spent. To determine that cost growth was about 26 percent, we adjusted the contract price ($10.1 million spent to date minus the $2.1 million in change orders). Using the original price would not have shown the cost growth that occurred. Construction costs for each of the remaining three activities experienced negative cost growth (between -10 percent and nearly -13 percent) following changes in the contracted scope of work.

Activities Initiated Under SARA Are Likely to Have Higher Cost Growth

As stated in chapter 1, pre-SARA cleanups did not emphasize permanent cleanup remedies employing new or alternative technology, largely due to higher costs and greater levels of uncertainty. Permanent cleanup remedies often cost more than routine remedies because the technology is unproven for full-scale use and, therefore, involves many more associated uncertainties. Consequently, as more remedial construction activities using new or alternative technologies are initiated as encouraged under SARA, it is likely that EPA's overall remedial construction cost growth will increase over the next 4 years that Superfund is authorized.

The 30 activities we reviewed did not involve new or alternative technologies to achieve permanent cleanup remedies. However, as calculated from tables 2.1 and 2.2, the cost growth for the 17 nonroutine construction activities averaged nearly four times more than cost growth for the nine routine construction activities. EPA headquarters and regional officials believe that remedial actions employing new or alternative technologies for permanent site remedies, because of the uncertainties involved, will more closely resemble nonroutine construction than those we categorized as routine construction. EPA officials also told us that the more uncertainties involved, the greater the potential for construction cost growth. Although our review showed that overall cost growth for the 30 activities was within industry ranges, this may change as more permanent remedies are selected and implemented under SARA.

Conclusions

Overall Superfund remedial construction cost growth averaged about 12 percent for 30 construction activities exceeding $1 million. Routine construction averaged about 5 percent cost growth, while nonroutine construction averaged about 19 percent cost growth. These averages were within the 2- to 25-percent range experienced by the construction industry.

The more uncertainties surrounding the tasks to be performed during construction, the greater the potential for cost growth. The nonroutine construction activities we reviewed are similar to the new or alternative treatment technologies that may be used under SARA to permanently clean up NPL sites. Just as the uncertainties surrounding nonroutine construction caused higher cost growth for 17 of the activities we reviewed, remedial actions using new or alternative technologies may also experience higher cost growth. Over the next 4 years as more remedial construction activities are initiated under SARA, it is likely that overall Superfund remedial construction cost growth will rise. Depending on the extent of future cost growth, EPA may need to analyze the reasons for such cost growth to determine whether any actions are needed to control it.

Development of Superfund Remedial Construction Data Base for Selecting the Largest Construction Activity Expenditures for Review

We developed a data base for selecting remedial construction activities with the largest expenditures using a January 31, 1987, Superfund site-specific remedial funding data base maintained by EPA headquarters. We first identified all NPL sites with remedial construction activity. Then, based on discussions with the regional Superfund planning coordinators in each of the 10 EPA regions, we separated the Superfund-financed construction from construction financed by other sources, such as private funding. Next, through telephone interviews with EPA's Hazardous Site Control Division, we identified the number of Superfund-financed construction activities at each site. We then matched the activities with the individual obligations and expenditures reflected in the EPA site-specific data base. From this universe, we selected for review all activities with expenditures exceeding $1 million—30 activities met these criteria.

For each of these 30 activities, we contacted EPA regional officials and officials at state environmental protection agencies, the Corps, and private sector contractors to obtain financial and management information for each selected activity. The telephone survey addressed the amount of the contingency fund; the number, type, and expenditures from the fund for contract modifications, such as change orders and claims; and the final construction costs for each of the 30 remedial construction activities. We measured the extent of construction-related cost growth by calculating the difference between the original contract amount and the final construction expenditures. We limited our cost growth analysis to change orders and claims because they represented about 92 percent of total cost growth. According to EPA, Corps, and private sector construction officials contacted, the remaining 8 percent resulted primarily from pricing changes allowed by the original contracts and thereby requiring no contract modifications. Finally, we verified our telephone survey results with the cognizant EPA regional administrators. Table I.1 shows the overall results of our work.

Table I.1: Construction Activities by Region

Dollars in thousands

Activities by region	Site location	Original construction price[a]	Total construction cost[a]	Cost growth (decrease)	Percentage cost growth[b]
EPA region I					
Keefe Environmental Services	Epping, N.H.	$795	$1,156	$361	45.41
Re-solve Incorporated	North Dartmouth, Mass.	4,561	5,093	532	11.66
Sylvester—treatment plant	Nashua, N.H.	5,375	5,550	175	3.26
Sylvester—slurry wall	Nashua, N.H.	2,222	2,431	209	9.41
EPA region II					
Bridgeport	Bridgeport, N.J.	1,133	1,446	313	27.63
Burnt Fly Bog	Monmouth County, N.J.	2,183	3,200	1,017	46.59
Krysowaty Farm	Hillsborough, N.J.	3,367	3,891	524	15.56
Lipari Landfill	Glouchester County, N.J.	2,144	2,204	60	2.80
Love Canal — hydraulic	Niagara Falls, N.Y.	3,343	2,925	(418)	−12.50
Love Canal — excavation/cap	Niagara Falls, N.Y.	3,900	5,188	1,288	33.03
Pollution Abatement (construction)	Oswego, N.Y.	2,963	3,475	512	17.28
Pollution Abatement (excavation)	Oswego, N.Y.	1,492	1,497	5	0.34
Price Landfill	Atlantic County, N.J.	3,159	3,257	98	3.10
Syncon Resins	Kearney, N.J.	1,573	1,938	365	23.20
EPA region III					
Bruin Lagoon	Butler County, Pa.	2,167	2,841	674	31.10
Enterprise Avenue	Philadelphia, Pa.	3,017	2,948	(69)	−2.29
Lehigh Electric-Phase I	Old Forge, Pa.	1,052	1,006	(46)	−4.37
Lehigh Electric-Phase II	Old Forge, Pa.	2,551	2,641	90	3.53
Matthews	Roanoke, Va.	1,466	1,359	(107)	−7.30
EPA region IV					
Miami Drum	Miami, Fla.	1,100	1,626	526	47.82
PCB Spills	Raleigh, N.C.	2,544	2,364	(180)	−7.08
EPA region V					
Charlevoix Municipal	Charlevoix, Mich.	2,877	2,996	119	4.14
Verona Well Field	Verona, Mich.	1,724	1,697	(27)	−1.57
EPA region VI					
Tar Creek (clear/plug wells)	Ottawa County, Okla.	2,648	2,383	(265)	−10.01
Tar Creek (divert creek)	Ottawa County, Okla.	1,694	1,524	(170)	−10.04

(continued)

Activities by region	Site location	Original construction price[a]	Total construction cost[a]	Cost growth (decrease)	Percentage cost growth[b]
EPA region VII					
Aidex	Council Bluffs, Iowa	6,939	7,421	482	6.95
EPA region IX					
Jibboom Junkyard	Sacramento, Calif.	$1,985	$3,949	$1,964	98.94
McColl	Fullerton, Calif.	7,974	10,062	2,088	26.19
Mountain View Globe	Globe, Ariz.	1,871	1,871	0	0.00
Stringfellow	Glen Avon, Calif.	4,189	4,449	260	6.21
Total		**$84,008**	**$94,388**	**$10,380**	**12.36**

Note: Total NPL sites, 25; total activities, 30.

[a]Contract and cost data were obtained by GAO and further verified by EPA.

[b]Percentages were calculated by dividing cost growth by the original construction price.

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