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Executive Summary March 1995

Estimating the Cold War Mortgage

The 1995 Baseline Environmental Management Report

U.S. Department of Energy
Office of Environmental Management

At a Glance:
The 1995 Baseline Environmental Management Report

RESULTS
"Base-Case"

$230 Billion over a 75-year period

- Waste Management – **49%**
- Environmental Restoration – **28%**
- Nuclear Material and Facility Stabilization – **10%**
- Technology Development – **5%**
- Other – **8%**

Top 5 Sites - 70% of costs

- Hanford Site – **21%**
- Savannah River Site – **21%**
- Rocky Flats Site – **10%**
- Oak Ridge Reservation – **10%**
- Idaho Laboratory – **8%**

ASSUMES:

- Significant productivity increases
- Meeting current compliance requirements
- Use of existing technologies

Development of most assumptions occurred at field locations (e.g., degree of cleanup)

EXCLUDED:

- Cleanup where no feasible cleanup technology exists (e.g., Nuclear explosion sites, most contaminated groundwater)
- Cleanup of currently active facilities (e.g., Pantex, Labs)
- Naval Nuclear Propulsion facilities cleanups handled by U.S. Navy.
- Activities during first 5 years of program ($23 billion)

ALTERNATIVE CASES evaluated the effect of:

- Landuse: biggest potential cost impact
- New Technologies
- Waste Management Facilities configuration
- Funding & Schedule
- Residual Risk: inadequate data limited analysis

WHAT DID WE LEARN?

- Total projected environmental costs are comparable to total U.S. nuclear weapons production costs.
- Projected future land use will dramatically affect costs.
- Significant ($24 billion) projected costs to support ongoing programs could be substantially reduced through greater pollution prevention.
- Development of new technologies will reduce certain cleanup costs and make possible other cleanups that are currently infeasible.
- Minimum action to stabilize sites - $170 billion.

ESTIMATES, NOT DECISIONS

- The estimated costs do not reflect final Departmental decisions in many cases. The report is intended to provide a framework for constructive local and national debate about the future of the environmental management program.
- Projected costs significantly exceed current budget targets. Bridging this gap will require renegotiating compliance agreements and some statutory changes, in addition to planned productivity improvements.

For further information, please contact the Center for Environmental Management Information (1-800-736-3282)

Executive Summary

This is the first annual report on the activities and potential costs required to address the waste, contamination, and surplus nuclear facilities that are the responsibility of the Department of Energy's Environmental Management program. The Department's Office of Environmental Management, established in 1989, manages one of the largest environmental programs in the world—with more than 130 sites and facilities in over 30 States and territories. The primary focus of the program is to reduce health and safety risks from radioactive waste and contamination resulting from the production, development, and testing of nuclear weapons. The program also is responsible for the environmental legacy from, and ongoing waste management for, nuclear energy research and development, and basic science research. In an attempt to better oversee this effort, Congress required the Secretary of Energy to submit a Baseline Environmental Management Report with annual updates.

The 1995 Baseline Environmental Management Report provides life-cycle cost estimates, tentative schedules, and projected activities necessary to complete the Environmental Management program.

The 1995 Baseline Environmental Management Report (Baseline Report) provides life-cycle cost estimates, tentative schedules, and projected activities necessary to complete the Environmental Management program. In doing so, it represents the Department's most comprehensive effort to date to develop a clearer picture of the "Cold War Mortgage."

The Cold War Mortgage

During World War II and the Cold War, the United States developed a vast network of industrial facilities for the research, production, and testing of nuclear weapons, known as the "nuclear weapons complex." It includes thousands of large industrial structures such as nuclear reactors, chemical processing buildings, metal machining plants, and maintenance facilities. During the last 50 years, this enterprise manufactured tens of thousands of nuclear warheads and detonated more than a thousand. The Department of Energy, the Federal agency responsible for managing the nuclear weapons complex, manages more than 120 million square feet of buildings and 2.3 million acres of land—an area larger than Delaware, Rhode Island, and the District of Columbia combined.

In addition to creating an arsenal of nuclear weapons, the complex left an unprecedented environmental legacy. Because of the priority on weapons production, the treatment and storage of radioactive and chemical waste was handled in a way that led to contamination of soil, surface water, and ground water and an enormous backlog of waste and dangerous materials. As a result of revelations by the news media and various organizations, as well as studies conducted by the Department of Energy during the last 10 years, this legacy has become increasingly well-known. However, part of the purpose of this report is to establish a more disciplined inventory of the problems and the potential liabilities so it can be used as a management tool.

The cost of dealing with these problems can be considered a "Cold War Mortgage." Much of these costs were deferred during the nuclear arms race. Paying the mortgage will take decades and substantial resources comparable to the level of effort expended for the nuclear weapons production and research activities.

The Environmental Management Program

The Office of Environmental Management was created in 1989 to help address the environmental legacy of nuclear weapons production and other sources such as nuclear research programs.

Activities that encompass the Environmental Management program include: (1) environmental restoration; (2) waste management; (3) nuclear material and facility stabilization; and (4) technology development (see Figure 1). Landlord functions (e.g., fire-fighting response, road maintenance, utilities) represent a fifth area, which includes cross-cutting support activities.

These activities are often simplified as "cleanup," but it is clear they involve a lot more than cleanup. Moreover, these activities are not only interrelated (e.g., facilities must be stabilized before they can be decontaminated, and waste must be managed after it is generated as a result of restoration work), but they are also inextricably related to the functions of the Department of Energy and other Federal agencies. For example, although the nuclear danger is greatly reduced in the wake of the Cold War, the United States continues to rely on nuclear weapons as a vital military deterrent for which the Environmental Management program provides critical infrastructure and waste management support. The Environmental Management program also provides waste management services to the facilities that continue to operate and maintain the nuclear weapons stockpile such as the Los Alamos National Laboratory, the Savannah River Site, and the Kansas City Plant. Nuclear submarines, aircraft carriers, and other vessels also continue to play a critical national defense role. The spent nuclear fuel generated from these U.S. Navy vessels is handled by the Environmental Management program.

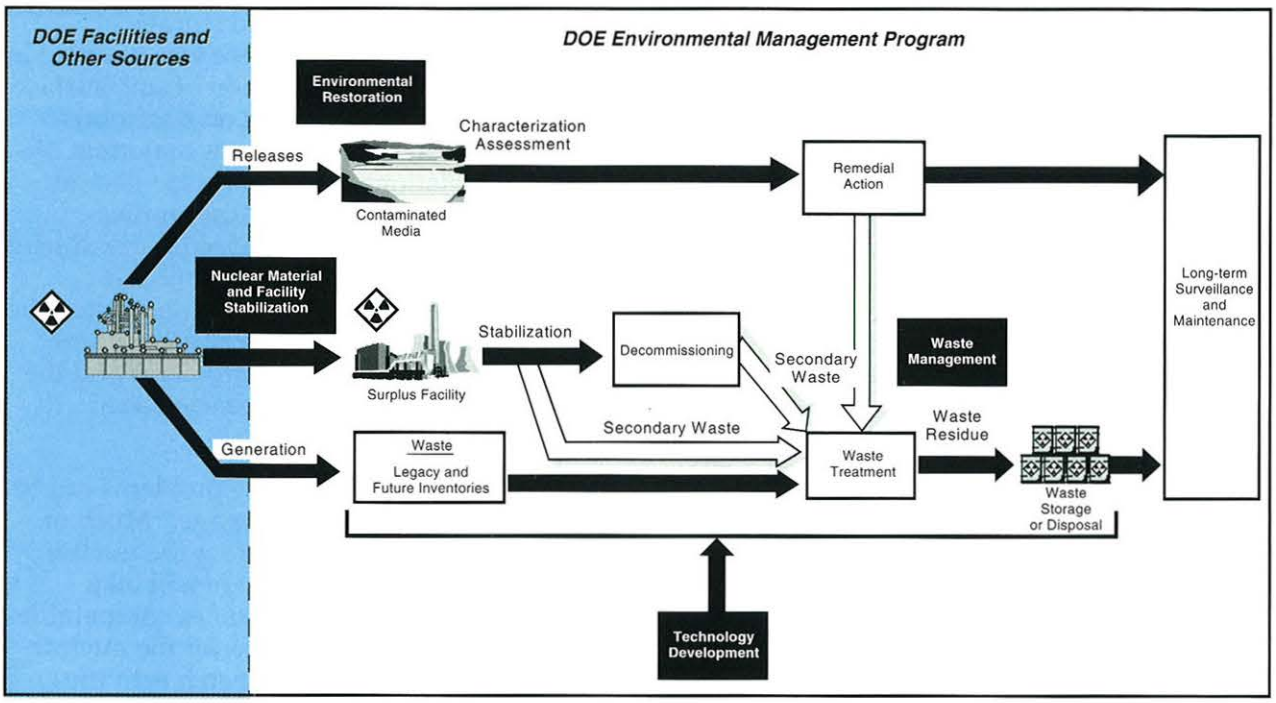


Figure 1. Overview of Department of Energy Environmental Management Activities

In addition to these defense support functions, the Environmental Management program supports the variety of basic and applied scientific research facilities operated by the Department of Energy, including Brookhaven National Laboratory, Fermi National Accelerator Laboratory, and Oak Ridge National Laboratory, which conduct unparalleled research. Finally, the Environmental Management program manages waste from certain private-sector activities, such as the cleanup of the Three-Mile Island nuclear power plant accident, failed commercial irradiation enterprises, and factories that produced lantern mantels.

Although most Environmental Management program work involves dealing with the legacy of contamination and the backlog of accumulated wastes, a significant amount involves handling newly generated waste from these programs—all while protecting worker health and safety. This report covers this broad span of Environmental Management program activities.

What Does the Nation Want to Buy?

The future course of the Environmental Management program will depend on a number of fundamental technical and policy choices, many of which have not yet been made. Ultimately, these decisions will be made on the basis of fulfilling congressional mandates, regulatory direction, and adequate stakeholder input. The cost and environmental implications of alternative choices can be profound. For example, many contaminated sites and facilities could be restored to a pristine condition, suitable for any desired use; they also could be restored to a point where they pose no near-term health risks to surrounding communities but are essentially surrounded by fences and left in place. Achieving pristine conditions would have a higher cost, but may or may not warrant the economic costs and potential ecosystem disruption or be legally required. Resolving such issues will depend on what the Nation wants to buy.

Other key questions that affect the cost of the program include the following:

- What level of residual contamination should be allowed after cleanup?
- Should projects to reduce maintenance costs (i.e., high storage costs pending ultimate disposition of materials) be given priority over certain low-risk cleanup activities? In other words, how should cost affect priorities?
- Should cleanup and waste management proceed with existing technologies or is it prudent, in some cases, to wait for the development of improved technologies? What criteria should guide decisions on this issue?
- Should waste treatment, storage, and disposal activities be carried out in decentralized, regional, or centralized facilities? How are issues of equity among states factored into configuration decisions?

The most cost-effective way to resolve these issues is to engage in a broad debate to assess the costs, risks, and other public trade-offs associated with different approaches. The 1995 Baseline Report lays the foundation for this constructive discussion. It describes where the Environmental Management program is headed, according to current assumptions, and illustrates potential impacts if these assumptions vary.

Estimates, Not Decisions

Many broad assumptions were required to make it possible to estimate the long-range costs and schedules to complete the

Previous Cost Estimates

The Federal Government last estimated the total cost of environmental liabilities at Department of Energy facilities in 1988 before the end of the Cold War, when the renovation and indefinite operation of the existing nuclear weapons complex was being planned. These cost estimates primarily assessed what was needed to bring installations into compliance with environmental regulations to allow continued weapons production. For example, estimates focused on permitting installations and operation of air and water monitoring systems with limited short-term corrective action at active sites. Little emphasis was placed on more expensive activities such as remedial action at inactive sites. Most estimates ranged from $100 to $300 billion for total program cost. Even higher estimates were produced by speculative extrapolation without the benefit of the type of field data on which this report is based.

The Baseline Report is substantially different – both the results and the methodology – from past estimates for a number of reasons. First, the Base Case estimate in this report is based on a "bottom up" approach using large amounts of data and assumptions collected from field offices, rather than centralized estimating processes, which were used in previous estimates. This method resulted in more realistic land-use assumptions and, consequently, substantially lower costs than previous cost estimates. Second, this report does not attempt to provide cost estimates for cleanup activities that are not technically feasible using existing technologies. Such costs, which were included in some previous estimates, do not make sense because complete cleanup using existing technologies cannot be attained at any price for certain contamination situations such as nuclear weapons test residues or large areas of contaminated ground water and river system sediments. Third, the activities for which estimates are provided in this report reflect the Department's significantly reduced nuclear weapons production requirements. Finally, the Baseline Report also reflects a greater understanding of the nature and extent of contamination, as well as broader program support responsibilities than assumed for previous estimates. As a result of these differences, this Baseline Report is not comparable in scope and is substantially improved in the level of detail and integration over past estimates.

Environmental Management program. Indeed, preliminary assumptions had to be made regarding future land use; cleanup levels; and pace, priority, and configuration of activities even to define the Base Case.

The development of the Base Case and alternative cases, which are based on preliminary assumptions and limited data, should not be interpreted as final Departmental policy, budget requests, or long-term plans. The Baseline Report is a tool to help guide policy development.

Formal decisions will require careful interactions with Congress, regulators, Indian Tribes, and other stakeholders. Future Baseline Reports will change as a result of each previous report's impact on developing and sustaining national and local debate involving the citizens whose lives these decisions will affect. Providing a framework for such discussion is a key purpose of the 1995 Baseline Report.

Estimating Costs in the Face of Large Uncertainties

Estimating the cost of future activities necessarily involves assumptions about what those activities will be and are, therefore, highly uncertain. The uncertainty stems, first, from the lack of characterization of the problems. For example, of the 10,500 hazardous substance release sites addressed in this report, only one-fourth have been fully characterized. Nonetheless, the Department believes it has characterized the largest and most significant of the 10,500 sites, and preliminary information is available for a substantial portion of the balance. A second major uncertainty stems from a lack of knowledge about what remedies will be effective or considered acceptable to regulators and the public, or what level of human health and environmental protection is sought through these remedies. For example,

substantial uncertainty exists about the long-term effectiveness of capping as a permanent solution to contaminated sites. Also, the effectiveness and utility of pump-and-treat remedies for contaminated ground water, where no water use or offsite migration exists, was criticized by the National Academy of Sciences in 1994.

An authoritative estimate of the costs for the Environmental Management program in light of this substantial technical uncertainty is impossible to determine. Compounding this lack of technical information is the uncertainty about fundamental economic and social decisions such as the future use of land and facilities. Hence, this first baseline analysis serves as a benchmark to gauge future progress in defining, as well as solving, the problems.

In some instances, no remedy for the problem is available or is even on the horizon. The contamination of soils deep underground from nuclear tests in Nevada is one such case. The costs to remediate these types of sites were excluded from the cost estimate, not because of a departmental policy to ignore such problems, but because no effective remediation technology currently exists.

In addition to the uncertainties that arise from the above-mentioned technical problems, the Environmental Management program is subject to uncertainties that stem from its legal and institutional obligations. These include the legal requirements for an institutional framework that involves the U.S. Environmental Protection Agency and States where sites are located in making decisions about a majority of projects in the program. These participants make the final decisions about the choice of remedial action and the satisfactory completion of each action. In many cases, these decisions have not yet been made.

Further, remediation objectives or future land-use decisions upon which they must be based, have not been fully defined at many sites. For example, policy decisions related to the role of sites for nuclear nonproliferation and defense readiness will define the future mission for the Department's nuclear weapons complex. These policy decisions will affect the continued operations of some installations, including future land-use options and the final disposition of nuclear materials. These developments will affect the scope of the Environmental Management program in ways that are difficult to predict. Finally, there is the length of the program—approximately 75 years. That in itself is sufficient to introduce a variety of uncertainties into any cost and schedule estimate.

Despite these uncertainties, there is an important advantage in attempting to estimate costs before all this information is available or these decisions have been made: the cost consequences of different technical and policy options can be explicitly analyzed and debated to make wise decisions in an open manner. In addition to better facilitating program management, this is exactly the value of this study.

The Department expects assumptions about the program and the resulting cost-and-

The Baseline Report Is Not a Budget Document

The purpose of the Baseline Report is to provide a total long-term (life-cycle) cost estimate for the Environmental Management program. The Baseline Report is not intended to be a budget document, and none of the estimates given in the document should be interpreted as Federal budget requests.

Furthermore, the schedule of activities presented in the Baseline Report should not be interpreted as establishing specific long-term priorities or construed as a definitive basis for planning specific projects. Too many decisions that will affect the strategic long-term goals for the program are yet to be made. The issues underlying these decisions, such as future land use, funding availability, and acceptable levels of residual contamination, will be resolved over several years in conjunction with broad public discussion. Fostering and informing this discussion is a key purpose of this analysis.

schedule estimates to change in future Baseline Reports as new information becomes available, and ongoing decisionmaking processes evolve, thereby reducing uncertainty.

The 1995 Baseline Report does *not* include the following assessments and cost estimates:

- an explicit quantitative evaluation of risks to public health, workers, and the environment associated with projected activities. In June 1995, the Department will complete an analysis of human health and safety risks from conditions at weapons complex facilities. Information from this risk report will be factored into subsequent Baseline Reports.
- an explicit evaluation of economic and other *benefits* associated with projected activities.
- costs associated with potential future activities not currently within the scope of the Environmental Management program (for example, disposition of surplus weapons-grade plutonium).

Approach Used For Estimating Costs and Schedules

The Department used two methods for estimating costs in this report: the "Base Case" and "Alternative Cases." The Base Case was used to represent current views of the most likely set of activities. Because many assumptions are preliminary (i.e., they were made to estimate costs for activities that will happen decades from now), and will undoubtedly change in many cases, alternative cases are presented.

Estimates of Base Case costs and schedules provided in the Baseline Report are based largely on site-specific assumptions regarding future land use; treatment, storage, and disposal facility needs; and the technologies to be used at the site. These assumptions were developed at individual sites and reflect specific regulatory requirements and site-specific planning efforts.

Alternative case cost and schedule estimates were developed by Department of Energy Headquarters to show the potential cost impacts of changing assumptions in four key areas: future land use, program funding and scheduling, technology development, and waste management configurations. Information from these analyses better enables Congress, the public, and the Department to assess the potential effects of broad policy changes on total cost and schedule of the program. A fifth factor—residual risk—was analyzed, but inadequate data were available to produce useful results.

Developing the Base Case

Data for the Base Case generally came directly from Department of Energy installations across the country. Installations provided estimates of waste amounts, costs, and schedules for the following activities:

- environmental restoration;
- waste management, treatment, storage, and disposal;
- nuclear material and facility stabilization; and
- related activities such as landlord responsibilities, program management, and program direction.

For this study, the Environmental Management program was considered to be substantially complete after approximately 75 years of sustained effort when all sites have been remediated and when waste generated from previous missions and from remediation and

stabilization activities is safely disposed. Annual costs were included for surveillance and monitoring of all closed sites to protect human health and the environment. Finally, annual costs were estimated for managing wastes projected to be generated from future Department activities, such as nuclear energy, nuclear weapons, and basic science research.

Assumptions

Because the Baseline Report uses currently available information, the Base Case estimates reflect a broad range of assumptions. These assumptions reflect potential decisions regarding the scope and pace of the Environmental Management program.

For example, the Baseline Report estimates costs associated with disposing vitrified high-level radioactive waste in a geologic repository beginning in 2016. Although under consideration, a permanent geologic repository location has not been finalized; indeed, the suitability of a specific site has not yet been determined.

In addition, the Department excluded projects with no current feasible remediation approach from this year's Baseline Report scope. These projects include large contaminated river systems like the Columbia, Clinch and Savannah rivers and the Nevada Test Site's underground weapons test area. The cost estimate would obviously be higher if some remediation were assumed for these areas for which complete cleanup is not technically feasible with existing technologies. However, because no effective remedial technology could be identified, no basis for estimating cost was available.

Note: Volume II provides summary assumptions and results for each site as well as site personnel contacts for additional details.

Key Assumptions

- Estimates reflect current expectations for the future of each site, such as land use, which is primarily locally determined.
- The first geologic repository for high-level radioactive waste will open in 2010. At that time, it will accept spent nuclear fuel from commercial utilities. In 2016, the repository will begin accepting defense high-level waste, and Department-owned spent fuel shortly thereafter.
- Only existing technologies, such as pumping and treating ground water, are assumed to be available for the Base Case.
- The Waste Isolation Pilot Plant will open in 1998.
- The Environmental Management program will be considered substantially "complete" when all sites have been remediated and when waste generated from previous missions and from remediation and stabilization activities is safely disposed.

General Exclusions

- Nuclear explosion test areas (e.g., Nevada Test Site)
- Large surface water bodies (e.g., Clinch and Columbia rivers)
- Most ground water (even with treatment, future use will remain restricted)
- Some special nuclear materials (e.g., 50 tons of plutonium not now identified as surplus).

Schedule/Funding

The Base Case estimates the costs necessary to meet all existing compliance agreements. Funding is then capped at the target level for the year 2000.

Environmental Restoration

Usually described as "cleanup," environmental restoration encompasses a wide range of activities such as stabilizing contaminated soil; treating ground water; decontaminating and decommissioning nuclear reactors and process buildings, including chemical separation plants; and exhuming buried waste.

The Base Case estimate for environmental restoration was developed by compiling data from approximately 10,500 "release sites," grouped into 614 subprojects or "operable units."

The assumptions used in developing the Base Case were virtually all developed at the particular site or field office, usually in consultation with regulatory officials. Table 1 lists examples of some key site-specific assumptions.

Although each site generally used its own assumptions for developing the Base Case estimate, several fundamental assumptions were used by all sites. These general assumptions include the following:

- use of existing technologies;
- compliance with existing or reasonably anticipated regulatory/negotiated agreements or Energy Department Orders; and
- remedies considered technically and environmentally reasonable and achievable by local project managers and appropriate regulatory authorities.

These general assumptions were used because of the need to establish a base cost from which other estimates could be compared. For example, the impact of changes to existing regulatory agreements can be compared to the base cost for existing agreements. And the reasonableness of remedies, future land uses, and other plans can be explicitly catalogued and debated by affected stakeholders.

To the extent that restricted future land use was assumed by field offices to estimate costs, it reflects current or anticipated agreements with regulators and /or stakeholders, or interim determinations based on what remediation goal is achievable using existing technologies. The Administration has proposed legislative changes to the Superfund law to allow such considerations to be used in selecting remedies to a greater extent. In some cases, the cost estimates reflect projected remedial actions that assume these changes to the law because unrestricted future land use was not reasonably achievable using existing technologies. The particular assumptions used varied among sites because of the "bottom up" method used for estimating Base Case costs in this report.

Waste Management

The Department is responsible for storing, treating, and disposing of an extraordinary array of wastes and spent nuclear fuel. These wastes include a variety of physical forms (e.g., solids, liquids, and sludges); chemical types (i.e., solvents, metals, and salts); and sources (e.g., high–level waste from reprocessing, spent nuclear fuel from production reactors, and naval reactors); transuranic waste from plutonium operations; and low-level waste, which includes virtually everything else that is radioactive waste.

The Department, or its predecessor agencies, generated most of the wastes included in the Baseline Report during the production of nuclear weapons during the Cold War. Smaller amounts of the existing waste legacy resulted from various nuclear and other research projects. In the future, the Department expects that the quantities of waste from these sources will decrease as pollution prevention efforts become more effective, and nuclear weapons production activity decreases, and that a new source of waste will become increasingly

Table 1. Examples of Site-Specific Assumptions for Environmental Restoration Activities

Site	Site Issue	Baseline Report Assumptions
Hanford Site	• Reactors	• Reactor buildings decontaminated and demolished • Reactor core blocks moved 15 miles to a disposal area
	• PUREX and other processing buildings	• Decontaminated, collapsed, and entombed in place
	• 200 Area	• 200 Area buildings would have their equipment removed, demolished, and buried onsite. All contaminated areas will be capped and monitored. Engineered barriers will be used to protect human health and the environment.
	• Ground water	• Remediation of most ground water is not included in formulating the current baseline.
Savannah River Site	• Canyons	• Buildings will be decontaminated; process equipment will be removed; structures are not assumed to be demolished.
	• Reactors	• Reactors will remain in place once deactivated.
	• Ground water	• Pump and treat operations, air stripping, and in-situ bioremediation. In areas where tritium is present (high-level waste tanks and reactor areas), assumes pump and treat to contain, not remove, contamination.
Idaho National Engineering Laboratory	• Pit 9 and buried waste at Radioactive Waste Management Complex	• Excavate buried waste, segregate it, send transuranic waste to Waste Isolation Pilot Plant; return low-level waste to the Pit. The Pit will then be capped and monitored.
	• Idaho Chemical Processing Plant	• All facilities deactivated, collapsed, and entombed in place.
Oak Ridge Reservation	• Gaseous Diffusion Plants (K-25 Site, Portsmouth, Paducah)	• Deactivate and decontaminate the gaseous diffusion plants. Wastes will be disposed of at each site. Superstructure of the facilities will remian in place.
	• Offsite Program	• No feasible technology available for the Clinch River, the Watts Bar Reservoir, and the Poplar Creek embayment. These sites are excluded from the analysis.
	• Y-12	• Buildings assumed transferred to Environmental Management are decontaminated and prepared for reuse or demolished and capped. • Pump-and-treat contaminated ground water. • Contaminated soil is to be capped in place or relocated to another portion of the site and capped.
Rocky Flats Environmental Technology Site	• 881 Hillside	• Contain and treat ground water.
	• Solar Ponds	• Pond sludge solidified and shipped to the Nevada Test Site
Fernald Environmental Management Project	• Silos	• Residues and oxides will be vitrified, then sent to the Nevada Test Site. Concrete silo structures will be demolished, and debris will be buried onsite.
Nevada Test Site	• Underground Test Area	• Excluded from analysis; no feasible remediation technology available.
	• Soils	• Excavate areas with high levels of contamination, dispose in Areas 3 and 5.

important: secondary waste generated as a result of environmental restoration and nuclear material and facility stabilization. Table 2 summarizes waste volumes compiled for the Base Case. The amount of waste generated from these activities in the future is one of the factors that will affect waste management costs.

Costs for waste management cover all life-cycle phases from planning through decommissioning. The Base Case reflects site-specific planning assumptions, which may include the use of commercial facilities (e.g., hazardous waste treatment and disposal). Costs were compiled from existing program

Table 2. Total Waste Volumes Addressed in the Base Case from 1995 - 2070 (in cubic meters)*

Waste Type	Current Inventory and Ongoing Operations	Environmental Restoration and Decontamination and Decommissioning	Facility Stabilization	Total
High-Level Waste	403,000	400	100	403,500
Spent Nuclear Fuel	2,300	0	0	2,300
Transuranic Waste	106,000	113,000	18,000	237,000
Low-Level Waste	1,700,000	16,810,000	28,000	18,538,000
Low-Level Mixed Waste	510,000	999,000	27,000	1,536,000
Hazardous Waste	600,000	11,563,000	48,000	12,211,000
Total	3,321,300	29,485,400	121,000	32,927,800

**Does not include wastewater, sanitary waste, by-product waste, or mill tailings.*

cost estimates for high-level waste and spent nuclear fuel and from standardized calculations designed to estimate treatment, storage, and disposal costs based on predicted waste throughput for transuranic, low-level, low-level mixed, and hazardous wastes. Table 3 shows examples of site specific assumptions for waste management activities.

Nuclear Material and Facility Stabilization

With the end of the Cold War, production of most nuclear weapons materials has been indefinitely halted. Consequently, many Department of Energy facilities are not needed for their previous missions. Before "cleanup" can safely occur at many sites, however, the facilities and the nuclear material they contain must be stabilized. Because of the urgent risks associated with these materials, this work is one of the highest priorities for the Environmental Management program. Also, the cost of maintaining facilities before stabilization is usually significantly higher than after it is completed.

The Base Case estimate for nuclear material and facility stabilization activities was based on cost estimates for stabilizing 22 different types of facilities as well as the costs for maintaining them before and after stabilization. In this way, the source of the Base Case estimates is somewhat different than that for waste management and environmental restoration activities. Because of limited data and experience, nuclear material and facility stabilization Base Case estimates are largely extrapolated from available data regarding the 22 categories of facilities for the number of facilities known to exist in each category.

The assumptions used for estimating the nuclear material and facility stabilization activities Base Case costs were derived, to the extent possible, from the overall strategy for conducting these activities in context of the overall Environmental Management program. The strategy for the Environmental Management program is to address urgent risks first and then pace the subsequent final cleanup with the availability of effective technologies,

Table 3. Base Case Waste Management Assumptions

Waste Type	Activity		
	Storage	Treatment	Disposal
High-Level Waste	• Continued storage in tanks at Hanford, Savannah River Site, and West Valley Demonstration Project • Continued storage of Calcine in bins at Idaho National Engineering Laboratory	• Vitrify at Hanford, Savannah River Site, West Valley Demonstration Project, and Idaho National Engineering Laboratory	• Geologic repository assumed available beginning in 2016
Spent Nuclear Fuel	• Continued storage at 10 sites, with majority at Hanford, Idaho National Engineering Laboratory, and Savannah River Site • Cost of building new storage facilities, both wet and dry included.	• No reprocessing	• Geologic repository assumed available in 2016
Transuranic Waste	• 10 installations, primarily at Hanford, Idaho National Engineering Laboratory, Los Alamos National Laboratory, Savannah River Site	• Processed to meet disposal criteria	• The Waste Isolation Pilot Plant beginning in 1998
Low-Level Mixed Waste	• Storage at more than 30 generator sites	• Land disposal restrictions met • Treatment performed at 34 sites	• Hanford, Idaho National Engineering Laboratory, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge, Savannah River Site • Western sites will use shallow land disposal techniques, eastern sites will use an engineered disposal technique
Low-Level Waste	• Storage at generator sites while waiting for disposal at six Department of Energy sites	• Minimal treatment to meet transport and disposal criteria	• Disposal onsite at Hanford, Idaho National Engineering Laboratory, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge, Savannah River Site • Western sites will use shallow land disposal techniques, eastern sites will use an engineered disposal technique

funding, and legal requirements. This strategy helps focus available resources appropriately. To implement this strategy, the Department recently completed an inventory of surplus "assets" (i.e., buildings, reactors, structures, etc.); identified high risks among them; and began transferring management responsibility and performing stabilization work. The Base Case estimates assume that:

- 3,500 contaminated facilities identified through this analysis are being transferred from other Department of Energy programs to the responsibility of the Environmental Management program;
- these facilities will require 10 years of surveillance and maintenance, followed by 5 years of stabilization activities and 2 years of post-deactivation surveillance and maintenance before final decontamination or disposition;
- most nuclear material and facility stabilization activities will occur in later years because these activities are not typically driven by legal requirements (a reevaluation of this sequence may be warranted based on results of the risk report to be completed in June 1995 and renegotiation of compliance agreements with regulators); and
- surplus plutonium scraps and residues must be stabilized, safeguarded, and dispositioned. The Environmental Management program currently is responsible for approximately 26 metric tons of plutonium in these various forms. The Department currently is involved in a process to decide on the future disposition of surplus plutonium and what quantities of plutonium will be considered surplus.

Technology Development

The Environmental Management program manages a national program of applied research, development, demonstration, testing, and evaluation of technologies. These technologies support environmental restoration, nuclear material and facility stabilization, and waste management. Examples of savings from specific technologies are discussed in Chapter 5 of the report.

Landlord

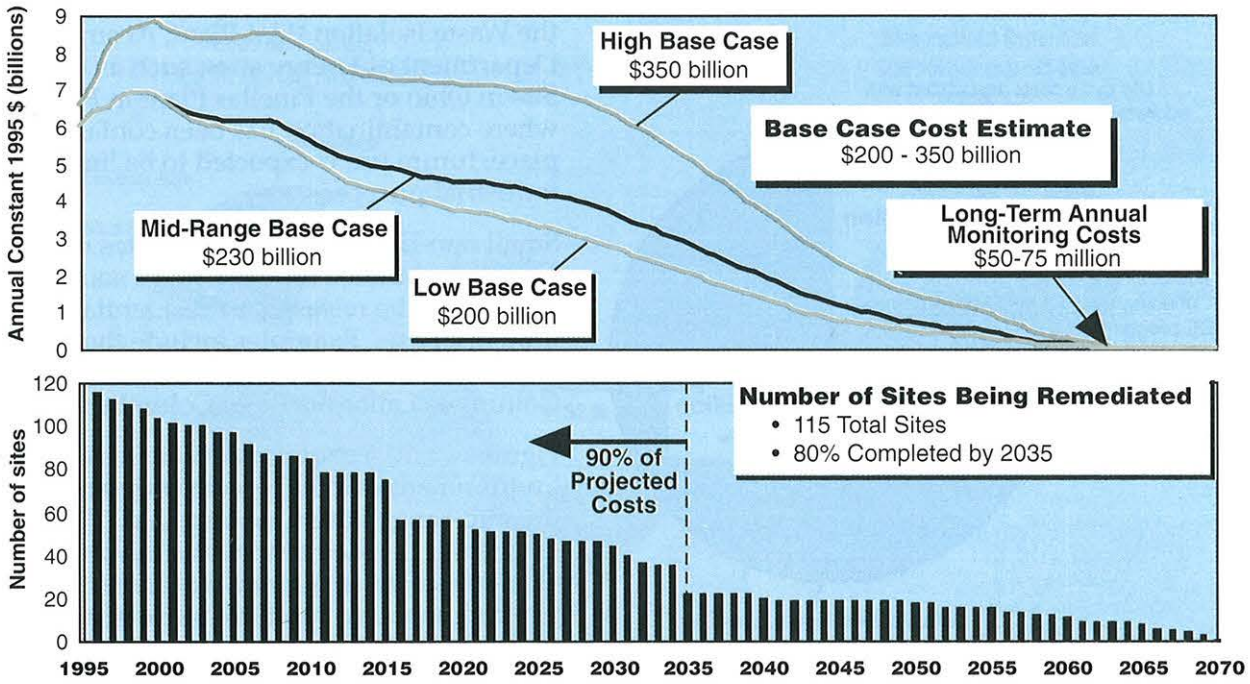
Landlord activities include such services as safeguards and security, transportation, property management, and emergency preparedness (e.g., fire and medical response). The Base Case includes costs for landlord activities at the 10 installations where the Office of Environmental Management has landlord responsibility.

Results

The Base Case cost estimate begins in 1995 and ends in approximately 2070, when environmental management activities are projected to be substantially completed. The estimate does not include costs expended since the program's formal inception in October 1989—about $23 billion–or costs incurred before 1989. Nor does it include costs beyond 2070 for long-term surveillance and maintenance, which are estimated at about $50-75 million per year. These costs are assumed to continue indefinitely after a disposal site or restricted access area is closed.

Under the Base Case, the life-cycle cost estimate for the Department of Energy's Environmental Management program ranges from $200 to $350 billion in constant 1995 dollars, with a mid-range estimate of $230 billion. Figure 2 graphically depicts the life-cycle cost profiles. This includes not only the $172 billion for dealing with the nuclear weapons complex legacy, but $24 billion for future wastes from nuclear weapons activities, and $34 billion for past and future wastes from other activities. The projected costs for treatment, storage, and disposal of waste generated by ongoing defense and research activities is $19 billion. Figure 3 illustrates the proportion of costs projected to be devoted to legacy waste and contamination

Figure 2. Base Case Cost and Schedule Estimate



compared to support for ongoing programs. This significant projected cost for support for future ongoing programs indicates the value of vigorous pollution prevention efforts to reduce these costs and threats.

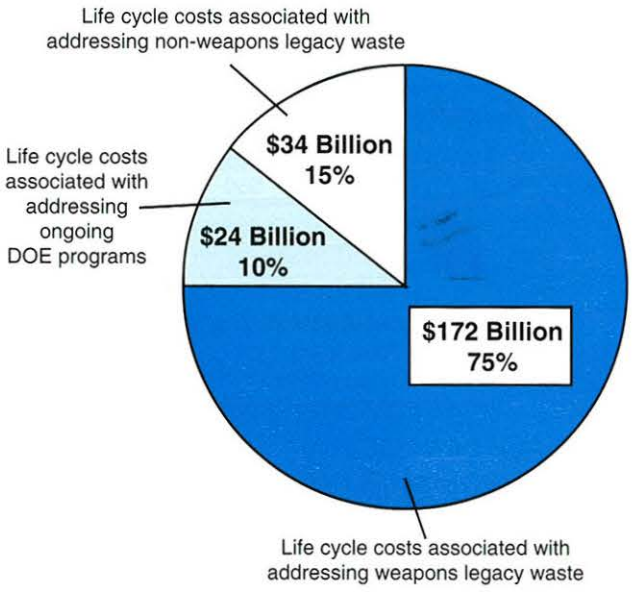
The range of the cost estimate varies depending on the assumed level of productivity over the life of the program as described below.

- The mid-range total program estimate of $230 billion reflects a planned 20-percent increase in productivity and efficiency over the next 5 years, plus an annual 1-percent productivity improvement over the remaining life of the program.
- The low-end estimate of $200 billion reflects a more aggressive efficiency and productivity improvement program—20-percent for the next 5 years as in the mid-range total estimate, and subsequent annual improvements of nearly 2 percent (a number commonly used by the private sector in today's business climate).
- The high-end estimate of $350 billion reflects costs if current levels of inefficiency and productivity were sustained over the program's life.

These levels of efficiency improvement are not only needed and planned, they are attainable. The Environmental Management program already has achieved significant improvements in efficiency and productivity. From FY 1994 to FY 1996, the program will have saved more than $2.1 billion through greater productivity.

Although the total life-cycle estimate is derived from a 75-year program duration, more than 90 percent of the life-cycle cost estimate reflects activities projected to occur during the next 40 years. The remaining costs are primarily for the operation of large waste treatment facilities at a limited number of sites. In 2070, given the Base Case assumptions, access will be restricted at the large, isolated Department of Energy sites with existing burial grounds. These sites include certain sections of the Hanford Site, Idaho National Engineering Laboratory,

Figure 3. The Life-Cycle Costs Associated with Addressing Department of Energy Wastes



Savannah River Site, Nevada Test Site, Oak Ridge, Los Alamos National Laboratory, and the Waste Isolation Pilot Plant. At smaller Department of Energy sites, such as the Mound Site in Ohio or the Pinellas Plant in Florida, where contamination has been contained in place, future use is expected to be limited to industrial purposes.

Small non-Department sites or sites near heavily populated areas or water sources are assumed to be released for residential or industrial use. Examples include the General Atomics Site at La Jolla, California, and Battelle Columbus Laboratories in Columbus, Ohio.

Figures 4 and 5 show cost estimates for the Environmental Management program under the mid-range Base Case estimate. The cost estimate is divided among the five major elements of the program: waste management, environmental restoration, nuclear material and facility stabilization, program management, and technology development.

Figure 4. Mid-Range Base Case Cost Profile for Major Elements of the Environmental Management Program

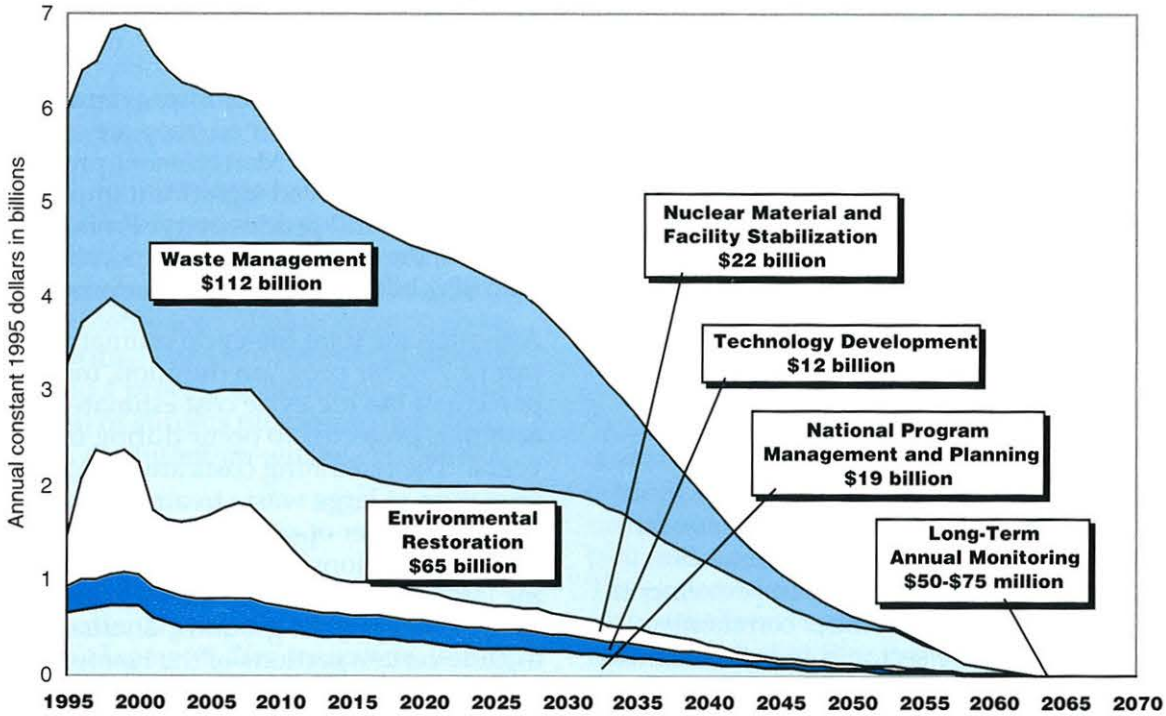
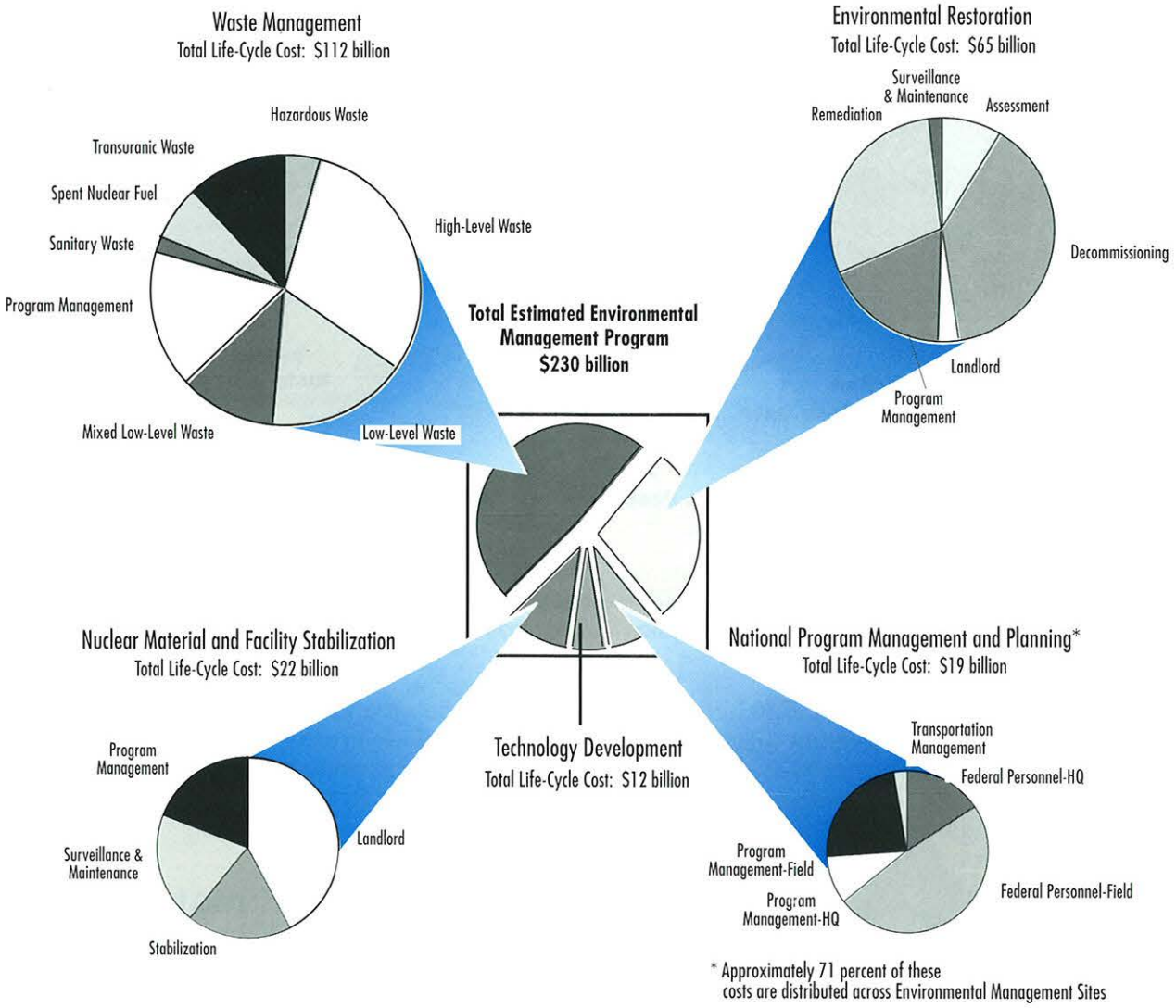


Figure 5. Mid-Range Base Case Estimate for Major Elements of the Environmental Management Program

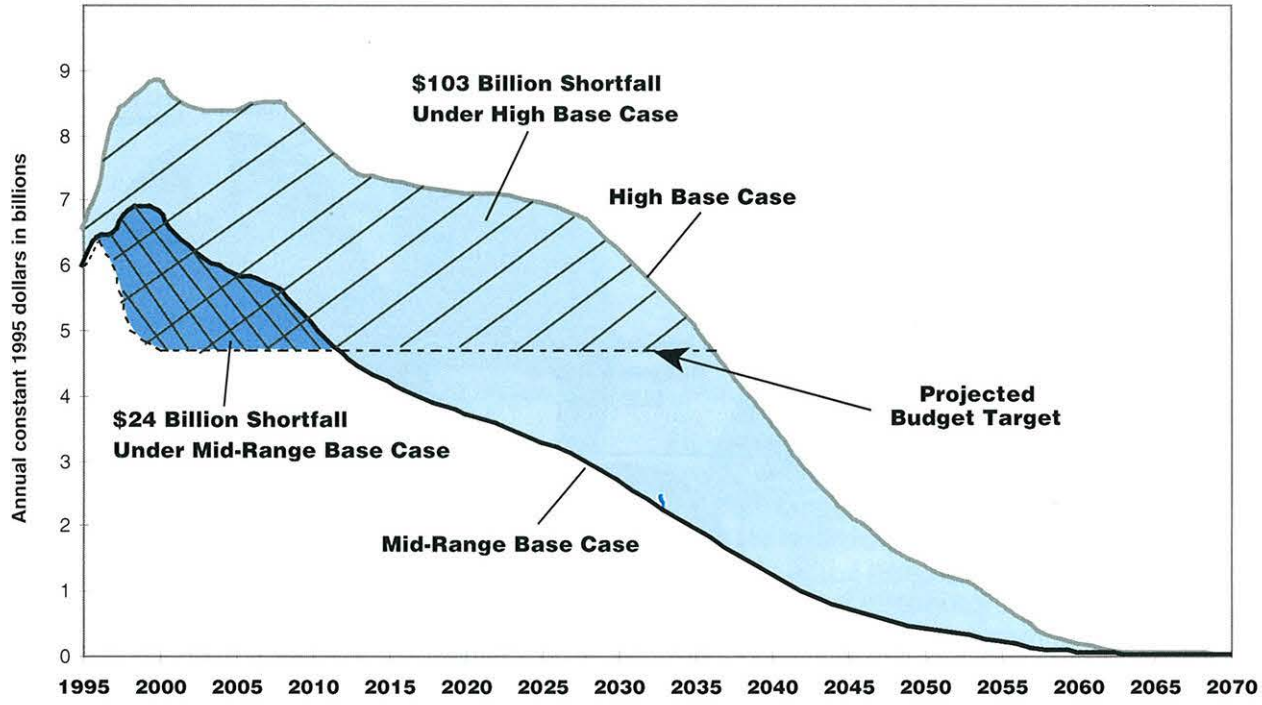


The Administration's Budget and the 1995 Baseline Report

The Administration has established budget targets for the next 5 years that reflect the allocation of resources among competing national priorities, including lower taxes and deficit reduction. These targets move the Environmental Management program from $6.6 billion in FY 1996 to $5.5 billion in FY 2000 in current dollars. This equates to a target of $4.8 billion in constant 1995 dollars in FY 2000. For purposes of this comparison, this target was assumed to remain unchanged over the life of the Environmental Management program.

A shortfall remains between the Base Case cost estimate (the estimated costs of meeting the Department's compliance agreements) and the FY 1996 funding request and outyear targets. For the high Base Case estimate of $350 billion, this shortfall would be about $100 billion over the next 40 years.

Figure 6. Comparison between the Base Case Report Cost Estimates and the Administration's Budget Projection



For the mid-range estimate of $230 billion, the savings of about $8 billion from the assumed 20-percent productivity improvement over the next 5 years begins to bridge this gap. Even with these savings, however, a shortfall remains of about $7 billion through FY 2000. The total projected shortfall for the mid-range cost estimate is $24 billion until 2015, at which point the projected budget target would match the projected needs. Figure 6 compares the Baseline Report cost estimate and the administration's FY 1996 budget and outyear projections.

The Department is addressing this shortfall in several ways. First, it has reduced the cost of doing business by streamlining the contractor workforce and negotiating and recompeting contracts. Second, the Department is renegotiating compliance agreements for various sites and installations, many of which were crafted during a different budget climate. In addition, the Administration has proposed legislative improvements to Superfund to make it work better and cost less. These changes would include greater opportunities to consider future land use in remedy selection and potential risks to workers.

Base Case Estimate by State and Site

Further examination of projected costs by State and site shows where the mid-range Base Case would be incurred (see Figure 7, Table 4, and Figure 8):

- Washington, South Carolina, Tennessee, Colorado, and Idaho account for $170 billion over the life of the Environmental Management program (71 percent).
- Washington and South Carolina together account for $97 billion (42 percent).
- The most costly sites are the Hanford Site

Figure 7. Mid-Range Base Case Estimate by State

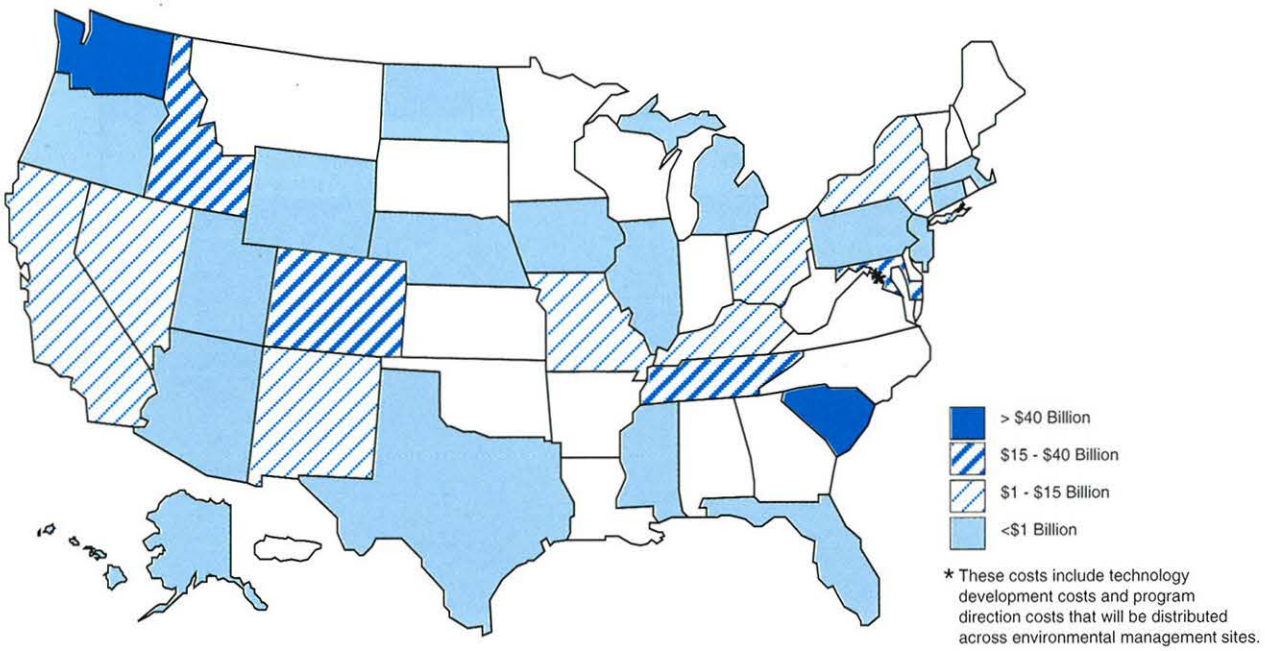
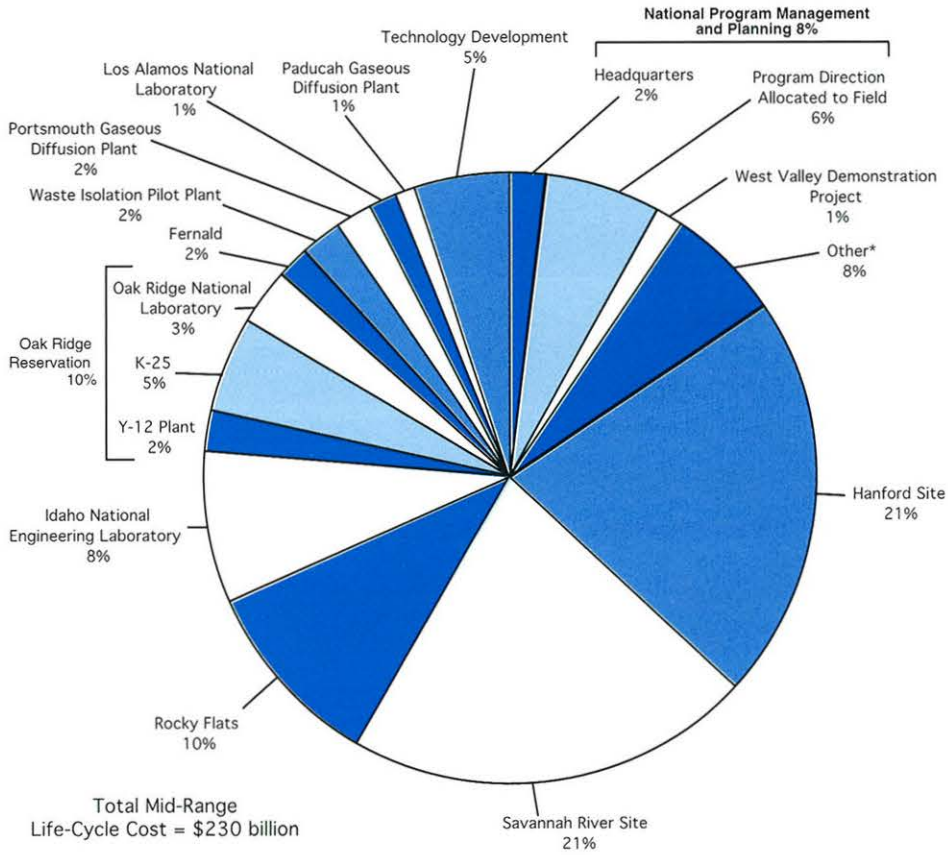


Figure 8. Mid-Range Base Case Estimate by Site



*Other denotes total of all other sites listed in Table 4.

Table 4. Mid-Range Base Case Estimated by State and Site

Site	Mid-Range Base Case Cost (Constant 1995 $ in Millions)	Percentage of Total Mid-Range Base Case Cost
Alaska	***2***	***<1%***
Nevada Offsite* - Alaska	2	<.01%
Arizona	***139***	***<1%***
Completed UMTRA S&M** - Arizona	139	0.06%
California	***2,273***	***0.98%***
Energy Technology Engineering Center	249	0.11%
General Atomics	12	0.01%
General Electric Vallecitos Nuclear Center	18	0.01%
Geothermal Test Facility	6	<.01%
Laboratory for Energy Related Health Research	34	0.01%
Lawrence Berkeley Laboratory	208	0.09%
Lawrence Livermore National Laboratory	1,521	0.66%
Oxnard	13	0.01%
Sandia National Laboratories - Livermore	92	0.04%
Stanford Linear Accelerator Center	119	0.05%
Colorado	***23,294***	***10.10%***
Completed UMTRA S&M - Colorado	7	<.01%
Grand Junction Project Office Site	707	0.31%
Gunnison	14	0.01%
Maybell	23	0.01%
Naturita	26	0.01%
Rifle	34	0.01%
Rocky Flats Environmental Technology Site	22,455	9.74%
Nevada Offsite - Colorado	3	<.01%
Slick Rock	26	0.01%
Connecticut	***3***	***<.01%***
FUSRAP*** - Connecticut	3	<.01%
Florida	***189***	***<1%***
Pinellas Plant	189	0.08%
Idaho	***18,658***	***8.09%***
Argonne National Laboratory - West	229	0.10%
Completed UMTRA S&M - Idaho	<1	<.01%
Idaho National Engineering Laboratory	18,430	7.99%
Illinois	***612***	***<1%***
Argonne National Laboratory - East	527	0.23%
Fermi National Accelerator Laboratory	76	0.03%
FUSRAP - Illinois	1	<.01%
Site A/Plot M	8	<.01%
Iowa	***12***	***<1%***
Ames Laboratory	12	0.01%
Kentucky	***3,390***	***1.47%***
Maxey Flats	221	0.01%
Paducah Gaseous Diffusion Plant	3,368	1.46%
Maryland/District of Columbia	***30,143***	***13.07***
FUSRAP - Maryland	7	<.01%
Environmental Management Headquarters****	30,136	13.07%
Massachusetts	***14***	***<1%***
FUSRAP - Massachusetts	14	0.01%
Michigan	***1***	***<1%***
FUSRAP - Michigan	1	<.01%
Mississippi	***3***	***<1%***
Nevada Offsite - Mississippi	3	<.01%
Missouri	***1,074***	***0.47%***
FUSRAP - Missouri	388	0.17%
Kansas City Plant	312	0.14%
Weldon Spring Site Remedial Action Project	373	0.16%

*Nevada Offsite are locations where nuclear detonations occurred and environmental management activities are managed by the Nevada Operations Office.

** UMTRA S&M is the acronym for Uranium Mill Tailings Remedial Action projects with long-term Surveillance and Maintenance activities.

***FUSRAP is the acronym for the Formerly Utilized Sites Remedial Action Program.

****Approximately 71 percent of these costs are distributed across Environmental Management sites.

Table 4. Mid-Range Base Case Estimated by State and Site (continued)

Site	Mid-Range Base Case Cost (Constant 1995 $ in Millions)	Percentage of Total Mid-Range Base Case Cost
Nebraska	***<1***	***<1%***
Hallam Nuclear Power Plant	<1	<.01%
Nevada	***2,472***	***1.07%***
Nevada Test Site	2,443	1.06%
Nevada Offsite - Nevada	29	0.01%
New Jersey	***440***	***<1%***
FUSRAP - New Jersey	322	0.14%
Princeton Plasma Physics Laboratory	118	0.05%
New Mexico	***9,647***	***4.18%***
Albuquerque Operations Office	456	0.20%
Ambrosia Lake	<1	<.01%
Completed UMTRA S&M - New Mexico	3	<.01%
Inhalation Toxicology Research Institute	19	0.01%
Los Alamos National Laboratory	3,304	1.43%
Nevada Offsite - New Mexico	10	<.01%
Sandia National Laboratories - New Mexico	890	0.39%
South Valley Site	18	0.01%
Waste Isolation Pilot Plant	4,948	2.15*
New York	***4,003***	***1.74%***
Brookhaven National Laboratory	460	0.20%
FUSRAP - New York	273	0.12%
Separations Process Research Unit	112	0.05%
West Valley Demonstration Project	3,157	1.37%
North Dakota	***22***	***<1%***
Belfield/Bowman	22	0.01%
Ohio	***11,743***	***5.09%***
Battelle Columbus Laboratories	110	0.05%
Fernald Environmental Management Project	4,186	1.82%
FUSRAP - Ohio	197	0.09%
Mound Plant	1,539	0.67%
Piqua Nuclear Power Plant	<1	<.01%
Portsmouth Gaseous Diffusion Plant	5,575	2.42%
Reactive Metals, Inc.	135	0.06%
Oregon	***3***	***<1%***
Completed UMTRA S&M - Oregon	3	<.01%
Pennsylvania	***3***	***<1%***
Completed UMTRA S&M - Pennsylvania	3	<.01%
South Carolina	***48,174***	***20,90%***
Savannah River Site	48,174	20,90%
Tennessee	***24,812***	***10.76%***
Oak Ridge Y-12 Site	4,127	1.79%
Oak Ridge Reservation	277	0.12%
Oak Ridge K-25 Site	12,662	5.49%
Oak Ridge Associated Universities	18	0.01%
Oak Ridge National Laboratory	7,729	3.35%
Texas	***582***	***<1%***
Completed UMTRA S&M - Texas	21	0.01%
Pantex Plant	562	0.24%
Utah	***140***	***<1%***
Completed UMTRA S&M - Utah	8	<.01%
Monticello Millsite and Vicinity Properties	131	0.06%
Washington	***48,671***	***21.11%***
Hanford Site	48,671	21.11%
Wyoming	***25***	***<1%***
Completed UMTRA S&M - Wyoming	25	0.01%
Total	**$230 Billion**	**100%**

(Washington); the Savannah River Site (South Carolina); the Rocky Flats Environmental Technology Site (Colorado); the K-25 Site, the Y-12 Plant, and the Oak Ridge National Laboratory (Tennessee); and the Idaho National Engineering Laboratory.

Alternative Cases

The alternative cases reflect ways the Base Case could change if certain policy decisions were made. The alternative cases analyzed four areas most likely to affect total cost, scope, and pace of the Environmental Management program:

- **land use**—What are the ultimate uses for currently contaminated lands, waters, and structures at each installation?
- **program funding and schedule**—How might activities be prioritized, and how rapidly will this money be spent?
- **technology development**—How might future technologies influence the Environmental Management program?
- **waste management configurations**—Where and how will we treat, store, and dispose of wastes?

Land Use

How land will be used after environmental remediation dictates the type and extent of remedial approaches, and thus, total costs. The Base Case estimate in this report is based on a "bottom up" approach using large amounts of data and assumptions collected from field offices, rather than centralized estimating processes. This method resulted in more realistic land-use assumptions and, consequently, substantially lower costs than previous cost estimates. For comparison, total program costs were analyzed for a range of alternative future land uses, ranging from most to least restricted. Figure 9 depicts a continuum of land use ranging from totally restricted to totally unrestricted use.

The most restricted case involves containing existing contamination in place and restricting public access thereafter. The least restricted land use requires removing or destroying contaminants in all parts of the environment, which would leave land clean enough for a wide variety of uses, potentially including farming and public recreation. Two other cases were also analyzed that were more reflective of the contractual and legal requirements accounted for in the Base Case analysis.

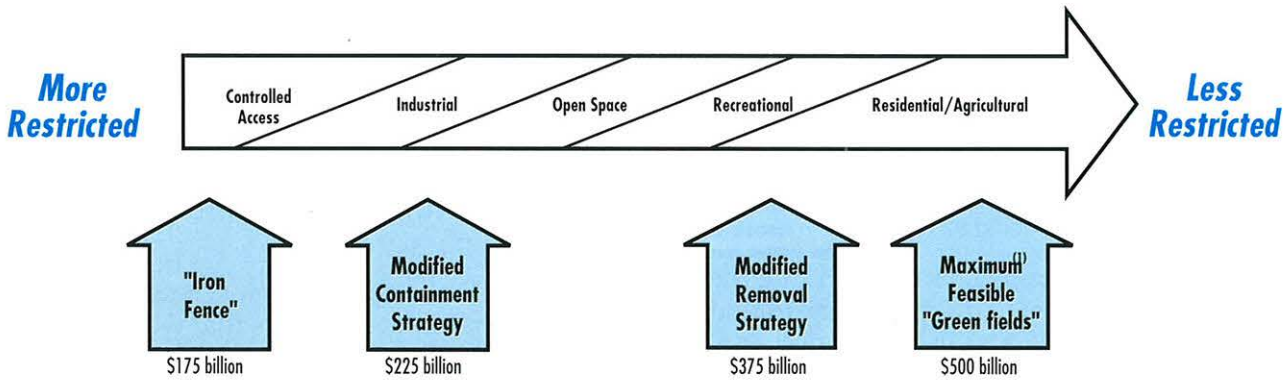
The life-cycle cost estimates for the range of land uses vary from approximately $175 billion to $500 billion depending on the level of cleanup assumed. This analysis indicates that future land-use determinations will have the single greatest impact on total program cost among the factors analyzed.

Each land-use case has its limitations. For example, containment rather than remediation is unrealistic across the Department of Energy complex because it would violate several existing cleanup compliance agreements. Also, in some cases, it is less costly to remediate contamination than to contain it. Establishing "green fields" at Department facilities nationwide is not realistic because it would preclude establishing any waste disposal areas, which must be located in restricted areas. Also, for certain contamination situations, technologies do not yet exist to remediate the environment to the level required for unrestricted use. For example, ground water beneath 150 square miles of the Hanford Site is contaminated with radioactive and chemical particles captured within a labyrinth of sediment and rock layers.

Residual Contamination Standards

Costs and schedules reported in the Base Case are based on each installation's best estimate of ultimate cleanup levels. The site-specific land use assumptions in the Base Case result in

Figure 9. Conceptual Illustration of Land Use Continuum



significant restrictions on future land-use at many of the sites. Variations in residual contamination standards have little impact on costs because containment, rather than the removal of contamination, is assumed to be used. The Department believes that more stringent cleanup standards will result in higher costs if active remediation approaches are assumed. However, if less active remediation, such as containment is assumed, then little change in cost will occur from more stringent residual contamination standards. More information must be collected, and analyses need to be conducted before costs can be quantified nationwide.

Program Funding and Schedule

Another set of analyses addressed the impacts of more or less available funding for the program. Assuming additional funding, the impacts of accelerating stabilization activities and early closure of sites were analyzed. Assuming reduced funding, the impacts of reducing the scope of remediation and waste management activities are also addressed. Highlights of the scheduling analysis are shown below.

- The life-cycle cost estimate for surveillance and maintenance could be reduced to approximately $500 million if pre-stabilization surveillance maintenance was reduced from 10 years (as in the Base Case) to 1 year. This is about 87 percent lower than the $4 billion in the Base Case. However, annual costs during the early years of the program would exceed the constant, or "flat," funding limit assumed for the Base Case.

- Almost $5 billion would be saved if the Department closed the Rocky Flats Site, Oak Ridge's K-25 Plant, and the Fernald Plant substantially earlier (20-40 years) than currently scheduled. However, annual costs would exceed flat funding limits for several years.

- If funding were significantly reduced beyond the year 2000, minimal action would require about $170 billion. This is about 27 percent lower than the Base Case through 2070. Minimal action would exclude environmental restoration, decontamination and dismantlement, and all treatment and disposal activities associated with future low-level, low-level mixed, and transuranic wastes. Annual surveillance and maintenance costs, however, would be as high as $500 million, compared with $50-$75 million projected in the Base Case.

Technology Development

Innovative technologies could make cleanup and other related activities more efficient and cost effective. More than 100 potential technology systems scheduled to be implemented by the year 2000 were screened based on the potential applicability to high-cost remediation projects. Of these, 15 were selected to evaluate potential cost savings.

Potential cost savings from implementing these new technologies range from $9 to $80 billion, depending on future land use strategies, and assuming the technologies could be implemented by 2010.

Waste Management Configurations

The Department currently is examining alternative configurations (centralized, regionalized, and decentralized) for waste management facilities. This involves deciding where in the country wastes will be stored, treated, or disposed.

Alternative configurations, ranging from decentralized to centralized approaches, could increase costs by $9 billion or decrease them by $5 billion from the Base Case, because of the potential for economies of scale in building and operating fewer facilities. There is substantial uncertainty about the exact benefits of these economies. More analysis should be available for next year's version of the report.

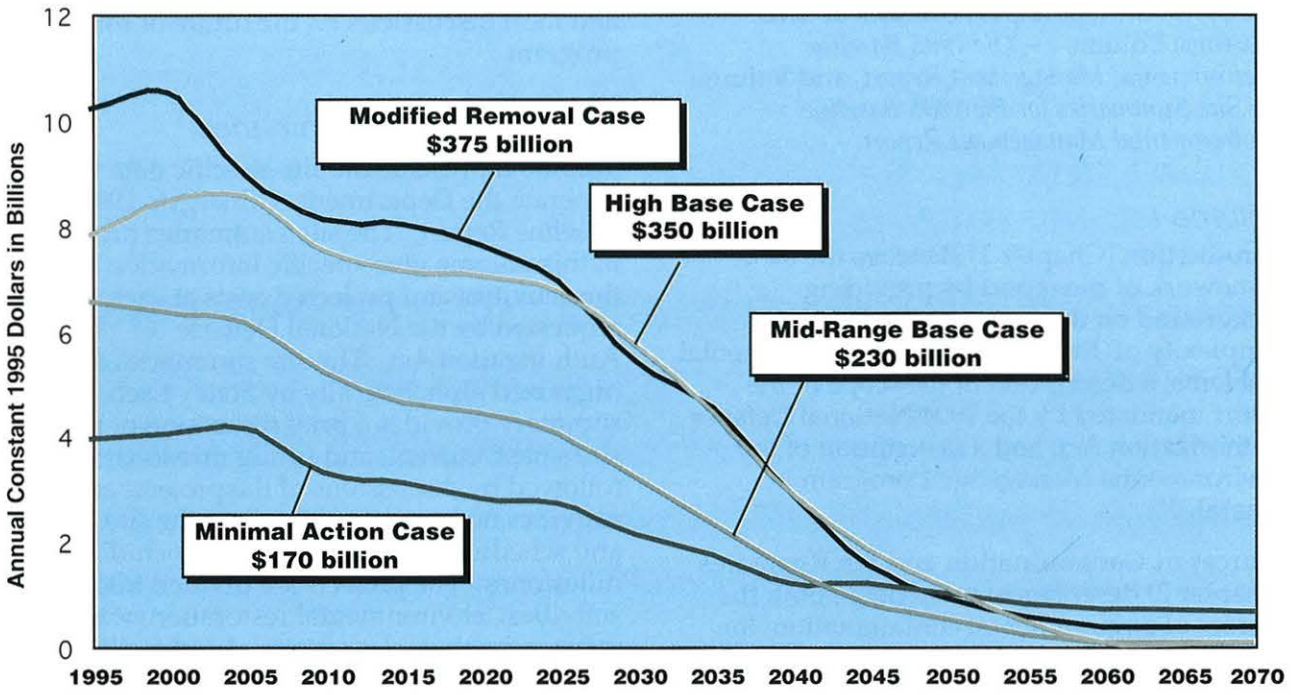
Next Steps

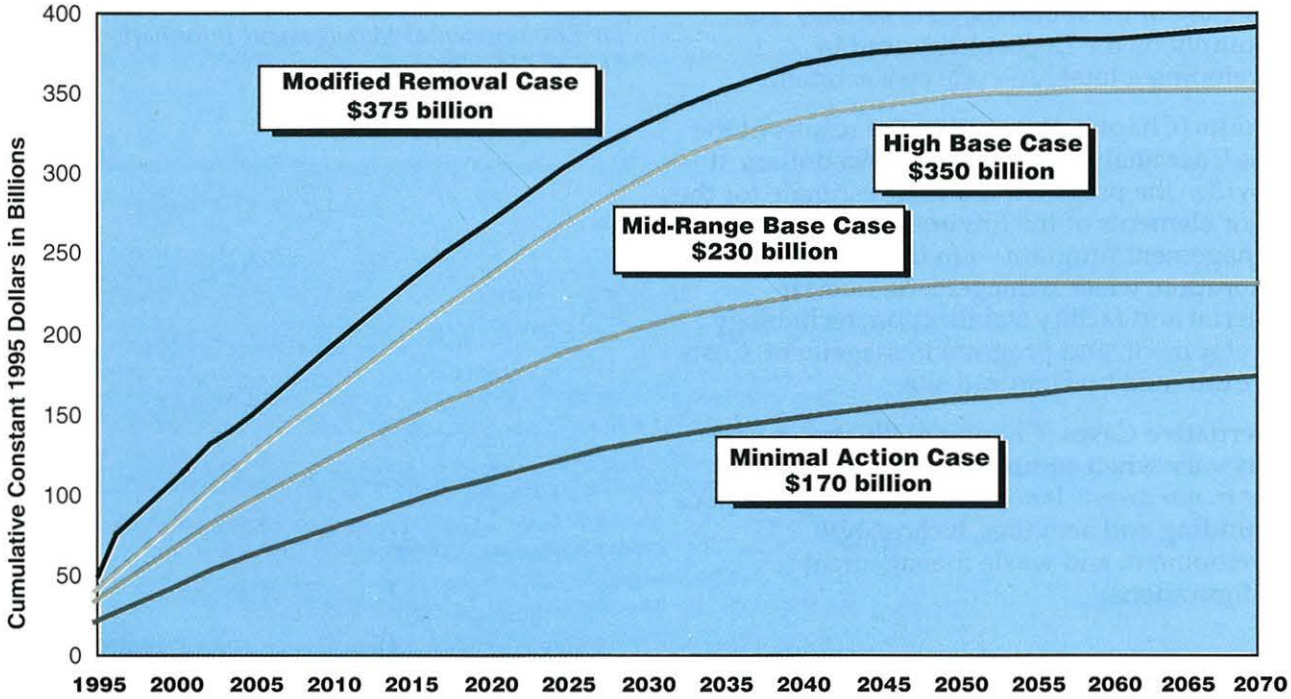
The purpose of the Baseline Report is to clearly articulate the potential life-cycle cost and schedule of the Department of Energy's Environmental Management program. The report represents numerous perspectives on the Base Case estimate, together with the analysis of the alternative cases, the range of policy, technical, and management decisions facing the program, and indeed, the Nation. After considering economic factors, productivity improvements, and alternative cases, the range of life-cycle costs for the Environmental Management program is seen to be substantial. This range is depicted in Figure 10. Naturally, this range will narrow as the program matures. However, in the short term, the range of uncertainties highlights the need for a broad public debate both nationally and locally regarding the future of the Environmental Management program.

Many significant decisions must be made during the next several years that will affect the cost and direction of the Environmental Management program for years to come. This report provides a useful framework to analyze those decisions–the alternatives and their impacts. We expect next year's version of this report to change as a result of better information, additional analyses, and different assumptions resulting from stakeholder input. In addition, the compliance agreement and legal requirements underlying many of these estimates could be altered by regulators and Congress. The potential impacts of these changes can be better analyzed using an open process and an analytical tool such as this Baseline Report. Specifically, the next steps currently planned for next year's report are to:

- broaden the range of policy, technical, and management issues evaluated by the Baseline Report;
- improve the life-cycle cost and schedule estimates;
- use the Baseline Report tools to address ongoing program issues; and
- expand stakeholder involvement in the debate.

Figure 10. Potential Range of the Life-Cycle Cost Estimate





Contents

The 1995 Baseline Report consists of two volumes: Volume I – *The 1995 Baseline Environmental Management Report*, and Volume II – *Site Summaries for the 1995 Baseline Environmental Management Report.*

Volume I

Introduction (Chapter 1) sketches the basic framework of the report by providing background on the scope and technical complexity of the Department's environmental problems, a description of the scope of the report mandated by the 1994 National Defense Authorization Act, and a description of the Environmental Management program in general.

Sources of Contamination and the Remedies (Chapter 2) describes in more detail both the sources of environmental contamination, the nuclear weapons production process and the various resulting waste types, and the responsibilities of the Environmental Management program.

The Base Case (Chapter 3) provides a detailed overview of the methods, data sources, and assumptions the Department used in developing a total life-cycle cost estimate.

Results (Chapter 4) describes the results of the Base Case analysis in constant 1995 dollars. It provides the projected life-cycle estimate for the major elements of the Environmental Management program—environmental restoration, waste management, nuclear material and facility stabilization, technology development, and program management. Costs are examined by State and site.

Alternative Cases (Chapter 5) illustrates how costs vary when assumptions are changed in four major areas: land use, scheduling, the pace of funding and activities, technology development, and waste management configurations.

Next Steps (Chapter 6) discusses how this report can be a more useful tool for national and local discussions on the future of this program.

Volume II: Site Summaries

Volume II presents the site-specific data used to generate the Department of Energy's 1995 Baseline Report. The site summaries provided in this volume give specific information about the activities and projected costs at each site as requested by the National Defense Authorization Act. The site summaries are organized alphabetically by State. Each summary provides a brief discussion of the site's past, current, and future missions followed by discussions of the projects and activities necessary to remediate the site. Costs and schedules are also provided, including milestones. The projects are divided into five activities: environmental restoration; waste management; nuclear material and facility stabilization; landlord activities; and program management.

This executive summary provides a brief, non-technical overview of the report, which is available in Department of Energy reading rooms and the Center for Environmental Management Information (1-800-736-3282).