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Information on Cost Growth in Site Characterization Cost Estimates

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Resources, Community, and
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The Honorable J. Bennett Johnston
Chairman, Committee on Energy
and Natural Resources
United States Senate

The Honorable James A. McClure
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

As requested by your office on May 28, 1987, we are providing you with this fact sheet, which discusses growth in the Department of Energy's (DOE) cost estimates for testing, or characterizing, the three sites under consideration as the nation's first repository for the permanent disposal of high-level nuclear waste. As you know, the Nuclear Waste Policy Act of 1982 (P.L. 97-425) established a comprehensive program for disposing of these wastes in geologic repositories, including detailed site characterization to determine the suitability of each candidate repository site. The three sites are located in Deaf Smith County, Texas; on DOE's Hanford Reservation, Washington; and at Yucca Mountain, Nevada, adjacent to DOE's nuclear weapons test site. This fact sheet supplements our recent report to your committee, Nuclear Waste: A Look at Current Use of Funds and Cost Estimates for the Future (GAO/RCED-87-121, Aug. 31, 1987).

Briefly, DOE's earliest estimates of site characterization costs, made in 1981, were from $60 million to $80 million per site, or from $180 million to $240 million for three sites. Since then, DOE's cost estimates for characterizing three sites have increased dramatically, to $2.2 billion in 1984, and to $4.8 billion in its latest preliminary estimates. Because these figures are expressed in 1981, 1983, and 1986 dollars, respectively, they are not directly comparable. However, adjusting for inflation does not significantly change the magnitude of the increases since

1981. In year-of-expenditure dollars, which takes future inflation into account, the latest estimate totals almost $5.8 billion.

Sections 2 and 3 of this fact sheet discuss the two basic reasons for these dramatic increases. First, the early estimates pre-dating the act did not anticipate the comprehensive program that DOE now believes is necessary to address and resolve technical, regulatory, and institutional issues. For example, since DOE developed its early cost estimates, it has expanded substantially its plans for sinking exploratory shafts and excavating rock at the depth at which a repository might be built. Second, in June 1987 DOE extended its schedule for bringing the first repository on line from 1998 to 2003, including lengthening the time allowed for site characterization by over 3 years. This extension and additional new work plans generally account for the increase in DOE's most recent cost estimates.

Data and information discussed in this fact sheet were obtained from DOE headquarters and from DOE officials and contractor representatives at each of the candidate site project offices located at Hereford, Texas; Richland, Washington; and Las Vegas, Nevada. In general, the Nevada project office had the most extensive data, including data on the most recent site characterization cost estimates, which were readily available for our review. As a result, this fact sheet frequently uses examples of cost estimates and planned activities at the Yucca Mountain, Nevada, site. We made our review in the period of June through August 1987.

We did not evaluate the accuracy of DOE's site characterization cost estimates in detail or the adequacy of DOE's justification for the site characterization activities. We discussed the facts presented with cognizant DOE officials and incorporated their views where appropriate. DOE pointed out that its most recent site characterization cost estimates were developed for use in the fiscal year 1989 budget, and as such, have not yet been finalized or released outside DOE.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days from the date of this letter. At that time, we will send copies of this fact sheet to the Secretary of Energy, interested

congressional committees and subcommittees, and other interested parties. Copies will be made available to others upon request. If you have further questions, please contact me at (202) 275-1441.

Major contributors are listed in appendix I.

Keith O. Fultz
Associate Director

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ABBREVIATIONS

DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
GNP	gross national product
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
QA	quality assurance

SECTION 1

SITE CHARACTERIZATION REQUIREMENTS

BACKGROUND

On January 7, 1983, the Congress enacted the Nuclear Waste Policy Act of 1982 (NWPA) to establish a federal policy for nuclear waste management and to ensure the safe storage and permanent disposal of high-level nuclear waste. The act provides, among other things, for screening, testing, and selecting sites for two deep-underground geologic repositories and for the licensing, construction, and operation of the first repository. NWPA established a time schedule and a step-by-step process by which the President, the Congress, the Department of Energy (DOE), other federal agencies, and states and Indian tribes could cooperate in developing waste repositories. The costs of the program, including site screening and testing, are to be paid by generators of nuclear wastes through fees paid into the Nuclear Waste Fund.

On May 28, 1986, the President approved the three sites that the Secretary of Energy had recommended for detailed geologic study (site characterization). The sites are located in Deaf Smith County, Texas; on DOE's Hanford Reservation, Washington; and at Yucca Mountain, Nevada, adjacent to DOE's nuclear weapons test site.

SITE CHARACTERIZATION

The site characterization phase of the nuclear waste program began immediately following the President's approval of the three candidate sites. Because how one defines the work scope and time frame for site characterization can result in a substantial difference in cost estimates, a clear and consistent definition is needed to provide a basis for comparing cost estimates from one year to another. To provide for consistent terminology, this fact sheet considers site characterization costs to be all of the first repository costs occurring between the date that the President approved the three candidate sites through the submission of a license application to the Nuclear Regulatory Commission (NRC). DOE officials told us that this is the definition DOE uses in estimating site characterization costs.

The objectives of site characterization are to (1) determine if the geologic, hydrologic, and geochemical conditions at a candidate site are suitable for the safe and permanent disposal of nuclear waste, (2) obtain information to assist in developing a design for the waste disposal package that will meet NRC's regulatory requirements, (3) provide information for the design of the repository facility, and (4) evaluate whether the site can meet the requirements of the Environmental Protection Agency (EPA) and NRC. Site characterization is expected to continue through site

selection and submission of an application to NRC--currently scheduled for January 1995--for authorization to construct a repository at the selected site.

Site characterization activities include extensive field and laboratory testing and studies to collect and evaluate geologic, hydrologic, and geochemical information; and other studies that assess the potential environmental and socioeconomic effects of repository development and operation. During the field and laboratory testing phase, DOE plans to investigate the host rock at repository depth through the construction and use of two exploratory shafts and underground test facilities at each test site. The first shaft will be used mainly for conducting tests. The primary purpose of the second shaft is to provide an emergency exit for the safety of workers. The subsurface investigations will include activities such as ground water monitoring, core extraction, and stratigraphic, tectonic, geochemical, and geohydrologic studies.

Studies of the rock at repository depth and surrounding strata will assess the effect of the repository environment on the waste package, the ability of the rock to contain radionuclides, and its ability to retard radionuclides by chemical interaction. In addition, DOE will conduct surface-based investigations, such as geologic mapping, geophysical surveys, and seismologic studies. Environmental and socioeconomic studies will be used along with data obtained from field and laboratory studies to prepare an environmental impact statement for the three sites.

SITE CHARACTERIZATION PLANS

NWPA requires DOE to prepare a site characterization plan before beginning to sink exploratory shafts at any candidate repository site. Site characterization plans are also required by the NRC regulations for the disposal of high-level waste. Although surface-based research and development have begun at the Hanford and Yucca Mountain sites, which are located on federal lands, testing associated with sinking the exploratory shafts at each of the three sites is contingent upon DOE completing these plans.[1] NWPA also requires DOE to provide the plans to NRC for review and comments before proceeding to sink shafts. The site characterization plans are intended to provide mechanisms to aid in the identification of specific issues at a proposed repository site. The plans are also intended to identify the specific investigations that DOE determines is required to obtain data needed to resolve issues and evaluate the sites.

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[1]The Deaf Smith site is on privately owned land to which DOE has not yet gained access.

In May 1986 NRC and DOE met to determine the appropriate level of detail to be included in the site characterization plans. The agencies agreed that each plan would include a complete description of the site characterization program with supporting documents consisting of references and study plans, including test procedures. In addition, study plans would provide detailed test descriptions and procedures, whenever possible, about 6 months before each test would be conducted.

DOE's plans for site characterization have changed substantially from the tests and activities that it envisioned prior to and shortly after passage of NWPA. Since 1984, for example, the Yucca Mountain site characterization plan has grown from roughly 300 pages to over 5,000 pages. In addition, at each site DOE will be required to prepare more than 100 study plans, which may total about 10,000 pages, describing in detail specific tests and test procedures. DOE intends to issue the Yucca Mountain and Hanford plans later this year and the Deaf Smith plan early next year.

SECTION 2

SITE CHARACTERIZATION COST ESTIMATES BEFORE DOE REVISED THE WASTE PROGRAM MILESTONES

In 1981 DOE estimated that site characterization would cost $60 million to $80 million for each site, or $180 million to $240 million for three sites (1981 dollars). By 1984 the estimate had increased 10-fold to $2.2 billion (1983 dollars) because the 1984 cost estimate was the first comprehensive DOE estimate reflecting its strategy for carrying out the waste program mandated by NWPA. Cost estimates then stabilized for 2 years and, when the effects of inflation are considered, actually decreased slightly in 1985 and 1986.

DOE's cost estimates pre-dating NWPA did not anticipate the magnitude of the waste program. As the program evolved, requirements for characterizing sites became more defined, the scope of work was clarified and expanded, and cost estimates increased. For example, plans for an exploratory shaft and testing at repository depth have changed substantially. Early plans called for one shaft at each site with about 1,000 feet of underground horizontal excavation, called drift.[1] Now, however, DOE is planning two shafts of larger diameter and substantially more underground excavation.

PRE-NWPA COST ESTIMATES

DOE's pre-NWPA cost estimates for "site characterization," such as its 1981 estimate of $60 million to $80 million per site and a 1982 estimate of $423 million to characterize three sites, are not comparable in scope to cost estimates made after the act was passed and DOE had begun to implement it. For example, early projections often did not include detailed descriptions of the activities considered in developing the cost estimates or how the estimates were developed. In addition, changes in how DOE defines site characterization since the act was passed prevent any comprehensive comparisons between pre-NWPA and later cost estimates.

The earliest DOE estimate of site characterization costs that we identified was prepared in 1981 in response to a question from a congressional subcommittee. Following a June 18, 1981, hearing on H.R. 1909, "Nuclear Waste Research, Development and Demonstration Act of 1981," the Subcommittee on Energy Research and Production, House Science and Technology Committee, submitted a series of questions to DOE and NRC. One question asked for cost estimates

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[1]A drift is a horizontal opening excavated out from the exploratory shaft, where testing can be conducted at repository depth.

for the site characterization process required by NRC regulations for full-scale, high-level waste repositories.

On July 20, 1981, DOE replied that "site characterization with exploratory shafts as required . . . will involve expenditure of . . . $60 million to $80 million for each site, most of which is for shaft and at-depth tests." NRC responded that construction costs for testing at repository depth were estimated at $25 million to $30 million for soft rock, such as salt, and up to 30-percent higher for hard rock, such as basalt and tuff. Neither response listed the specific work activities on which these pre-NWPA cost estimates were based. Earlier, however, in a final rule on "Disposal of High-level Radioactive Wastes in Geologic Repositories: Licensing Procedures," dated February 25, 1981, NRC had indicated that much of the data for its cost estimates were obtained from a 1979 study.[2]

We also identified a DOE estimate of site characterization costs prepared about the time NWPA was enacted. A December 1982 report prepared for DOE by a contractor, Battelle Memorial Institute, projected cost estimates for a waste program to comply with then current NRC and EPA regulations.[3] The cost estimates for site characterization included the costs of scientifically collecting and evaluating information about the physical, chemical, geologic, and human environment necessary to judge site suitability. Also included were costs for detailed surface and subsurface studies, construction of an exploratory shaft, and testing of rock at repository depth. In addition, the report contained a schedule of major project milestones providing for a first repository start-up date in October 1998.

Estimated costs of program research and development were broken down into cost categories of activities to be performed. For the site characterization category, the report projected combined costs for three sites of about $423 million, or $141 million per site (1982 dollars). Although the report did not contain specific details about the activities to be conducted during site characterization, it did indicate that the site characterization estimate included costs for collecting and evaluating information about the physical, chemical, geologic, and human environment necessary to judge site suitability.

Representatives from DOE and Roy F. Weston, Inc., a DOE contractor that assists DOE in preparing total waste program cost estimates, examined the study at our request and determined that

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[2]A Cost Optimization Study for Geologic Isolation of Radioactive Wastes, Battelle Memorial Institute (May 1979).

[3]Projected Costs for Mined Geologic Isolation of Radioactive Wastes, Battelle Memorial Institute, ONI-3 (Dec. 1982).

the activities Battelle included in its site characterization cost estimate in its December 1982 report are not comparable to DOE's current cost estimating approach. In particular, many work activities that DOE now includes in site characterization cost estimates were assigned to other categories in the 1982 report. For example, costs for waste package and repository design activities and for program management were included in the cost category, "Technology for Development of Repositories."

COST ESTIMATES INCREASED AND THEN STABILIZED AFTER NWPA WAS ENACTED

In 1984, after enactment of NWPA, site characterization cost estimates rose to about $2.2 billion (1983 dollars) for three sites. This large increase in projected costs remained generally stable in 1985 and 1986. After enactment of NWPA and as the requirements for site characterization became better defined, DOE began developing cost estimates for implementing the total waste system over its approximately 100-year life cycle. These annual cost analyses are intended to provide cost estimates that reflect the most current plans and information about DOE's waste management program. A primary data source for the life cycle cost estimates is the information developed for the annual nuclear waste fund budget requests.

The 1984 estimate was the first to reflect DOE's program strategy to carry out the waste program activities mandated by NWPA and, because of the additional activities it included, was much larger than pre-NWPA estimates. Table 2.1 illustrates this cost increase after adjusting all of the cost estimates to 1986 dollars to eliminate the effects of inflation. In 1986 dollars, the 1984 estimate was about $1.9 billion more than the estimate in Battelle's 1982 report.

Table 2.1: Cost Estimates for Characterizing Three Sites--1981 to 1986

1981	1982	1984	1985	1986
(in millions)				
$219 to $292	$484	$2,384	$2,345	$2,254

Note: Cost estimates are in constant 1986 dollars.

The cost estimates from 1984 through 1986 remained relatively stable even though DOE changed intermediate program milestones and its plans for some work activities. Changes in milestones appear to have had little impact on the cost estimates primarily because they resulted in little change in the length of the site characterization phase. For example, the April 1984 draft mission plan scheduled site characterization activities to begin in February 1985 and end in August 1990, while the March 1986 project decision schedule slipped the start date 16 months, to June 1986, and the ending date by 16 months, to December 1991.[4] In addition, increased costs for some work activities were offset by decreased costs in other activities.

SEVERAL HIGH-COST ACTIVITIES WERE INCLUDED IN SITE CHARACTERIZATION AFTER NWPA

Although several high-cost activities have been introduced into DOE's site characterization plans since enactment of NWPA, no single activity has caused the dramatic increase in cost estimates. Our discussions with DOE project office and headquarters officials indicate that as the waste program requirements became better defined, it became apparent that many activities and studies would be necessary that had not been forseen. DOE officials repeatedly told us that the early estimates of site characterization costs did not anticipate all of the potential activities, and therefore the costs, of a program of this size. We identified many activities introduced into the site characterization phase after passage of the act--and after the 1982 Battelle site characterization cost estimate was made--that contributed to the increased costs. These include exploratory shaft activities, an expanded technical testing program, and funding for states and affected Indian tribes. A description of some of these activities follows.

Exploratory Shaft Activities

In 1986, cost estimates for exploratory shaft activities reached $516 million for the three sites. As noted earlier, the 1982 Battelle estimates for the total site characterization program was approximately $383 million (or $439 million in 1986 dollars). The reasons for the escalated exploratory shaft cost estimates include the requirement of a second shaft at each of the three sites, changes to larger diameter shafts, and additional drift.

Exploratory shaft activities now include costs for a second shaft at each of the three sites as well as an expanded program for the initial shaft. The initial concept for the site

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[4]As discussed in section 1, for cost estimating purposes, the site characterization start date refers to the date of the President's decision to select three sites for characterization, and the ending date refers to the date a license application is submitted to NRC.

characterization program included a single shaft with a minimal testing program. In 1984, however, DOE authorized a second shaft for the Hanford site in response to Hanford's concern that a second and independent avenue for emergency exit was needed for safety reasons. Immediately thereafter, in an April 1984 memo, DOE concluded that all three projects should plan for a second shaft. Costs for the added shafts were then included in project office budgets.

Changes to larger diameter shafts and provisions for additional drift in both shafts further added to exploratory shaft cost estimates during this period. At Hanford, the July 1982 plans called for one 6-foot diameter shaft with 1,000 feet of drift. By 1984 the design for the exploratory shaft had changed to provide for two 6-foot shafts and 1,500 feet of drift. In May 1986 DOE's site characterization planning called for one 6-foot shaft, one 10-foot shaft, and 3,300 feet of drift--more than triple the original amount.

The exploratory shaft concept changed at the other sites as well. For example, in 1983 DOE's plans for the Yucca Mountain site called for one 12-foot diameter shaft and 700 feet of drift. By 1986 the plan had changed to a concept of one 12-foot shaft, one 6-foot shaft, and 1,500 feet of drift. Further, the concept has continued to change. Yucca Mountain is now planning for two 12-foot shafts with 9,200 feet of drift. Reflecting these expanded shaft and drift plans, the corresponding project office cost estimate increased from about $50 million in 1983 to about $200 million in 1986.

Technical Site Testing

By 1986 estimates for technical site testing had increased to over $550 million for the three sites. These activities include studies concerning the geology, hydrology, and geochemistry of the proposed sites. Unlike the exploratory shaft activities, however, no single item appears to have contributed substantially to cost increases. As the field offices became more knowledgeable concerning what needed to be done to resolve the issues and demonstrate the suitability of the site, more detailed technical studies were incorporated into the site characterization plans.

Quality Assurance Program

The development of a site characterization quality assurance program has also accounted for significant cost increases throughout the implementation of the testing program. At one field office we were told that the "QA program being implemented is far in excess of the documentation required by good scientific practice" and that it is being reflected in every phase of documentation during the project's planning process. In this

regard, another project office has contracted for up to 75 staff-years for quality assurance and other project management services, throughout the site characterization program. DOE headquarters pointed out that, while the appropriate level of quality assurance needs to be worked out between DOE and NRC, the prudent approach at this time is to plan site characterization conservatively to ensure that the data collected and supplied with a repository license application is adequate and correct.

Grants to States and Tribes

Grants to states and Indian tribes also absorb a substantial percentage of the moneys targeted for the site characterization phase. DOE did not originally consider such grants in estimating site characterization costs. Although the grants have totaled only $29 million for the first repository program since the first grants were awarded in 1983, they will likely continue to grow. For example, the Nevada project office estimates that its grants will cumulatively amount to over $50 million by 1990.

SECTION 3

SITE CHARACTERIZATION COST GROWTH AFTER DOE REVISED THE WASTE PROGRAM MILESTONES

Recent changes in DOE's nuclear waste program milestones have lengthened the planned site characterization period by over 3 years, and overall cost estimates--based on DOE's total system life cycle cost analyses--have increased from $2.3 billion in 1986 to $4.1 billion in 1987 (1986 dollars). DOE attributes this increase of about $1.8 billion (or about 80 percent) to additional work requirements along with the need to retain DOE staff and contractor personnel for the additional period. (See table 3.1.)

On the basis of the latest budget submission from the project offices, however, DOE's cost estimates show further increases to a total of $4.8 billion for the three sites (1986 dollars). When the effects of future inflation are considered and the estimates are adjusted to year-of-expenditure dollars, the costs for site characterization are about $5.8 billion for the three sites, including as much as $2.4 billion at the Hanford site. In providing these data, DOE headquarters staff cautioned that the estimates are preliminary and have not been finalized or released outside the agency.

Table 3.1: Cost Estimates--1986 to 1987

	Life cycle cost analysis		FY 1989 budget requests	
	- - - - - - - (in millions) - - - - - -			
	1986	1987	1987	
Hanford	$ 758	$1,592	$1,899	$2,385[a]
Deaf Smith	828	1,351	1,372	1,641[a]
Yucca Mountain	668	1,173	1,505	1,799[a]
Total (3 sites)	$2,254	$4,116	$4,776	$5,825[a]

Note: Cost estimates are in constant 1986 dollars unless otherwise noted.

[a]Year-of-expenditure dollars.

SITE CHARACTERIZATION MILESTONES EXTENDED

Schedule delays in the early years of the waste program eventually compressed the remaining time available to meet key waste program milestones, as discussed in our August 31, 1987, report, Nuclear Waste: A Look at Current Use of Funds and Cost Estimates for the Future (GAO/RCED-87-121). As a result, in the June 1987 amendment to its mission plan, DOE revised its milestones to delay the operational date for the first repository 5 years, from 1998 to 2003. The extension of the first repository milestones changed intermediate program milestones and extended the site characterization phase. The change in the program schedule added over 3 years to the previous 5-year site characterization period on which DOE's 1984 through 1986 cost estimates were made.

SOME REASONS FOR THE MOST RECENT COST INCREASES

Although both the projected costs and milestone dates remained relatively stable from 1984 through 1986, the change in program schedule greatly escalated cost estimates between 1986 and 1987. In May 1987 DOE headquarters requested each of the three project offices to explain significant increases in their fiscal year 1989 budget submittals. Generally, the project offices reported increased cost estimates due to (1) the need to perform technical tasks more comprehensively as required by the site characterization planning that was underway and (2) the accompanying retention of staff and contractor personnel for the extended program.

Our review of the Nevada project office's response to the request and our discussions with project office officials indicate that maintaining staff and contractor personnel through the extended site characterization phase explains much of the cost increase. The project office noted that specialized staff must be available to provide periodic site characterization progress reports and to respond to NRC comments on the licensing application. The office also noted the high cost of maintaining contractors for technical site characterization activities.

Another reason for the most recent cost increases is that some activities, which were compressed under the earlier milestones, may now be performed more comprehensively within the longer time frame. The additional work also adds to the cost estimates. As we indicated in our August 1987 report,[1] project office staff were concerned about doing the necessary work in the time allowed under the earlier milestones. In this regard, one field office noted that budget requests based on the earlier schedule were unrealistic.

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[1]GAO/RCED-87-121.

ALL COST CATEGORIES EXPERIENCED SUBSTANTIAL COST INCREASES

The extension of the milestone dates had a significant effect on cost estimates in all of the cost categories that DOE uses in its work breakdown structure for each candidate site. Tables 3.2, 3.3, and 3.4 show the increases by cost category for each of the three sites.

Table 3.2: Cost Increase by Cost Category--Deaf Smith

Cost category	1986 estimate	1987 estimate	Increase
	----- (in millions) -----		
Systems	$ 26.2	$ 51.4	$ 25.2
Waste Package	32.6	67.4	34.8
Site	208.5	259.9	51.4
Repository	163.1	398.4	235.3
Regulatory and Institutional	109.3	162.0	52.7
Exploratory Shaft	197.1	277.0	79.9
Test Facilities	4.8	6.2	1.4
Land Acquisition	26.2	34.0	7.8
Project Management	60.5	94.5	34.0
Total	$ 828.3	$1,350.8	$ 522.5

Note: Estimates are in constant 1986 dollars.

Total estimated costs for the Deaf Smith site increased by 63 percent, from $828.3 million to $1.35 billion. (See table 3.2.) The largest increase is in the Repository category where the projected costs rose from $163.1 million to $398.4 million, or 144 percent. The Exploratory Shaft category is projected to rise 41 percent from $197.1 million to $277.0 million, while the Regulatory and Institutional category estimates increased by 48 percent, or $52.7 million. (Regulatory and Institutional activities are concerned with licensing requirements, environmental compliance, and liaisons with and grants to states and affected Indian tribes.) In addition, the Deaf Smith site includes the category entitled Land Acquisition. This cost category is unique to Deaf Smith and reflects DOE's need to purchase the land for site characterization.

Table 3.3: Cost Increase by Cost Category--Hanford

Cost category	1986 estimate	1987 estimate	Increase
	(in millions)		
Systems	$ 43.9	$ 105.3	$ 61.4
Waste Package	79.8	147.9	68.1
Site	155.1	270.4	115.3
Repository	149.5	479.6	330.1
Regulatory and Institutional	76.8	163.7	86.9
Exploratory Shaft	193.0	286.6	93.6
Test Facilities	15.4	24.3	8.9
Project Management	44.7	114.2	69.5
Total	$758.2	$1,592.0	$833.8

Note: Estimates are in constant 1986 dollars.

Like Deaf Smith, Hanford's largest single increase is in the Repository category, where estimated costs jumped from $149.5 million to $479.6 million, an increase of approximately 221 percent. (See table 3.3.) The Site category is projected to increase by $115.3 million, or 74 percent. Systems and Project Management cost estimates escalated by $61.4 million (140 percent) and $69.5 million (156 percent), respectively. (The Systems category includes engineering activities, technical data base management, and performance assessment.) The projected increase for Hanford is $833.8 million, or 110 percent, and is the largest total increase projected for any site.

Table 3.4: Cost Increase by Cost Category--Yucca Mountain

Cost category	1986 estimate	1987 estimate	Increase
	(in millions)		
Systems	$ 31.7	$ 66.7	$ 35.0
Waste Package	33.1	50.2	17.1
Site	187.0	304.5	117.5
Repository	115.8	224.7	108.9
Regulatory and Institutional	61.6	155.2	93.6
Exploratory Shaft	126.0	180.2	54.2
Test Facilities	2.9	3.7	.8
Project Management	109.7	188.1	78.4
Total	$667.8	$1,173.3	$505.5

Note: Estimates are in constant 1986 dollars.

Total estimated costs for the Yucca Mountain site are projected to increase 76 percent. Both Site and Repository category estimates show large increases: by $117.5 million and $108.9 million, respectively. Regulatory and Institutional costs are projected to increase 152 percent, from $61.6 million to $155.2 million, while Project Management projections show a 71-percent increase of $78.4 million.

For the three sites, the largest projected overall increase is in the Repository category where the collective estimate from the project offices rose from $428 million to approximately $1.1 billion--a 157-percent increase. The Systems category increased from $101.8 million to $223.4 million--a 119-percent jump. Overall, the total site characterization cost estimate increased from approximately $2.3 billion to $4.1 billion--an 81-percent increase.

SUMMARY OF INCREASES BY CATEGORY

Information we obtained from the Nevada project office describes in detail the reasons for projected cost escalation in its fiscal year 1989 budget proposal.[2] Substantial increases between the Nevada field office's fiscal year 1988 budget request and its fiscal year 1989 budget submission to DOE headquarters are broken down into both time- and work-based increases. Time-based increases result from the extended site characterization schedule. Work-based increases reflect an expansion of the work to be done.

In the Regulatory and Institutional cost category, state grant requests to the Nevada project office are expected to increase by $117 million. This work-based increase is a result of a significant rise in requests from the state to cover socioeconomic studies, independent technical studies, operation of the state office, and other miscellaneous costs. This estimate is based on projected 1989 budget figures and therefore is not directly comparable to the Regulatory and Institutional cost estimate shown in table 3.4. This category also includes a time-based increase of over $9 million for retaining specialized staff to respond to NRC comments on the license application, to be available for testimony to the NRC licensing board, and to prepare DOE's response to the NRC staff safety evaluation report on a potential repository at Yucca Mountain.

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[2]DOE headquarters officials told us that the preliminary cost estimates obtained from the Nevada project office were prepared for use in the project office's fiscal year 1989 budget proposal and are subject to change prior to the President's budget submission in January 1988. Because of this, DOE declined to provide us with similar data for the Deaf Smith and Hanford sites.

Almost $13 million in work-based increases for Yucca Mountain is a result of expanding the scope of the site characterization plan. In May 1986 DOE and NRC agreed that (1) each plan would present a complete description of the site characterization program and would be supported by separate documents consisting of references and study plans, including test procedures, and (2) detailed test descriptions and procedures would be provided in study plans about 6 months before the activity would be conducted. As a result, the project office added 9 months to its scheduled completion date for the Yucca Mountain plan.

Retention of the staff assigned to prepare the plan for the expanded schedule adds additional time-based costs not projected in earlier estimates. Further, earlier estimates assumed that site characterization plan progress reports would end upon submission of the license application in December 1991. The field office preliminary budget submittal for fiscal year 1989, however, assumes that the reports will continue until October 1995. Increased costs from the maintenance of staff and the additional progress reports required over the extended schedule result entirely from the changes in the milestones.

Time-based cost increases resulted in an additional $18 million, which would be required for preparing position papers containing technical information needed to resolve regulatory issues. The 1986 cost estimates assumed that 15 papers would be completed in fiscal year 1990 so that the staff would be free to work on the license application in fiscal year 1991. However, the shift in the milestones moved the projected completion date for the papers to fiscal year 1994 with staff working on the application during 1995. The increased cost estimate reflects the milestone extension. The project office believes that it will be able to take advantage of data obtained from testing at repository depth when preparing the position papers.

Finally, the earlier 1991 deadline for license application submittal--and for completing site characterization--forced a sharp increase in the staff required to complete the needed work, which would then be followed by a sharp decrease after the submittal. The additional time supplied by the amended schedule will allow the project office to spread staff growth and decline over an additional 4 years. Maintaining some staff longer than may be necessary will cost an additional $5 million. However, the field office sees the additional cost as bringing benefits such as increasing management's capability to recruit high-quality staff and place staff in other positions as specific work activities are completed.

SCHEDULE SLIPPAGE COULD AFFECT FUTURE COST ESTIMATES

In our August 1987 report, we stated that work had accumulated because of delays in the program.[3] Regarding the most recent cost estimates, some field office staff raised concerns about delays in the revised schedule, which could escalate costs even further. Officials at one project office told us that even though DOE slipped the end of the site characterization schedule from 1991 to 1995, work is already starting to pile up because of work restrictions caused by funding reductions. Uncertainty in funding affects both staffing and planning. One project official noted that "sometimes, it's well into a fiscal year (November) before the project office knows how much money it will actually have available for the fiscal year."

Contractor representatives and DOE field office officials at one project office agreed that the current schedule must be adhered to if future cost estimates are to remain stable. They stated that if the 1995 date for license submission is to be met, 1988 will be a crucial year for site characterization work.

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[3]GAO/RCED-87-121.

APPENDIX I

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