



## Project Summary

# Compendium of Costs of Remedial Technologies at Hazardous Waste Sites

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Accurate estimates of hazardous waste site remedial responses are important in order to: (1) budget the Superfund Response Fund, (2) estimate costs at specific sites, (3) cost-effectively select remedial actions, and (4) effectively negotiate with private response parties for private action or cost recovery. Unfortunately, standard engineering costing methodologies have been relatively inaccurate in estimating actual response costs. This is primarily due to the uniqueness of the site problems and the uncertainties in eventual effectiveness of the responses.

The purpose of the full document is to record and analyze the actual expenses incurred during the remedial responses for seven major types of engineering technologies. The cost documented are the "bottomline" numbers showing the ultimate cost of the responses. The data supporting the compendium is derived for a series of 31 case studies of actual hazardous waste remedial responses. The full report also investigates the divergence between actual remedial costs and estimates from existing engineering cost methodologies. In addition, the compendium lists the major factors that cause the costs' movements. Because of the scope of the report coverage and the small sample size, the data provided are to be viewed as "bench marks" for estimating future response costs. Users are urged to examine the specific site conditions underlying the reported costs by con-

sulting the case studies from which these estimates are derived.

*This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### Introduction

Response cost information is critical to several aspects of implementation of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), known as Superfund. These aspects include:

- Selecting cost-effective response alternatives
- Documenting reasonable costs for cost recovery
- Budgeting for fund balancing

The purpose of the Cost Compendium is to summarize existing information for these uses. Actual expenditures and estimated costs are both given to assemble data from all available sources into one data base. The immediate use of this centralized source of cost information is to provide consistency in various site-specific costing tasks such as: remedial alternative costing as required in the Feasibility Study Guidance Document (FSGD), and budgeting or immediate and planned removals. The full compendium should be viewed as the first installment



of an outgoing data base, which will be updated periodically as more cost information becomes available from completed Superfund responses. Cost data in the compendium are organized according to related technologies, such as "Surface Water Controls," and "Ground Water Controls." The costs given are for technologies that have been most commonly used at uncontrolled hazardous waste sites, although some rarely used technologies are given because of the paucity of data. Typically, however, the number of estimates and the depth of background information are often proportional to the frequency of use of the technology. In addition to the organization of cost data according to technologies, several other features of this cost compendium merit highlighting.

## **Discussion**

### ***Actual Expenditures Versus Estimates***

Most available cost information is from engineering estimates. Few such estimates have been field tested, however. Preliminary comparison of these estimates with actual expenditures has shown significant differences in many cases. Since merging these two types of data would be misleading to the reader, the compendium separates, *ex ante*, engineering estimates from actually observed expenditures. Although actual expenditure data, which has been "ground truthed," are generally more reliable than estimated cost data, estimates are useful because they broaden the range of site characteristics and technical circumstances for which costs are available. The factors that were included in deriving the cost estimates may reflect a situation that more closely parallels the intended use of the cost data than any of the situations for which actual expenditure data are available.

### ***Focus on Unit-Cost***

Data are given in a unit-cost form, in terms of dollars per unit operation, such as cost per square foot of slurry wall, or cost per gallon of treated water. Since the units used are important, consideration was given to the selection to ensure that they were useful and/or standardized throughout the industry. English measure only is used for simplicity. These unit costs typically include all related costs such as material, labor, and equipment and other capital costs. Operation and labor costs are given when they are applicable and available.

### ***Inclusion of Summary and Raw Data***

The full compendium organizes cost data into two levels: (1) summary data, and (2) raw data. The first level gives summary data such as range, and when possible, mean and standard error. This summation of the raw data should be used only for very general cost screening and budgeting, since the wide ranges of the data presented, and the lack of background explanation on this level render it unsuitable for more specific costing purposes. Such specific cost estimation should use raw data, on the second level, which provides more detail on the data compilation. This detail can be used for matching to the circumstances at the site for which it is to be used. The user should compare the site circumstances to the factors given in the raw data to estimate the effect of these factors on the estimated cost.

### ***Factors Found to Affect Costs***

A fundamental concept of estimating costs of technology is that a variety of factors influence these costs. The compendium discusses these factors for each technology. This brief discussion of the effects of these factors reflects the descriptive detail given for each data source in the table of raw data. The essential site characteristics for actual expenditure data are typically described. These site characteristics are drawn from a hypothetical site scenario that is usually established for making necessary assumptions for estimating costs. The level of detail available for actual site characteristics and hypothetical site scenarios varied widely.

### ***Constant 1982 Dollars***

Since the source data, on which the compendium is based, originated in different years between 1975 and 1982, all costs were indexed to constant 1982 dollars using the *Engineering News Record (ENR)* construction cost index. This index reflects the weighted cost trend of common labor (74%), structural steel (15%), lumber (9%), and portland cement (2%). Data from 1983 documents were not deflated to 1982 dollars for two reasons. First, most of the costs for 1983 were actually incurred in 1982 or estimated for 1982 dollars. Second, the change in the ENR index between 1982 and 1983 is expected to be very small.

### ***Cost of Health and Safety Protection***

One of the key factors affecting the costs of responses at uncontrolled sites is the level of protection for health and safety of on-site workers. The level of hazard determines the type of protective measures the workers must take, which ultimately affects the cost of the response. Many of the data sources used in the compendium, however, did not explicitly note health and safety concerns. The cost data for actual expenditures include whatever protective measures were taken at the site. Often, however, the available information on the response action did not fully describe the protective measures. This defect may be corrected by further research. Health and safety assumptions for estimates are usually less clear than expenditures. In only one case did the estimator explicitly consider the cost effect of various protective measures.

SCS Engineers recently completed a study on the cost of health and safety protection for the U.S. Environmental Protection Agency's Office of Research and Development. Six cleanup firms were asked to bid on six hypothetical uncontrolled site scenarios with five levels of personal protection for the study. First, the results, presented in the full compendium, are from a final draft version of the SCS report. Additional changes may be made to the results. Second, the validity of the results depends on how seriously the bidders took the hypothetical scenarios and whether the bidders were neutral in providing the estimates (i.e., free from motives that may misrepresent the costs).

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The complete report, entitled "Compendium of Costs of Remedial Technologies at Hazardous Waste Sites," (Order No. PB 88-113 477/AS; Cost: \$25.95, subject to change) will be available only from:

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