

FUSRAP COST TO COMPLETE

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ABSTRACT

The Energy and Water Development Appropriations Act for Fiscal Year 1998, signed into law on 13 October 1997, transferred the responsibility for executing the Formerly Utilized Sites Remedial Action Program (FUSRAP) from the Department of Energy (DOE) to the US Army Corps of Engineers (USACE). When the program was transferred to the Corps twenty-two sites remained to be remediated. The Corps felt it necessary to develop new cost estimates and schedules for the twenty-two sites in response to a request from the House and Senate Committees on Appropriations to determine the possibility and/or reasonableness of meeting DOE's proposed 2002 completion date for FUSRAP. The Hazardous, Toxic, and Radioactive Waste Center of Expertise (HTRW CX), along with the various districts responsible for executing the FUSRAP program coordinated and conducted a cost to complete effort. The term 'cost to complete' refers to capturing total costs for the program from the time of program transfer through completion. Such costs include Preliminary Assessment/Site Investigation, Remedial Investigation, Feasibility Study, Remedial Design, Remedial Action, and Operation and Maintenance. The Corps used a project management (PM) team approach along with existing Corps policies and procedures to develop the cost to complete estimates for the twenty-two sites.

This paper will address (1) USACE cost engineering policy used for FUSRAP; (2) the complexity of estimating the cost of FUSRAP projects; and (3) cost engineering procedures, software programs, databases, and documents used to develop the cost to complete estimates. The estimating resources and software programs used to assist the cost engineers and other engineering staff members discussed within this paper are listed below.

1. HTRW Work Breakdown Structure (WBS).
2. HTRW Productivity Study.
3. Treatment, Storage, and Disposal Facilities (TSDF) Report.
4. Parametric Estimating with Remedial Action Cost Engineering and Requirements (RACER) program and detailed estimating with Micro-Computer Aided Cost Estimating System (MCACES).

Effectively estimating project costs and schedules for FUSRAP was indeed a challenging endeavor for the Corps. However, in keeping with the PM team concept and using the

expertise within the Corps along with the above listed resources, the task of preparing the estimates and schedules was successful.

INTRODUCTION

FUSRAP was originally a Department of Energy (DOE) program created to address radiological contamination at sites used by the predecessor agencies to DOE, the Manhattan Engineer District and the Atomic Energy Commission from the 1940's to the 1960's. The contaminants are primarily low levels of uranium, thorium, and radium (with their associated decay products), and mixed wastes. There are a total of 46 sites in the program and remediation has been completed at 24 of these sites at the time of the transfer to the Corps. Remedial action is planned, underway or pending final closeout at the 22 remaining sites.

The Corps' initial assessment of the FUSRAP program took place during the transition period beginning in mid October 1997 through January 1998. The Corps developed a quick assessment of FUSRAP during this period and summarized it in a report to congress in March 1998. One focus of the assessment was to identify key areas where improvements to the cost and schedules could be enacted. As a result, the Corps decided to implement performance measurement procedures for management of the program. One of the first measurement procedures implemented was to develop a more detailed program-wide, bottoms-up, cost to complete estimate and to establish a comprehensive upward reporting system. Prior to developing cost to complete estimates and schedules, definitive scopes of work for the various sites had to be established. The Corps' objective for establishing these scopes of work was to select remedies based on remediation criteria which are fully protective of human health and the environment, yet provide an appropriate balance of protectiveness with cost, schedule and stakeholder desires. To achieve this objective, the Corps primarily followed the procedures specified in CERCLA and the NCP, to establish specific remediation criteria. The Corps Districts coordinated with regulators, state and federal agencies, and also other local interest groups to help establish the scopes of work at that time for each site. Selection of appropriate remediation objectives and cleanup criteria were the key cost and schedule drivers within this program.

COST ENGINEERING POLICY

The Corps evaluated the FUSRAP program similar to the Defense Environmental Restoration Program Formerly Used Defense Sites (DERP-FUDS) program and applied necessary resources consistent with policies established by the Directorates of Civil Works and Military Programs.

On 9 February 1998, Headquarters USACE issued a memorandum directing the cost to complete effort and providing guidance for preparation of the estimates. The guidance was issued to ensure consistency and quality of the estimates for the entire program. A PM team approach was used to develop the project technical assumptions, scope of work, and remedy selection, so accurate and defensible estimates could be developed for the program. The estimates included costs necessary for studies, design, remedial action, project management, construction management and other functional support costs for the

program. The memorandum also specified that the cost data be entered into the Project Management Information System (PROMIS) database utilizing the established Hazardous, Toxic, and Radioactive Waste Work Breakdown Structure (HTRW WBS). PROMIS is the Corps management software that facilitates tracking and reporting of resources for both in-house and contracting requirements using the HTRW WBS.

The Corps' estimating guidance emphasized that each estimate be prepared as accurately as possible, in as much detail as possible, and based upon the best information available. Much of the design/characterization details were limited for many of the sites, which presented a challenge for the Corps to meet this guidance. The PM team concept was employed to prepare the detailed cost estimates. Project/technical managers, designers, and cost engineers formed teams and extensively collaborated with each other to define project scopes and design information to help prepare the estimates. To help ensure quality and integrity of the estimates, the Corps' HTRW Center of Expertise (CX) completed a detailed independent review of each estimate.

The memorandum/guidance encouraged the use of the HTRW Remedial Action (RA) WBS to structure the estimates. The WBS provided a common ordered hierarchy framework for summarizing the information in the estimates and for quantitative reporting for each project. The RA WBS consists of four numbered levels of cost breakdown. Each level is identified by a two digit number; Level 1 (Account) represents HTRW RA and is identified by 33. The detail increases with each succeeding level as shown below:

Level 1 (Account)	33 1xx - HTRW Remedial Action
Level 2 (System)	33 1xx.08 - Solids Collection & Containment
Level 3 (Subsystem)	33 1xx.08.01 - Contaminated Soil Collection
Level 4 (Assembly Category)	33 1xx.08.01.02 - Excavation

As a minimum, the estimates were summarized to the third level of this hierarchy. The RA WBS also has a "standard description" manual referred to as the "Data Dictionary" to assist the estimator in determining where to put a particular work item within the appropriate breakdown structure. Preparing the estimates using this structure provided consistency among the districts and helped to ensure completeness.

COMPLEXITY

As previously stated, a major difficulty in developing meaningful and reasonable cost estimates for the program was the lack of detailed characterization/design information for some of the sites. The "PM team concept" approaches helped to a good degree alleviate some of this problem. To initiate the team concept, a meeting was held in January 1998 at Oak Ridge, Tennessee to gather together Corps cost engineers, project/technical managers, and the key contractors used by DOE, Bechtel, Inc. and SAIC to discuss specific FUSRAP site histories and current site information. This meeting was especially helpful to the cost engineers, providing them the necessary project backgrounds and some of the difficulties that could be encountered when developing cost estimates for the

program. The other major issues that needed resolution in order to develop credible cost estimates and schedules included adequate definition of project scopes and cleanup criteria for the sites. This affected the major cost drivers within each estimate such as soil volumes, disposal, location, transportation and treatment technologies. The Corps contracted the help of Bechtel, Inc. and SAIC to assist in developing this information, since they both were involved in the program prior to the Corps inception. The cost engineers routinely coordinated with the district project managers and engineers to discuss the assumption and quantities for the basis of the estimates

USACE COST ENGINEERING TOOLS AND RESOURCES

The Cost Engineering offices at each district have cost engineering software, databases, and documents available that were used in developing the cost to complete estimates for the FUSRAP program. Each of these estimating tools are described below:

a. **HTRW Remedial Action (RA) and Operation and Maintenance (O&M) Work Breakdown Structures (WBS):** Both the RA WBS and O&M WBS are hierarchical breakdowns of work tasks in a numbered structure, organized in a logical construction sequence. Both structures provide a uniform standard to organize and report RA and O&M work to be performed in accomplishing an HTRW project. The primary purposes of the structures are to (1) collect HTRW RA and O&M cost data in a standard format for cost reporting and tracking using the Project Management Information System (PROMIS); and, (2) to report, aggregate, and disseminate historical cost data in a standard format using the Historical Cost Analysis System (HCAS). The WBSs thus facilitate communication between management and technical disciplines concerning project elements during all project phases. Tracking and reconciliation of estimates between project phases is also accomplished more easily because of consistency of structure. Interpretation of the tasks listed in both WBSs is clarified by a data dictionary which indicates what is included in each task.

b. **Micro Computer-Aided Cost Engineering System (MCACES) Databases with HTRW Specific Items.** MCACES is available both in DOS and Windows. The latest DOS version is MCACES Gold version 5.30. The latest windows version is MCACES for Windows (MFW) version 1.1a. MCACES is the standard cost estimating system used by all district Cost Engineering offices. It is a detailed cost estimating program, which is utilized primarily for development of cost estimates where detailed design information is available. MCACES is a proven system and has been used by the Corps to estimate the cost of military, civil works, and HTRW projects. A number of enhancements have been made to improve the use of MCACES for estimating HTRW projects. For example, MCACES includes a Unit Price Book (UPB) database that contains cost information on more than 21,000 unit price line items for construction labor, equipment, and material. Approximately 4,000 of these items are HTRW items, which reflect costs for personal protective equipment, drum overpackings, treatment technologies, etc. In addition, a host of HTRW models and assemblies have been developed for MCACES that can be used to prepare remedial action cost estimates. The use of models and assemblies has several advantages including predefined tasks,

standardization using the Remedial Action Work Breakdown Structure (RA WBS), and applicability when detailed design is not completed.

c. **Remedial Action (RA) Cost Contingency Analysis.** Contingencies include RA costs of unknowns, unforeseen uncertainties, and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time a cost estimate is prepared, but must be represented by a sufficient cost to cover the identified risks. Contingencies are normally separated into two elements for incremental analysis - design contingencies and construction contingencies.

(1) Design contingencies include estimated RA cost increases due to design incompleteness, detail changes, alternative design changes, and associated pricing inaccuracy. The extent of site characterization and assessment that has been accomplished to compute project quantities must be considered when determining design contingencies for HTRW construction costs. For example, estimates of groundwater volume and concentration are often possible only after field pump tests are completed. Many feasibility studies are prepared prior to these tests and so must rely on assumed volumes and concentrations. Design contingencies will normally decrease, as design information becomes known.

(2) Construction contingencies are a reserve for RA cost growth due to adverse or unexpected conditions such as unforeseeable relocations, foundation conditions, utility lines in unknown locations, quantity overruns, or other unforeseen problems beyond interpretation at the time of or after contract award.

One of the most important tasks in estimating the cost of RA projects is predicting contingencies that will cover all the uncertainties associated with the nature and extent of the contamination and the design and effectiveness of the remedy being used. The project/technical managers must be aware of the cost risk in RA projects and manage it by allowing for contingencies commensurate with the level of cost risk.

The Corps has acquired a site license to use computer-based analysis software and database called HAZRISK, which is a windows-based program that analyzes a project and predicts cost contingencies. The HAZRISK database consists of historical costs and schedules of completed remedial actions from both Government and industry sites. It links cost growth and schedule with project characteristics such as the nature of the site, the contaminant(s) involved, the technologies selected, and the characteristics of the federal, state, and local regulatory requirements. HAZRISK is based on statistical analysis of 400+ HTRW projects. The program's Cleanup Contingency Allocation Model produces a bell-shaped curve that represents the range and probable distribution of both design and construction contingencies required for various confidence levels on similar-type projects. For example, if a project or technical manager needs to be 50% confident that a particular project cost won't be overrun, HAZRISK will predict contingency for that level of confidence. Contingency amounts/percentages are calculated for each of the system (second) level RA WBS elements that are identified for the project. As would be expected, HAZRISK predicts higher contingencies for those

projects that are less defined such as those in study phases. As the project progresses from study to preliminary design and on to final design, the project team may have additional project-specific information that may override the statistical approach used in HAZRISK. Therefore, the Cost Engineering office can utilize all available project data and the project or technical manager's desired confidence level to arrive at a proposed contingency for each of the project second level RA WBS elements.

d. Historical Cost Analysis System (HCAS). Historical project cost data is valuable information that can be used as an aid in developing budget estimates and comparing estimated project costs to actual experience. An interagency group was formed in 1990 to coordinate HTRW cost engineering activities and developments among various Federal agencies. One of the initiatives of the group was to develop an interagency cost collection database for HTRW remedial action project costs that would provide for standardization of RA cost collection among agencies. An interagency historical cost committee was formed in 1992 to coordinate development of the HCAS database, which was initially completed in November 1993. HCAS does not produce cost estimates, but is used by the Cost Engineering office to obtain historical remedial action cost information for comparison or programming purposes. The current database contains award costs for over 60 remedial action projects mostly from the Corps but also from other agencies. Remedial action costs are collected and grouped in HCAS primarily by the HTRW RA WBS.

e. Remedial Action Cost Engineering and Requirements (RACER) System. RACER was designed by the Air Force to assist in the development and evaluation of alternatives for remediation and to estimate costs of HTRW projects. The RACER system uses parametric models of cleanup systems to develop costs for HTRW remediation at all phases from characterization through final closeout. RACER uses generic cost models based on historical HTRW projects and technologies. The generic models available in RACER are modified to reflect actual conditions of new projects. The tailored models are then quantified and priced in accordance with the current costing data contained within the current UPB. RACER will estimate costs for studies, design, remedial action, and operation and maintenance. Over 100 generic cost models have been developed to date.

f. USACE HTRW Productivity Study. Worker productivity is one of the most variable cost elements in a RA project. The HTRW CX developed a productivity study for HTRW projects by observing remedial action work in progress, reviewing construction progress records, performing a literature search, and conducting face-to-face interviews with remedial action contractors and Corps field personnel. The study documents the dramatic impact that worker protection level requirements have on construction production rates. Variables that affect production include work intensity, personal protective equipment requirements, temperature, meetings, suiting up/off, air tank/filter changes, personal decontamination, monitoring delays, breaks, cleanup, and dexterity. Two tables were developed identifying HTRW productivity factors for both light work and heavy work. The tables provide factors for each OSHA protection level, i.e., A, B, C, D+, and D. For example, if a person is performing heavy work, i.e., hand

excavation, in 80-degree weather, and is in Level B protection, their productivity factor from the table is .36. In other words, if they could excavate 1 cubic yard per hour under normal conditions in street clothes, they could only excavate .36 cubic yards per hour under this scenario.

g. **USACE Treatment, Storage, and Disposal Facilities (TSDF) Report.** The TSDF report was updated and distributed in April 1998 to each Cost Engineering office and Construction Division at each USACE division and district. This report identifies all known commercial hazardous waste treatment, storage, and disposal facilities in the United States. The report includes charges identified by each facility for items such as disposal of various types of waste, state taxes and fees imposed on the disposal of hazardous waste, points of contact with telephone numbers for each facility, and transportation costs for hazardous waste. The report also identifies what the treatment capabilities and restrictions are for each facility.

h. **USACE Engineer Instructions (EI) 01D010- "Construction Cost Estimates".** This is a Corps of Engineers "how to" manual to prepare construction cost estimates for all programs, Military, Civil Works, and HTRW. The manual provides the cost engineer with the necessary HTRW unique requirements and features to prepare an HTRW RA cost estimate. The final manual was distributed via the Internet and can be found at <http://www.hnd.usace.army.mil> under TECHINFO, Engineer Instructions.

i. **USACE HTRW Center of Expertise (CX).** Centers of expertise are designated USACE organizations or individuals who have demonstrated capability and expertise in a specialized area. They improve capabilities and management, eliminate redundancy, and optimize the use of specialized expertise and resources. They also enhance Corps-wide consistency, facilitate technology transfer, help maintain institutional knowledge in key areas, and improve service to the customer. For more information on the HTRW Center of Expertise contact the home page at <http://www.environmental.usace.army.mil/>.

CONCLUSION

Using the above listed resources, USACE prepared cost estimates for each FUSRAP site. The HTRW CX reviewed the estimates for quality and consistency. The majority of the estimates were prepared using MCACES, and were detailed bottoms up estimates. RACER was also used to help develop some of the estimate details and this information was then put into the WBS format within MCACES. All major assumptions were included within the estimates to provide documentation as a basis for future change as design information becomes more complete. Price quotes were obtained for major cost drivers such as transportation and disposal.

The cost to complete effort was completed June 1998 and provided the USACE PM team a better understanding of the program. The effort also provided USACE more time to assess project data, tasks, schedules, cost and assumptions as to the undertaking that lay ahead. Where as, during the initial assessment of the program, as reported in the Report to Congress, the determination of project scopes, costs and schedules was completed

within a short time frame. The initial assessment of the program was based on existing plans, estimates, and schedules developed prior to the Corps' inception and also support from DOE's contractors.

During the initial assessment, the Corps developed a range of realistic scenarios for completing FUSRAP as reported in the Report to Congress. The most efficient schedule for completion assumes no annual funding constraints. Under this scenario the program would be completed by the year 2006 at a cost of approximately of \$1.56 billion. The other scenario assumes an annual funding level of \$140 million. If annual funding levels are held to \$140 million, the program would cost approximately \$1.88 billion and not be completed until 2011. The results of the cost to complete effort performed by the districts was based on unconstrained funding and compared favorably to the unconstrained funding scenario shown in the report to congress. The initial cost to complete estimates as reviewed by the HTRW CX projected program costs of approximately \$1.53 billion. Much of the site characterization for many of the sites was limited when these estimates were prepared so they are expected to change, as this information becomes more defined. However, cost and time contingencies were incorporated into the estimates to help accommodate much of this change.

The benefit of developing integrated, bottoms-up cost and schedule estimates for the program not only gave the project teams a better understanding of their FUSRAP projects but also a basis to help manage their projects. The Corps believes that with the adoption of balanced cleanup criteria, that is protective of human health and environment, it can accomplish cleanup goals for the program in a most prudent and cost effective manner.