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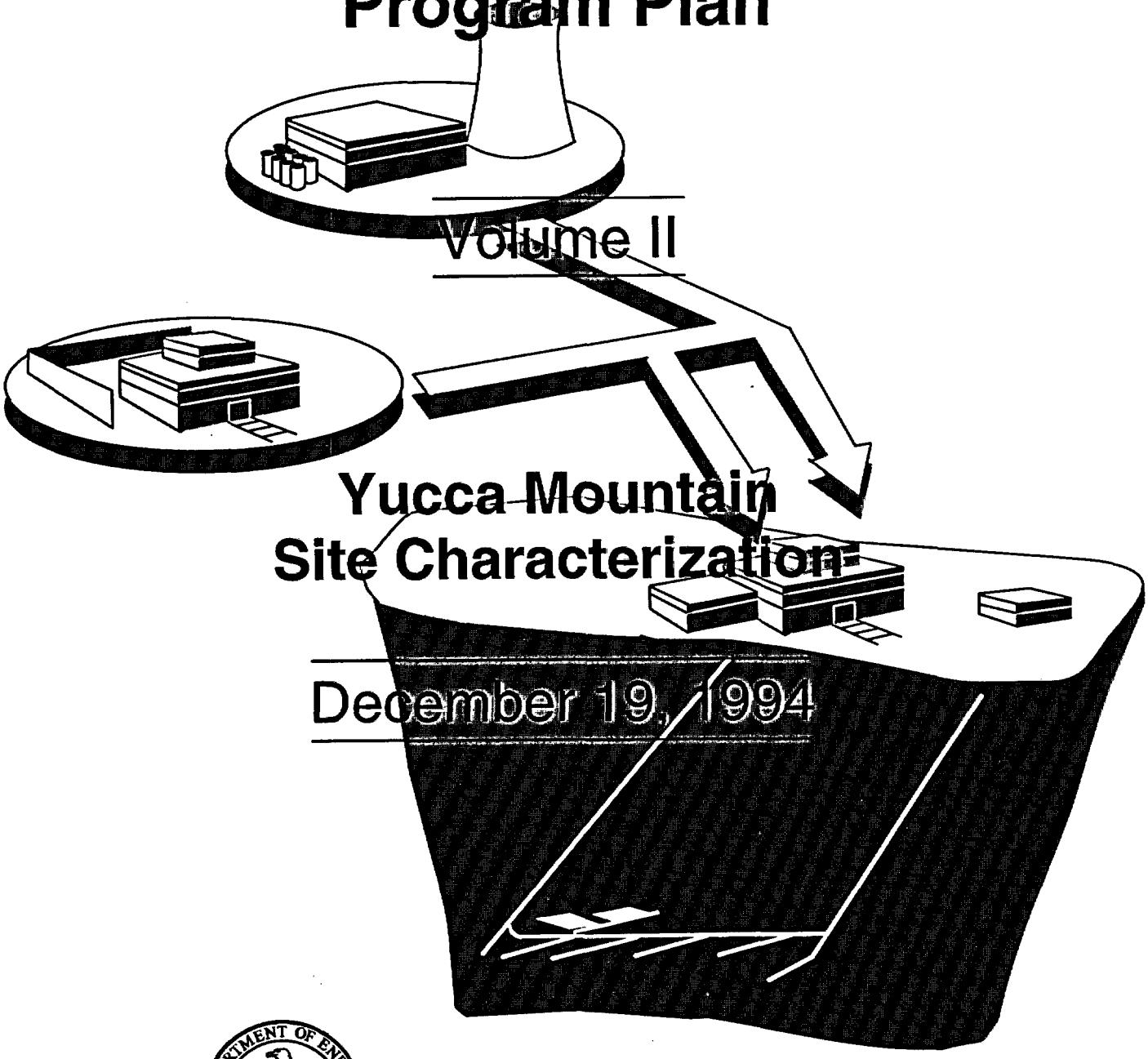
Civilian Radioactive Waste Management Program Plan



Volume II

Yucca Mountain Site Characterization

December 19, 1994

U. S. Department of Energy

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Civilian Radioactive Waste Management Program Plan

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1. EXECUTIVE SUMMARY

This plan for the Yucca Mountain Site Characterization Project describes the goals, activities, schedule milestones, and cost estimates for the Project's major products for fiscal years 1995-2000. The plan implements the site characterization, environmental, and repository licensing strategies in the Program approach recently presented to the United States Congress by the Department of Energy.

Key features of this plan includes the following:

1. A description of the activities necessary to implement the Program approach

2. A clear definition of progress with interim milestones and products

3. A clarification of the relationships among activities, products, and budgets

The proposed activities and preliminary cost estimates for the refocused Project are presented in terms of the following four major products required to meet the near-term goals of the Program approach:

1. **Site Suitability.** This includes the activities required to support the technical site suitability evaluation scheduled for 1998, which assesses those suitability conditions that depend on information from site characterization. If the outcome of the technical site suitability evaluation is favorable, assessments of the other suitability conditions--environmental quality, transportation, and socioeconomic impacts--will be included in a Site Recommendation Report, prepared by the end of fiscal year 2000, and drawing on information presented in the repository Environmental Impact Statement.

2. **National Environmental Policy Act Compliance Process.** This includes the activities required to collect, interpret, and analyze data required to prepare and review the draft and final Environmental Impact Statement in fiscal years 1998 and 2000 followed by issuance of a Record of Decision.

3. **Repository Licensing.** This includes the activities required to ensure that required information will be available to develop a license application for submission to the Nuclear Regulatory Commission in fiscal year 2001 if the site is found to be suitable.

4. **Management and Compliance.** This includes normal management activities required to direct and control the Project and special allocations required to support external agencies and the public in their review and interactions with the Project.

Table 1-1 shows the allocation of Project costs to each of the four product areas. The total cost through fiscal year 1994 is $1,753,303,000. Under the Program approach, the cost to license application in 2001 is estimated to be $4,520,951,000 as compared to the 1991 baseline estimate of $5,685,291,000 to reach the same milestones.

Table 1-1. Yucca Mountain Project Cost Estimate
$ x 1,000

Product	1995	1996	1997	1998	1999	2000	Total
Site Suitability	230,324	248,736	136,211	18,585	10,855	7,210	651,921
National Environmental Policy Act Process	15,066	25,163	28,086	26,813	23,980	16,988	136,096
Repository Licensing	28,718	79,261	229,979	348,830	340,620	256,380	1,283,788
Management and Compliance	101,162	120,541	138,868	136,880	151,280	188,062	836,793
Total	375,270	473,701	533,144	531,108	526,108	468,640	2,908,598

Note: Funding for fiscal year 1995 represents the current program budget as authorized by Congress. Projected funding requirements for 1996 - 2000 represent planning estimates and have not been submitted for approval.

Expenditure of resources for accomplishing the activities proposed in this plan will produce the following results:

- By the end of fiscal year 1998:

  - The Department of Energy will evaluate the technical suitability of the Yucca Mountain site based on a step-wise evaluation of compliance with the qualifying and disqualifying guidelines in 10 CFR Part 960 addressed in the Site Characterization Plan. This will be accomplished three years earlier than planned in the schedule put forward by the Secretary of Energy in 1989.

  - The Department of Energy will develop a draft repository Environmental Impact Statement for public comment.

- By the end of fiscal year 2000:

  - If Yucca Mountain if the site appears to be suitable, the Department of Energy will deliver a final repository Environmental Impact Statement, Record of Decision, and a Site Recommendation Report to the President--meeting milestones a year ahead of dates originally presented in 1989.

- In fiscal year 2001:

  - If the President and Congress have approved the site, the Department of Energy will submit a License Application for construction of a repository to the Nuclear Regulatory Commission, and be ready to provide any necessary support to the Commission to meet

legal obligation to decide on the repository construction authorization within three years of the date of the application.

The restructured program described in this report requires no changes to the Nuclear Waste Policy Act, as amended. However, it anticipates a new Environmental Protection Agency standard for a Yucca Mountain repository and conforming changes to the Nuclear Regulatory Commission regulation 10 CFR Part 60, as required by the Energy Policy Act of 1992. To successfully implement the restructured program, the Nuclear Regulatory Commission must first accept the new site characterization strategy as a suitable basis for evaluating a potential application, and second ensure that litigation over the application of the program will not cause delays.

1.1 OVERVIEW

1.1.1 Historical Perspective

The Yucca Mountain Site Characterization Project started in 1977 when the Department of Energy began looking into the possibility of disposing radioactive waste in a geologic repository at the Nevada Test Site. Over the next two years, the Department of Energy investigated a number of sites in the vicinity of the Nevada Test Site and finally selected Yucca Mountain as the most promising site.

In 1982, the United States Congress passed the Nuclear Waste Policy Act to establish a national policy for the disposing highly radioactive waste, specifically commercial reactor spent nuclear fuel and defense high-level waste. With the Nuclear Waste Policy Act, the Federal government began developing a national capability to accept, transport, store, and permanently dispose of highly radioactive waste in a manner that protects public health, worker safety, and the environment.

The Nuclear Waste Policy Act of 1982 created the Office of Civilian Radioactive Waste Management within the Department of Energy and assigned that office the responsibility for developing a waste management system. The Act also

- established a Nuclear Waste Fund to finance the system through a surcharge on electricity produced by nuclear power plants
- specified the process for siting repositories for the permanent, deep geologic disposal of high-level radioactive waste and spent nuclear fuel
- required the Department of Energy to submit a proposal to construct a monitored retrievable storage facility for spent nuclear fuel
- required the President to evaluate the possibility of using repositories developed under the Act for the disposing of high-level waste for defense activities
- included provisions for of State and Indian Tribe participation in the waste management program.

The Department of Energy developed guidelines for evaluating the suitability of sites for repositories, and started the site screening process. The 1987 Amendment to the Act specified Yucca Mountain, Nevada, as the only site to be characterized to determine its suitability as a geologic repository.

In 1988, the Department of Energy developed a Site Characterization Plan in accordance with the Nuclear Waste Policy Act and is now conducting scientific investigations to determine the suitability of Yucca Mountain. If it finds Yucca Mountain suitable, the Department of Energy must develop a Site Recommendation Report for submittal to the President. If the President and Congress approve the site, the Department will submit an application to the Nuclear Regulatory Commission for a license to construct a repository as mandated by the Act. A repository Environmental Impact Statement must accompany both the Site Recommendation Report and License Application. If the Department of Energy finds Yucca Mountain unsuitable, then it must terminate all site characterization activities, mitigate any significant adverse environmental impacts, and provide recommendations to Congress for further action to ensure the safe, permanent disposal of spent nuclear fuel and high-level radioactive waste.

1.1.2 Major Milestones

In 1989, the Secretary of Energy assessed the progress and needs of the site characterization program. The result was a milestone schedule that would determine the suitability of Yucca Mountain in fiscal year 2001 and, if the site is suitable, start disposal operations in fiscal year 2010.

Because the existing Program expectations could not be achieved with historical funding levels and site investigations could not fulfill expectations regarding the knowledge required for long-term performance, the Office of Civilian Radioactive Waste Management restructured the Program. The plan described here, which implements the new Program approach, assesses the suitability of Yucca Mountain. The Program approach milestones are

Technical site suitability evaluation	1998
Draft repository Environmental Impact Statement	1998
Final repository Environmental Impact Statement	2000
Site Recommendation Report for the President	2000
Record of Decision	2000
License Application to Construct a Repository	2001
Construction Authorization	2004
License Application Update to Receive and Possess Waste	2008
License to Operate a Repository	2010

The 1998 technical site suitability evaluation addresses those suitability conditions that depend on information from site characterization, including the qualifying condition in the System Guideline (10 CFR Part 960.4), which "establishes waste containment and isolation requirements that are based on Nuclear Regulatory Commission and Environmental Protection Agency regulations." Assessments of the other suitability conditions--environmental quality, transportation, and socioeconomic impacts--will be conducted prior to the full suitability evaluation required for the Site Recommendation Report.

1.1.3 Site Characterization Plan

In 1988 the Department of Energy developed a Site Characterization Plan to define an adequate scientific investigation of Yucca Mountain. The Site Characterization Plan is a comprehensive document that describes available data about Yucca Mountain, defines issues, and identifies information needs. A key hypothesis in the Site Characterization Plan is a low ground water flux through the thick zone above the water table. The Site Characterization Plan places high priority on testing this hypothesis because it implies low seepage of water into the repository and little transport of radioactivity to the environment. Because there still are reasonable uncertainties about whether sufficiently low bounds on seepage exist, the Site Characterization Plan calls for investigating other processes that can limit releases within the natural and engineered portions of the system.

In addition to providing a conceptual model of groundwater flow and related testing requirements, the Site Characterization Plan defines investigations of other site suitability issues such as the effects of volcanism, tectonics, geochemical dissolution, climate changes on repository performance, and the occurrence of economically desirable natural resources.

1.1.4 Approach to Demonstrating Waste Isolation

1.1.4.1 Regulatory Status

In the Waste Isolation Pilot Plan Land Withdrawal Act of 1992, Congress declared that the existing standard for radioactive waste disposal-40 CFR Part 191, Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste-does not apply to Yucca Mountain. At approximately the same time, the Energy Policy Act of 1992 directed the Environmental Protection Agency to develop a new Yucca Mountain standard. The new standard must be a health-based standard based on doses to individuals.

The Environmental Protection Agency must promulgate the new standard no later than one year after receipt of findings and recommendations from a National Academy of Sciences study of the issues. The Nuclear Regulatory Commission must then modify, within one year its technical requirements and criteria in its regulation 10 CFR Part 60, to be consistent with the National Academy of Sciences recommendations and new Environmental Protection Agency standard. The National Academy of Sciences plans to deliver its findings and recommendations in the first half of 1995.

Although this regulatory change by the Environmental Protection Agency and Nuclear Regulatory Commission will not be completed before the beginning of fiscal year 1997, current performance assessments on the range of possible forms of the forthcoming regulation show that the new and revised regulations are unlikely to affect the milestone schedules.

1.1.4.2 Technical Status

Completing of the entire Site Characterization Plan would have required more resources than can reasonably be expected to be available prior to the scheduled submission of a repository license application in 2001. This problem is addressed by the Program approach.

The Program approach does not conduct all measurements and analyses in the Site Characterization Plan before evaluating suitability, selecting a final design, and submitting a license application. Instead, it distinguishes three sets of investigations:

- Those required for evaluating site suitability
- Those required for a license application and the completion of cost-effective design
- Those required for confirming postclosure repository performance.

This distinction permits the phasing of tests to achieve the early technical site suitability evaluation and preserves the schedule for licensing, constructing, and operating the repository, should the site appears to be suitable.

Measurements and analyses conducted since 1988 largely support the hypotheses of near-steady-state low ground-water flux at the proposed depth of the repository. This appears to be the result of capillary forces that will keep water from seeping into excavations and geologic features in the upper interior of the mountain that tend to divert infiltrating water. It is unlikely that climate variations can significantly affect the hydrology at the depth of the repository. Measurements of dissolution rates for spent fuel and solubilities for radionuclides provide a basis for bounding the amount of radionuclides that can be released from the repository under a range of postulated hydrological conditions. Major remaining concerns include: (1) selecting an approach for determining and managing the effects of heat from the waste on the mobilization of ground water, and (2) characterizing variations in the hydraulic conductivity of the rock that might focus flow so that it seeps into the repository through fractures.

Approaches to addressing uncertainties over the interactions of waste heat with ground water include the following:

- Controlling the emplacement of waste so that temperature increases in the rock are small, and the effects of heat on the hydrology are insignificant in terms of extent or duration

- Designing robust waste packages that prevent water from contacting with waste as long as the thermal effects on the hydrology around the repository create uncertainties in potential flow paths or travel times

- Emplacing waste packages in close proximity so that temperatures in the vicinity of the repository--which can be predicted with reasonable confidence--cause ground water to boil away, producing a dry region around the repository that prevents significant interactions of water and waste packages for well over 1,000 years.

There are two key areas where information is needed: (1) the temperatures at which the uncertainties about the effects of the interaction of heat and water become significant; and, (2) which approach supports the most cost-effective system design. Early observations at repository depth in the Exploratory Studies Facility can assist in determining an adequate temperature range to bound the isolation analysis. In situ heater tests can assist in providing limited resolution of the design questions before the 2001 License Application for a construction authorization, with

fuller resolution to be achieved before the License Application Update to Receive and Possess Waste in 2008.

Fractures and variations in rock appear to be an advantage rather than a problem. Analyses based on observations in tunnels similar to those that may be constructed for a repository suggest that infiltrating water may be localized. The water may contact only a small fraction of waste packages, thereby potentially limiting waste package failures and total repository releases. Initial in situ observations of seepage can confirm the basis for assessing and bounding the amount of water that can reach waste packages, although the aforementioned waste-heat interaction with groundwater still must be evaluated.

In addition to these approaches to assess whether there is low seepage into the repository, there are features in the rock below the repository that can potentially slow the flow of water, retard the transport of radionuclides, and dilute radioactive concentrations. Dilution in the aquifer below the repository becomes more important with the anticipated change from a regulatory release limit to a dose limit.

1.1.4.3 Isolation Demonstration Strategy

Analyses of the recent regulatory developments and accumulating observations at Yucca Mountain define the following steps for demonstrating that a repository a Yucca Mountain can isolate radioactive waste:

1. **Confirm the Bases for Bounding the Water Contact with Waste Packages:** Current assessments conclude that ground water may enter the tunnels in intermittent pulses through fractures. Analyses of these events in other tunnels suggest that the intersection of such pulses with waste packages may be rare, thus corrosion rates, waste package failures, and releases are limited to low values. The analyses have not fully considered the role of water vapor, (which could support some corrosion) and possible thin films of water that may provide diffusion paths. Some laboratory measurements of these phenomena have been completed and the results are being analyzed. Observations and early tests in the Exploratory Studies Facility will be needed to complete the analysis.

2. **Confirm the Basis for Designing Long-Life Waste Packages:** The Project will assess the significance uncertain effects of the initial interactions between heat and ground-water are insignificant in terms of resulting waste package metal barrier corrosion, basket material, degradation and waste form dissolution. Confirmation of the initial basis for waste package design will be obtained through containment barrier, basket material and waste form testing.

3. **Complete the Basis for Bounding the Dissolution of the Waste Form and Transporting Radionuclides from the Repository:** Tests of waste form dissolution rates and radionuclide solubilities in water from Yucca Mountain are producing a significantly changed set of bounding values. These results have been incorporated into recent performance analyses and currently are under scientific review to establish a range of bounding values.

4. **Establish the Nature of Dilution of Radionuclide Concentrations in the Aquifer Below the Repository:** With the potential transition to a dose standard it becomes more important to understand the characteristics of the saturated zone. Concerns here are the amounts and velocities of water in the aquifer and the extent to which mixing would dilute contaminated water from the repository. Results support bounding values on radionuclide concentration in water accessible to humans. These results can be related to bounding values on what may be the regulated quantity -- the effective dose equivalent to individuals.

If the understanding of Yucca Mountain developed in the Site Characterization Plan and the analyses described above is correct, these four steps will support an argument that a repository can isolate radioactive waste at Yucca Mountain. Subsequent site characterization including extensive thermal testing, will sharpen the understanding of processes, further constrain bounding values, and permit development of more cost-effective repository and waste package designs. Results will serve the license application in 2001, the interactions with the Nuclear Regulatory Commission during the licensing process, and the updated license application in 2008. Confirmatory testing, including selected tests in selected drifts of the expanding underground facility, will continue through the building and then the operating of the repository to ensure that all emplaced waste is isolated. Testing to confirm the repository's isolation capability will continue until closure -- a period between 50 to 100 years.

1.1.5 Program Approach

The Site Characterization Plan issued in 1988 contains an extensive testing, design, and performance assessment program that provide a comprehensive understanding of Yucca Mountain. The original intent of the Nuclear Waste Policy Act and of the Nuclear Regulatory Commission was to create a site characterization program that provides sufficient information for decision making, realizing that some uncertainty must exist. The series of decisions to be made in the various licensing stages imply an increasing knowledge base much of which is gained after the construction authorization. In fact, the 1990 report, "Rethinking High-Level Waste," by the National Academy of Sciences stressed that it is unrealistic to assume that all information can be available before constructing a repository. The Program approach represents a fundamental change in the site characterization approach. Whereas the Site Characterization Plan described a program that attempted to provide answers for all possible questions related to the site, the Program approach recognizes that the resources required to carry out such a program have not been and are unlikely to be available. The Program approach is consistent with the original intent of the legislative and regulatory framework, as well as recommendations of the National Academy of Sciences.

Under the Program approach, the site characterization program initially will focus on those tests and analyses most critical to suitability evaluation and licensing issues. If the site appears to be suitable, the focus of the Program approach will shift emphasis to acquiring the additional site characterization data and developing the analyses needed to submit an application to the Nuclear Regulatory Commission for a Construction Authorization. These data and analyses will seek to provide confidence in the safety of repository operations and waste package containment. The data and analyses needed to support compliance with requirements related to longer-term radionuclide release and transport will likely be of a probabilistic nature, conservative, and

flexible enough to accommodate many possible site conditions. Additional confidence in the certainty of these data and the demonstration of the long-term performance of the site will be achieved through the performance confirmation program. The repository will be designed to permit waste retrieval for up to 100 years from the start of waste emplacement, twice as long as the 50-year retrieval period required by the Nuclear Regulatory Commission.

The Department of Energy must develop those necessary data and analyses to enable the Nuclear Regulatory Commission to make findings with reasonable assurance with regard to the performance of the site. This process is manifested by a maturing understanding of the performance of the natural and engineered components of the system as well as the system's sensitivities to the performance of its individual components. Iterative performance assessments will serve to drive and document the maturation of this understanding.

1.1.5.1 Major Goals

The major goals of this plan are:

- Describe activities necessary to implement the Program approach:
  - Evaluate, by the end of fiscal year 1998, whether site conditions at Yucca Mountain warrant further expenditures for site characterization (that is, whether site conditions satisfy higher level findings as written in 10 CFR Part 960, with the exception of the guidelines on environment, transportation and socioeconomics)
  - Describe the necessary activities, if the site appears to be suitable, to deliver a Site Recommendation Report and Environmental Impact Statement to the President in 2000
  - Apply for a Construction Authorization from the Nuclear Regulatory Commission in fiscal year 2001; if the President and Congress approve
- Clearly define progress using interim milestones in the areas of suitability, the National Environmental Policy Act process, and licensing.

1.1.5.2 Site Suitability

In the program approved by the Secretary of Energy in 1989, formal documentation of any site suitability finding would not appear until the Site Recommendation Report was submitted by the Secretary to the President in fiscal year 2001. A major concern of stakeholders was the expenditure of at least six billion dollars of the Nuclear Waste Fund before the first significant measure of progress.

The Program approach initially focuses resources on the site suitability evaluation process to produce earlier measures of progress. Several reports, each based on a subset of the siting guidelines, provide the basis for interactions among the Department of Energy, stakeholders, and

peer reviewers over the three-year period beginning in mid 1995. The reports cover the following topics:

- Surface Processes
- Preclosure Rock Characteristics
- Tectonics
- Preclosure Radiological Safety
- Geochemistry/Postclosure Rock Characteristics
- Geohydrology and Transport
- Total System Performance Assessment.

If site conditions at Yucca Mountain are found favorable for repository development the Director of the Office of Civilian Radioactive Waste Management will issue a technical site suitability evaluation in fiscal year 1998. After the 1998 evaluation, the Department of Energy will evaluate the remaining guidelines addressing environmental quality, socioeconomic impacts, and transportation in 2000. This evaluation will be based on information developed through the National Environmental Policy Act process to support the final repository Environmental Impact Statement in fiscal year 2000. Section 2. describes the site suitability product area.

1.1.5.3 National Environmental Policy Act Compliance Process

The National Environmental Policy Act and Nuclear Waste Policy Act determine the requirements for the Repository's Environmental Impact Statement. The process begins with a Notice of Intent to be issued by the Department of Energy in 1995, and ends with a Record of Decision filed by the Department in 2000. This repository Environmental Impact Statement must accompany the Site Recommendation Report to the President. The challenge is to prepare a technically adequate repository Environmental Impact Statement that focuses on the environmental impacts of repository construction, waste emplacement, and postclosure performance. The Department of Energy also will examine various repository operational scenarios that may affect design features. This may assist Department decision makers and provide a meaningful basis for comparison of the potential environmental impacts associated with the proposed action. Section 3. describes the Project National Environmental Policy Act product area; and includes the technical data gathering activities, analyses and document preparation required for the Repository Environmental Impact Statement.

1.1.5.4 Repository Licensing

The repository licensing program builds on the information, analyses, and designs required for the Department of Energy site suitability evaluation. The criteria that address site suitability conditions are consistent with those used by the Nuclear Regulatory Commission in licensing and require similar data sets and analyses. Therefore, evaluations relative to the licensing criteria reflect many of the suitability studies. Licensing activities will continue performing site characterization studies to obtain the data required by the licensing process. Selected technical basis reports used in the suitability findings may be incorporated into topical reports or iterative revisions of the annotated outline for a potential license application submitted to the Nuclear Regulatory Commission in the licensing process. Section 4. describes the licensing product area.

1.1.5.5 Management and Compliance

Basic elements associated with normal business functions, and compliance with Federal, State, and local statutes are included in this category. This function also provides for special allocations required to support the external interactions necessary to support external agencies and the public in their review of and interactions with the ongoing site investigation process at Yucca Mountain. Section 5. describes the management and compliance product area.

1.2 YUCCA MOUNTAIN PROJECT PROGRAM APPROACH MAJOR METRICS

Figure 1-1 shows the major metrics for the Site Suitability, National Environmental Policy Act compliance process, and the Licensing program. In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less tangible in processes such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions. Additional, more detailed milestone schedules for the Yucca Mountain Site Characterization Project are provided in Sections 2.5, 3.5, and 4.5.

1.3 PROGRAMMATIC STRATEGY AND COST PROFILE

1.3.1 Programmatic Strategy

The priority given to any Project activity is based on its contribution to meet the objectives of the four major products. This prioritization will require assessments of both technical and programmatic risks. The Program approach provides that decisions affecting technical site suitability evaluation are separate and earlier than decisions affecting either the institutional acceptance of the site-specific Environmental Impact Statement or the Nuclear Regulatory Commission's acceptance of portions of the License Application. Therefore, Project resources can be focused more effectively on the respective technical topics, findings, reviews, and decisions. Technical risk will decrease as the Project proceeds from the first guideline compliance assessment (described in Section 2.) within the Site Suitability product area to performance confirmation within the Licensing product area. The challenge is to balance the programmatic risk, that is, conserve Project resources to allow the Director of the Office of Civilian Radioactive Waste Management to make timely technical decisions, anticipate future technical issues, and allocate resources to address them.

When this plan is developed into a long-range plan with greater scope, schedule, and cost detail, the long-range plan will refine projected costs for each subelement supporting any of the four products. A programmatic risk assessment will be included; specifically, a range of costs will be provided to match a range of risks. For example, for greater expenditure on a given activity, the risk of technical uncertainty may be lowered. However, trade-offs will have to be made between technical uncertainty and risk and funding availability. The reference cost profile is the fiscal year 1995 Office of Civilian Radioactive Waste Management budget totals for fiscal years 1996 to 2000. The fiscal year 1995 cost profile is based on the actual budget allocation. This approach ensures that the cost-risk decisions are not made for any one year in isolation.

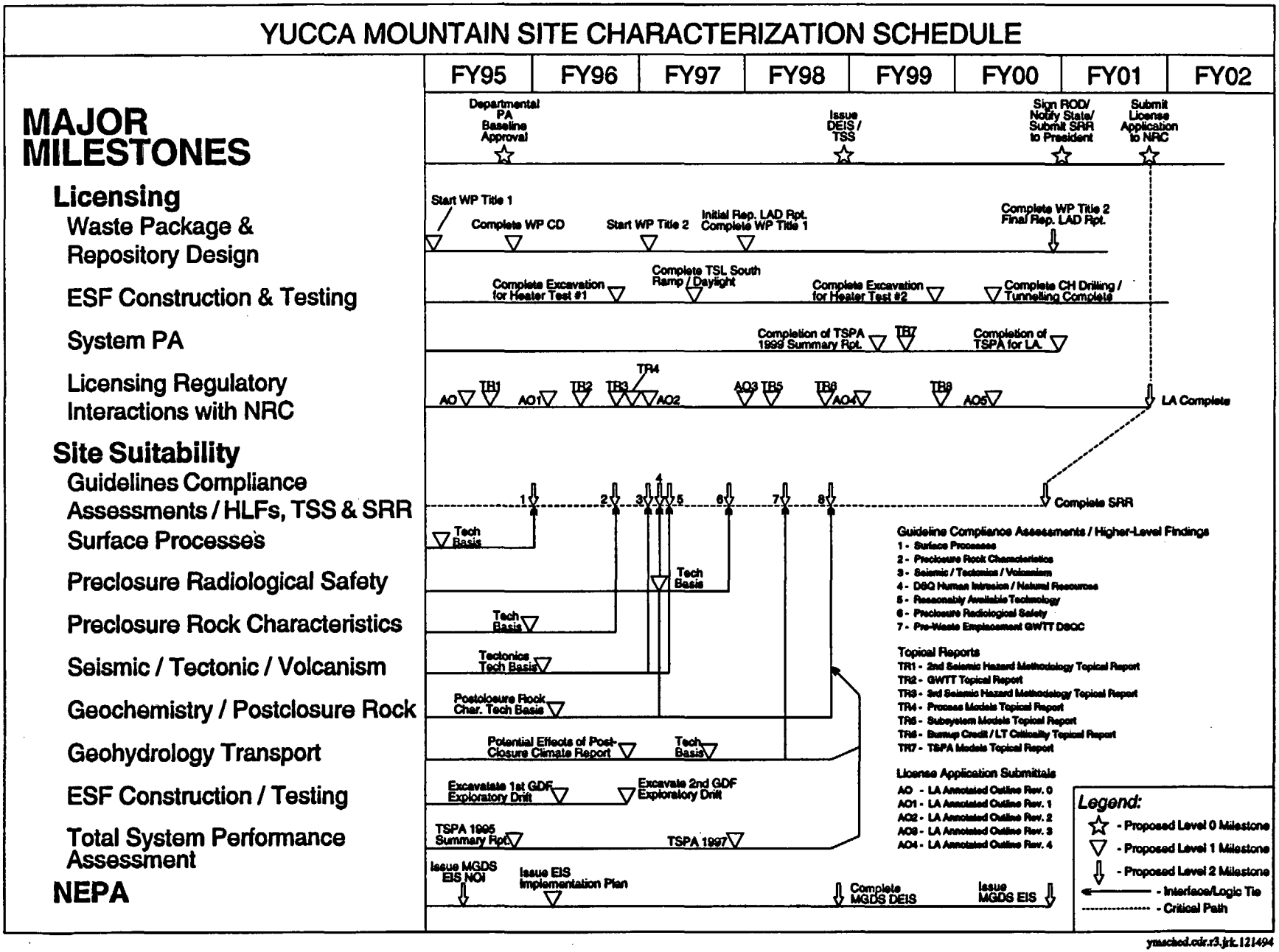
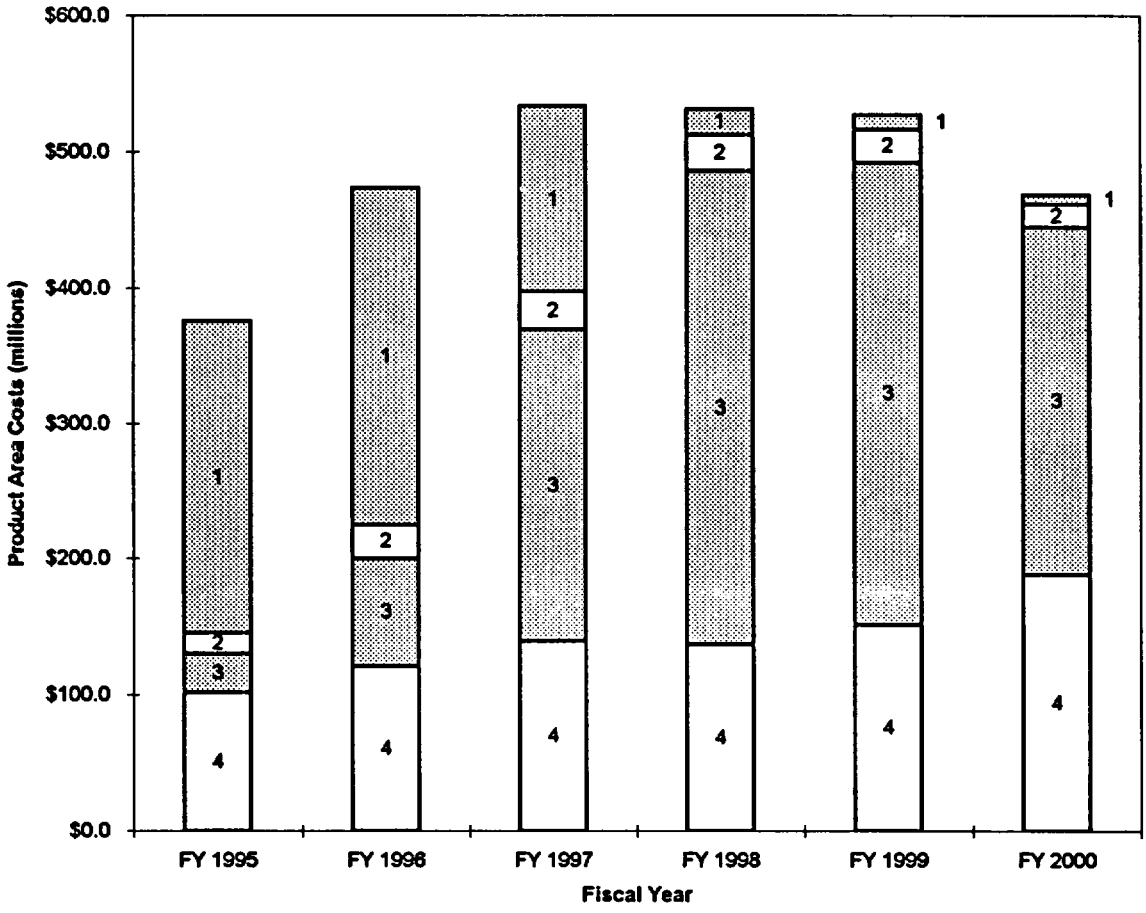


Figure 1-1. Major Metrics

1.3.2 Cost Profile

Figure 1-2 shows the cost profile for this plan for each of the four products: site suitability; National Environmental Policy Act activities; licensing; and management and compliance. A detailed mapping of these costs to the Project Work Breakdown Structure is contained in Appendix A.



Product Totals (millions)		Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1	Site Suitability	$230.3	$248.7	$136.1	$18.6	$10.9	$7.2	$651.8
2	National Environmental Policy Act (NEPA)	$15.2	$25.3	$28.2	$26.8	$24.0	$16.9	$136.4
3	Licensing	$28.7	$79.2	$230.0	$348.8	$340.6	$256.4	$1,283.7
4	Management & Compliance	$101.2	$120.5	$138.9	$136.9	$151.3	$188.1	$836.9
	Total:	$375.4	$473.7	$533.2	$531.1	$526.8	$468.6	$2,908.8

Figure 1-2. Cost Profile for Plan

2. SITE SUITABILITY PROGRAM

2.1 INTRODUCTION

The site suitability program consists of those site characterization, design, and performance assessment activities that are required to develop the data and analyses necessary to support a stepwise evaluation of the suitability or unsuitability of the Yucca Mountain site. The final determination of site suitability or unsuitability will be made in fiscal year 2000 in accordance with the Department of Energy's siting guidelines, 10 CFR Part 960 (see Section 2.2.1).

Site characterization activities include surface-based testing and testing in the Exploratory Studies Facility. The results of these testing activities will provide part of the technical basis that will be used to evaluate the Yucca Mountain site with respect to 10 CFR Part 960. Support activities, such as technical data management and regulatory activities, are also included in the site suitability program to provide traceability and consistency in the analyses and regulatory evaluations that are completed for the site suitability program.

Waste package and repository design activities include the development of design concepts to support the site suitability issues related to preclosure systems guidelines for radiological safety and reasonably available technology and the postclosure system guideline that addresses long-term performance of the geologic repository system (see Section 2.2.1).

Design and construction activities associated with Exploratory Studies Facility drifting in 1996 to complete the first two access drifts to the Ghost Dance fault are included in the site suitability program as shown in Figure 2-1. The results of testing in the first access drift to the Ghost Dance fault will be used to evaluate the hypothesis that this fault may provide a preferential flow path in the unsaturated zone. This hypothesis is a key issue that must be addressed in the evaluation of 10 CFR Part 960 (see Section 2.2.1).

Systems engineering studies that support the design activities and construction of the Exploratory Studies Facility are also included in the site suitability program.

2.2 SITE SUITABILITY OBJECTIVES

2.2.1 Background

The evaluation of site suitability comprises those activities, analyses, and assessments that are required to enable the Department of Energy to evaluate the suitability or unsuitability of the Yucca Mountain site for repository development. A stepwise evaluation of site suitability or unsuitability will be made with respect to the postclosure siting guidelines set forth in Subpart C and the preclosure siting guidelines set forth in Subpart D of 10 CFR Part 960, which are listed and described in Tables 2-1 through 2-4.

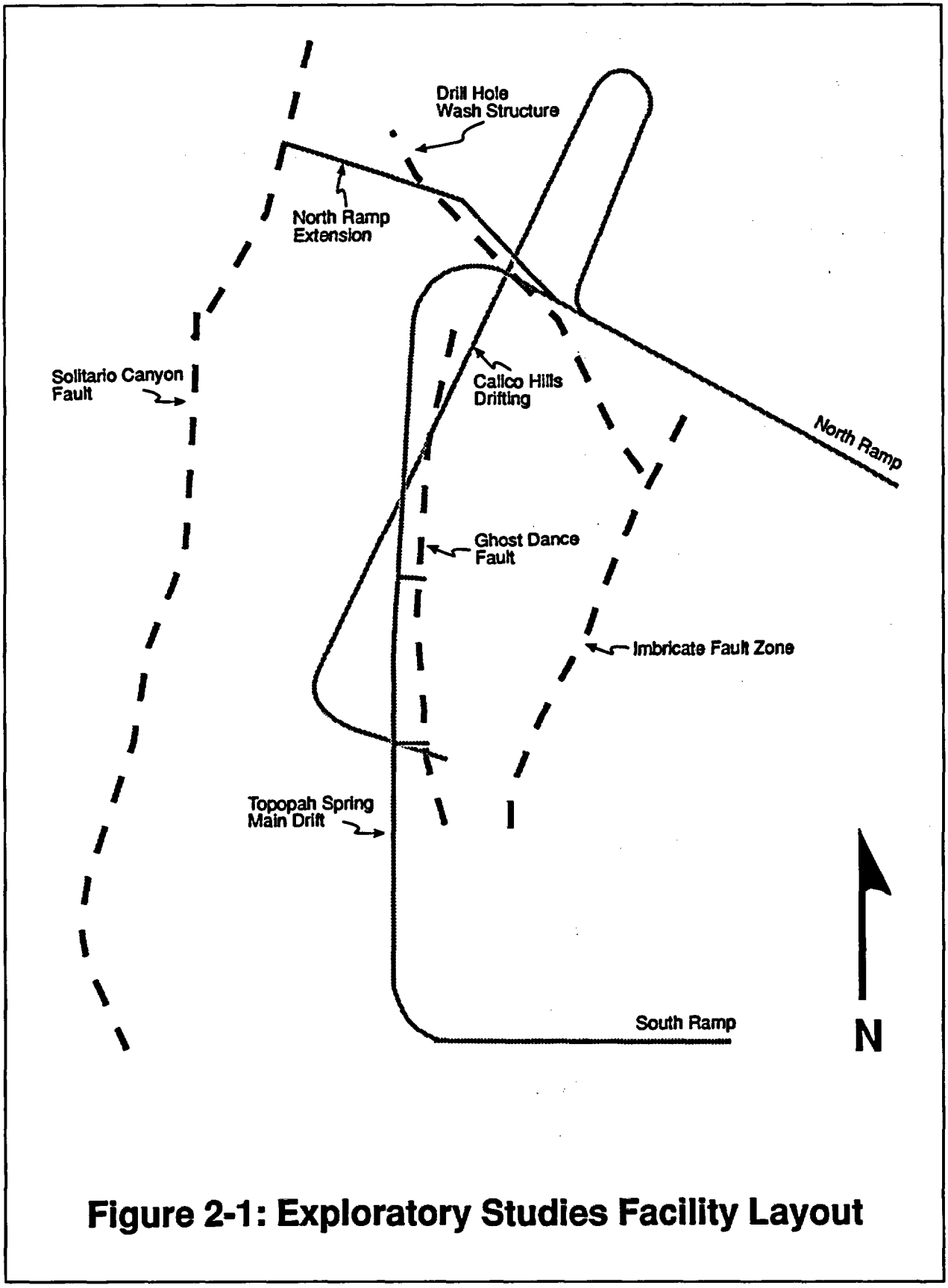


Figure 2-1: Exploratory Studies Facility Layout

Figure 2-1. Exploratory Studies Facility Layout

Table 2-1. Postclosure Guideline Descriptions From the Siting Guidelines in 10 CFR Part 960, Subpart C

Guideline	Condition	Description
System Guideline	Qualifying	Postclosure performance meets regulatory standards
Technical Guidelines		
Geohydrology	Qualifying	Geohydrologic setting is compatible with waste containment and isolation
	Disqualifying	Ground-water travel time is less than 1,000 years along paths of likely and significant radionuclide travel
Geochemistry	Qualifying	Geochemical characteristics are compatible with waste containment and isolation
Rock Characteristics	Qualifying	Rock characteristics will accommodate thermal, chemical, mechanical, and radiation stresses
Climatic Changes	Qualifying	Future climate is not likely to lead to releases greater than regulatory limits
Erosion	Qualifying	Erosion is not likely to lead to releases greater than regulatory limits
	Disqualifying	Site conditions preclude 200 m overburden above the repository
Dissolution	Qualifying	Dissolution is not likely to lead to releases greater than regulatory limits
	Disqualifying	Active dissolution could result in loss of waste isolation
Tectonics	Qualifying	Future tectonic processes and events are not likely to violate release limits
	Disqualifying	Fault movements are expected to cause loss of waste isolation

Table 2-1. Postclosure Guideline Descriptions From the Siting Guidelines in 10 CFR Part 960, Subpart C (Continued)

Guideline	Condition	Description
Human Interference		
Natural Resources	Qualifying	Natural resources are not likely to cause interference activities that could lead to releases greater than regulatory limits
	Disqualifying	1. Previous exploration has created significant pathways 2. Activities outside the controlled area are expected to lead to loss of waste isolation
Site Ownership and Control	Qualifying	Department of Energy can obtain ownership, surface and subsurface rights, and control of access

Table 2-2. Preclosure Radiologic Safety Guideline Descriptions From the Siting Guidelines in 10 CFR Part 960, Subpart D

Guideline	Condition	Description
System Guideline	Qualifying	Preclosure exposures meet applicable safety standards
Technical Guidelines		
Population Density and Distribution	Qualifying	1. Doses to highly populated areas are not likely to exceed small fraction of limits 2. Doses to any member of public in unrestricted area is not likely to exceed limits
	Disqualifying	1. Site located in a highly populated area 2. Site located adjacent to a one-square-mile area with population greater than 1,000 3. Department of Energy cannot develop emergency preparedness program
Site Ownership and Control	Qualifying	Department of Energy can obtain ownership, surface and subsurface rights, and control of access
Meteorology	Qualifying	Meteorological conditions are not likely to lead to releases above limits
Offsite Installations and Operations	Qualifying	Effects from offsite facilities can be accommodated and will not lead to releases above limits
	Disqualifying	Irreconcilable conflicts with atomic energy defense activities are expected

Table 2-3. Preclosure Ease and Cost of Siting, Construction, Operation, and Closure Guideline Descriptions From the Siting Guidelines in 10 CFR Part 960, Subpart D

Guideline	Condition	Description
System Guideline	Qualifying	Repository siting, construction, operation, and closure will be feasible using reasonably available technology
Technical Guidelines		
Surface Characteristics	Qualifying	Can be accommodated using reasonably available technology
Rock Characteristics	Qualifying	1. Thickness and lateral extent are adequate 2. No undue hazards to personnel are expected 3. Reasonably available technology will be adequate
	Disqualifying	Presence of significant risk to health and safety of personnel taking into account possible mitigation using reasonably available technology
Hydrology	Qualifying	1. Setting is compatible with repository development 2. Liners and seals will function as designed 3. Reasonably available technology will be adequate
	Disqualifying	Expected ground-water conditions require engineering measures beyond reasonably available technology
Tectonics	Qualifying	Expected tectonic activity can be accommodated with reasonably available technology
	Disqualifying	Expected fault movement will require engineering measures beyond reasonably available technology

Table 2-4. Preclosure Environmental Quality - Socioeconomic Impacts - Transportation Guideline Descriptions From Siting Guidelines in 10 CFR Part 960, Subpart D

Guideline	Condition	Description
System Guideline	Qualifying	Public and environment are adequately protected
Technical Guidelines		
Environmental Quality	Qualifying	Environmental quality is adequately protected
	Disqualifying	1. Environment cannot be adequately protected or impacts acceptably mitigated 2. Site is located within protected area 3. Irreconcilable conflicts are expected with a protected area
Socioeconomic Impacts	Qualifying	Impacts can be offset by reasonable mitigation or compensation
	Disqualifying	Significant reduction in water quality / quantity at offsite sources is expected
Transportation	Qualifying	1. Access routes will not cause irreconcilable conflicts with a protected area 2. Routes can be designed with reasonable available technology 3. No extreme performance standards are required 4. No unacceptable risks or environmental impacts are expected

The postclosure guidelines address the ability of the geologic setting of the site to contain and isolate radioactive waste in conjunction with the engineered barrier system after permanent closure of the repository. These guidelines are divided into one system guideline and eight technical guidelines. The system guideline concerns the overall performance of the geologic repository system after permanent closure. The technical guidelines refer to specific aspects of the geologic setting of the site.

The preclosure guidelines address factors that could affect the public, the environment, or workers during siting, construction, and operation of the repository prior to permanent closure. The preclosure guidelines consist of three system guidelines and eleven technical guidelines.

Each system and technical guideline consists of a qualifying condition and, for some but not all of the technical guidelines, one or more disqualifying conditions. In order to recommend a site as suitable for repository development, 10 CFR Part 960 requires a positive "higher-level finding" for each of the qualifying and disqualifying conditions. A positive higher-level finding can be supported when: (1) a disqualifying condition can be shown to be not present at the site and additional information is unlikely to change the conclusion; or (2) a qualifying condition can be shown to be present and additional information is unlikely to change the conclusion. The Secretary of Energy may determine that a site is unsuitable for repository development if either (1) a disqualifying condition is present at the site; or (2) a qualifying condition cannot be met at the site.

2.2.2 Objectives

The overall objective of the site suitability program is to conduct those site studies and perform those analyses and evaluations necessary to enable the Director to reach findings for the qualifying and disqualifying conditions of 10 CFR Part 960 and, if the site appears to be suitable, to develop a Site Recommendation Report by fiscal year 2000.

Specific objectives to achieve this goal are to provide demonstrable measures of progress towards a site suitability conclusion during site characterization that will be provided to the various program stakeholders. To measure progress in evaluating site suitability, a phased approach to the evaluation of compliance with the siting guidelines is planned. Individual guidelines or group of guidelines will be evaluated during site characterization (Figure 2-2). Each guideline evaluation will provide an interim measure of progress towards of compliance with 10 CFR Part 960. This approach must also be amenable to future refinements to enhance efficiency and cost effectiveness.

To achieve these objectives, the Department of Energy will complete a technical site suitability evaluation in fiscal year 1998 that will examine the postclosure guidelines related to waste isolation and the preclosure guidelines related to radiological safety and technical feasibility (Tables 2-1 through 2-3). The Department of Energy will complete an evaluation of the remaining guidelines addressing environmental quality, socioeconomic impacts, and transportation in fiscal year 2000 (Table 2-4). This evaluation will be based on information developed through the National Environmental Policy Act process to support the final Repository Environmental Impact Statement in fiscal year 2000.

Site Suitability Evaluation Schedule

(Note: A number shown below associated with Guideline Compliance Assessment indicates the number of qualifying and disqualifying conditions evaluated; see Table 2-5).

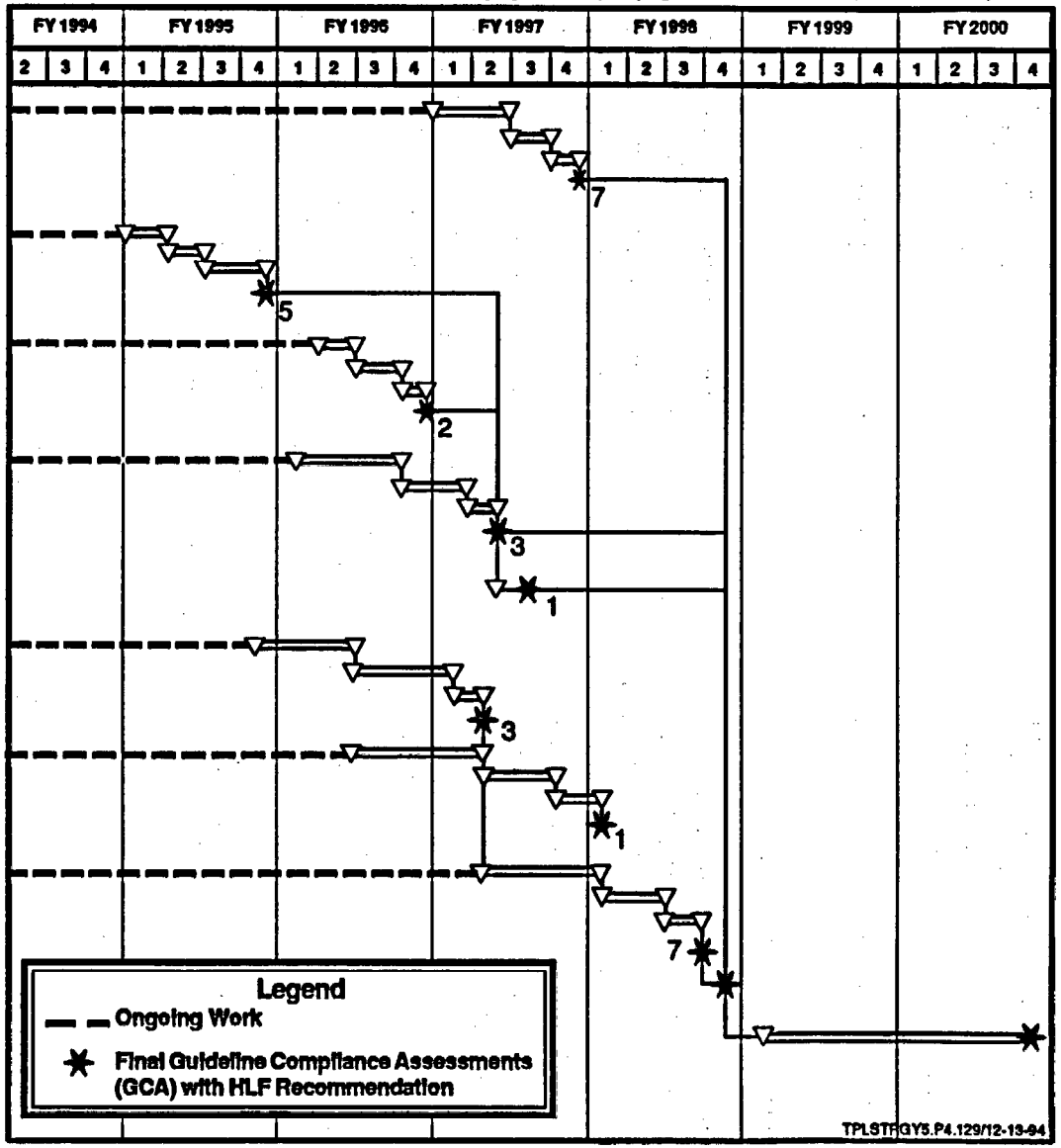


Figure 2-2. Technical Site Suitability Waterfall

If the site is determined to be suitable with respect to all of the siting guidelines, a decision to recommend the site is expected in fiscal year 2000. This decision will be based on the technical site suitability evaluation, the final Repository Environmental Impact Statement, input from the Nuclear Regulatory Commission and stakeholders (as required by Section 114 (a) of the Act, as amended), and other relevant information.

2.3 STRATEGY FOR ACHIEVING SITE SUITABILITY OBJECTIVES

2.3.1 Background

The previous program strategy planned an evaluation of site suitability based on an evaluation of all the 10 CFR Part 960 siting guidelines at the end of site characterization. All aspects of the site exploration and in-situ testing program were to be substantially completed before a site suitability finding and a License Application to construct a repository were completed. One of the difficulties with this approach is that it provided no measure of progress towards evaluating site suitability during site characterization that is clearly understandable by the various program stakeholders. In the Program approach, the Department of Energy will complete a sequence of interim evaluations of specific siting guidelines that measure progress towards a Department of Energy determination of site suitability or unsuitability according to 10 CFR Part 960 siting guidelines. The interim evaluations represent milestones that are within control of the Department of Energy and provide an opportunity to interact with stakeholders both to clarify the progress of the suitability evaluation and to clearly communicate the technical and regulatory bases for the suitability evaluation. In addition, it allows the Department of Energy flexibility in monitoring and adjusting the process, and provides documentation for the decision-making process that will be both sufficient and defensible in various arenas.

2.3.2 Site Suitability Strategy

The Department of Energy proposes to conduct the technical site suitability evaluation through a sequence of interim technical basis reports and guideline compliance assessments according to the schedule shown in Figure 2-2. Each technical basis report and guideline compliance assessment will address a set of one or more of the system or technical guidelines, which will be grouped according to technical discipline. The technical basis reports and the associated guidelines findings are listed in Table 2-5.

A technical basis report will be prepared to provide the data and results of analyses conducted as part of site characterization that support the evaluation of the relevant qualifying and disqualifying conditions. The technical basis report will contain a current understanding of the subject area, including evaluations of uncertainties, alternative models or interpretations permitted by the data, and bounds on conditions and processes that are consistent with the current understanding of the subject area. Each technical basis report will be submitted for review by experts external to the Department of Energy and the Yucca Mountain Site Characterization Project. This external review will be managed by the National Academy of Sciences. The National Academy of Sciences will select qualified reviewers and manage the review process.

Table 2-5. Interim Evaluations to be Addressed in the Proposed Site Suitability Decision Schedule (Figure 2-2)

Interim Evaluation Completion Date	Technical Basis Report	Guideline Compliance Assessment	Guideline Reference
Fiscal Year 1995	**Surface Processes**		
	Available Information on erosion, surface characteristics, and hydrology	Postclosure Erosion Qualifying Condition and Disqualifying Condition	§ 960.4-2-5
		Preclosure Surface Characteristics Qualifying Condition	§ 960.5-2-8
		Preclosure Hydrology Qualifying Condition and Disqualifying Condition	§ 960.5-2-10
Fiscal Year 1996	**Preclosure Rock Characteristics**		
	Existing information on rock characteristics and repository design concepts	Preclosure Rock Characteristics Qualifying Condition and Disqualifying Condition	§ 960.5-2-9
Fiscal Year 1997	**Tectonics**		
	Existing information on faulting, seismicity and volcanology; alternate tectonic models; probabilistic seismic hazard analysis for ground motion and faulting.	Preclosure Tectonics Qualifying Condition and Disqualifying Condition	§ 960.5-2-11
		Postclosure Tectonics Disqualifying Condition	§ 960.4-2-7
Fiscal Year 1997	**Reasonably Available Technology**		
	Preceding technical basis reports for surface characteristics, rock characteristics, hydrology, and tectonics; repository design concepts	Preclosure Systems guideline for ease and cost of siting, construction, operations, and closure Qualifying Condition	§ 960.5-2-8, 5-2-9, 5-2-10, and 5-2-11

Table 2-5. Interim Evaluations to be Addressed in the Proposed Site Suitability Decision Schedule (Figure 2-2) (Continued)

Interim Evaluation Completion Date	Technical Basis Report	Guideline Compliance Assessment	Guideline Reference
Fiscal Year 1997	**Geochemistry and Postclosure Rock Characteristics** Available information on rock and mineral distribution, mineral alteration history, ground-water chemistry, sorption characteristics, rock mechanical properties, and natural resources	Postclosure Human Interference Disqualifying conditions and Site Ownership and Control Qualifying Condition The postclosure qualifying conditions for geochemistry, rock characteristics, and human interference will be considered under the regulatory assessment for Total System Performance Assessment	§ 960.4-2-2 § 960.4-2-3 § 960.4-2-8
Fiscal Year 1997	**Preclosure Radiological Safety** Available information on population density and distribution, site ownership and control, meteorology, offsite installations and operations; repository design concepts; dose assessment calculations	Preclosure radiologic safety system guideline Qualifying Condition Population Density and Distribution Qualifying Condition and Disqualifying Condition Site Ownership and Control Qualifying Condition Meteorology Qualifying Condition Offsite Installations and Operations Qualifying Condition and Disqualifying Condition	§ 960.5-1(a) § 960.5-2-1 § 960.5-2-2 § 960.5-2-3 § 960.5-2-4
Fiscal Year 1998	**Geohydrology and Transport** Potential Climate Change Impacts on Radionuclide Transport, Geochemistry Impacts on Radionuclide Transport, Ground-Water Travel Time along Radionuclide Transport Pathways	Postclosure Geohydrology Disqualifying Condition	§ 960.4-2-4 § 960.4-2-3 § 960.4-2-1

Table 2-5. Interim Evaluations to be Addressed in the Proposed Site Suitability Decision Schedule (Figure 2-2) (Continued)

Interim Evaluation Completion Date	Technical Basis Report	Guideline Compliance Assessment	Guideline Reference
Fiscal Year 1998	**Total System Performance Assessment** Total System Performance Assessment 1997 and the preceding technical basis documents for geohydrology, geochemistry, rock characteristics, climate, and tectonics; waste package and repository design concepts	Postclosure System Guideline Qualifying Condition: System and Subsystem Requirements of 10 CFR Part 60 and 40 CFR Part 191 Postclosure Qualifying Conditions for Geohydrology, Geochemistry, Rock Characteristics, Climate, Human Interference and Tectonics	§ 960.4-1 § 960.4-2-1 § 960.4-2-2 § 960.4-2-3 § 960.4-2-4 § 960.4-2-7
Fiscal Year 1998	**Technical Site Suitability Evaluation** Collation of Preceding Technical Basis Documents	Technical Site Suitability Evaluation; collation of preceding regulatory assessments	Not A 10 CFR Part 960 Requirement
Fiscal Years 1999-2000	Environmental, Socioeconomic and Transportation Technical basis	Environmental Quality Qualifying and Disqualifying Condition Socioeconomic Qualifying and Disqualifying Conditions Transportation Qualifying Condition	§ 960.5-2-5 § 960.5-2-6 § 960.5-2-7
Fiscal Year 2000	**Site Recommendation Report**	Preclosure Environmental Quality Systems Guideline Qualifying Condition Site Recommendation Report	§ 960.5-1-2 § 960.3-2-4

Following review and evaluation of review comments, the Yucca Mountain Site Characterization Office will conduct a guideline compliance assessment to determine whether the data and information are sufficient to support higher level findings on qualifying or disqualifying conditions for a guideline or groups of related guidelines. The technical basis reports, together with the guideline compliance assessments, will provide the basis for the Director of the Office of Civilian Radioactive Waste Management to make a technical site suitability evaluation in fiscal year 1998.

The Program approach involves addressing the requirements of the 10 CFR Part 960 in steps. Technical basis reports for which analyses must be completed that require more comprehensive data are to be addressed later. For example, the 1997 total system performance assessment will provide the technical basis for the assessment of the Postclosure System Guideline and for the Qualifying Conditions of the technical guidelines that have a demonstrated effect on system performance. This occurs later in the technical site suitability evaluation process to allow the performance assessment program to take advantage of available technical data.

The Program approach adds new interim evaluations and allows an acceleration of these evaluations points compared to the Site Characterization Plan. There are several reasons for this acceleration. First, the Program approach separates by a minimum of three years evaluations of the technical aspects of site suitability from the License Application and allows program resources to be focused sequentially and more effectively on the respective topics. Second, the Program approach uses conservative and/or bounding assumptions on site conditions and processes to evaluate the suitability of the site as early as possible. These uncertainty bounds will be reexamined in the License Application when additional site characterization data and refined models are available. Third, while maintaining the existing focus on the natural barriers, the use of conservative and/or bounding assumptions on site conditions and processes can be used to evaluate the suitability of the site.

2.4 SITE SUITABILITY ASSUMPTIONS

The plan for the site suitability program is based on the following assumptions:

1. Access to the Calico Hills unit is not needed for a technical site suitability evaluation in 1998. In fiscal year 1995, a systems study will be conducted to provide an analysis of the issues associated with access to the Calico Hills nonwelded unit, identifying the potential data needs. The result of the systems study will help determine data needs from the Calico Hills formation, and will recommend means of access to obtain the data. In the currently planned time frame of 1999-2000, Calico Hills drifting is considered to be a licensing activity. It would include 5300 meters of tunnel excavated by tunnel boring machine from the north ramp of the exploratory studies facility. If the systems studies results indicated that Calico Hills exploration is needed sooner, or recommends a different means of access, it would require reprioritization and replanning of activities.

2. The new Environmental Protection Agency Standard will be similar to the voided one, but will enable compliance with a reasonable repository design and performance analyses, especially regarding Carbon-14 requirements.

2.5 SITE SUITABILITY PLAN

This section summarizes the plan for site suitability. The major milestones that support the plan for site suitability are shown in Figure 2-3. If the site suitability process results in positive higher-level findings with respect to the guidelines of 10 CFR Part 960; and if the remaining guidelines - environmental quality, transportation and socioeconomic impacts - are assessed and positive higher level findings result in the 1999 time frame the suitability element of the Program approach would produce a Site Recommendation Report in fiscal year 2000.

All activities assume support from performance assessment to provide sensitivity and uncertainty analyses to quantify risk wherever needed and appropriate.

2.5.1 Fiscal Year 1995 ($204.0M)

The evaluation of site suitability in fiscal year 1995 will address higher level findings on the Surface Processes guideline group, which includes evaluations of siting guidelines for preclosure hydrology, erosion, and surface characteristics. Addressing the higher level findings will entail preparation of a technical basis report on surface processes giving the data, interpretations, and analyses that will support the higher level findings. An external technical review will be conducted to assess the adequacy of the technical basis report, and a guideline compliance assessment with recommendations to the Director will be completed for this guideline group.

Drilling activities (WBS 1.2.3.5) will include drilling of one unsaturated-zone hole to provide hydrologic information, two systematic drilling holes to provide design input and rock characteristics information; one water table hole to provide information on the uppermost saturated zone; and packer installations to support aquifer tests at the C-well complex that are expected to provide input to the calculation of ground-water travel time. The Sample Management Facility will provide curatorial and core logging support.

Underground mapping, hydrochemistry, hydrology and major fault tests in the exploratory studies facility will continue as tunnel boring proceeds. Integration of surface based testing activities with exploratory studies facility activities and the technical, schedule and cost baseline will continue.

New site data from surface based testing, exploratory studies facility construction and testing, waste package and repository advanced conceptual design will be integrated and evaluated. Laboratory and field experiments of fluid flow and contaminant transport will continue.

Integration of performance assessment with site characterization will continue. Coordination and participation in technical/peer reviews and interactions with the Nuclear Regulatory Commission, Nuclear Waste Technical Review Board, Advisory Committee on Nuclear Waste, and similar organizations will be supported. Testing, construction and design functions will continue to be supported through appropriate waste isolation and other analyses as required.

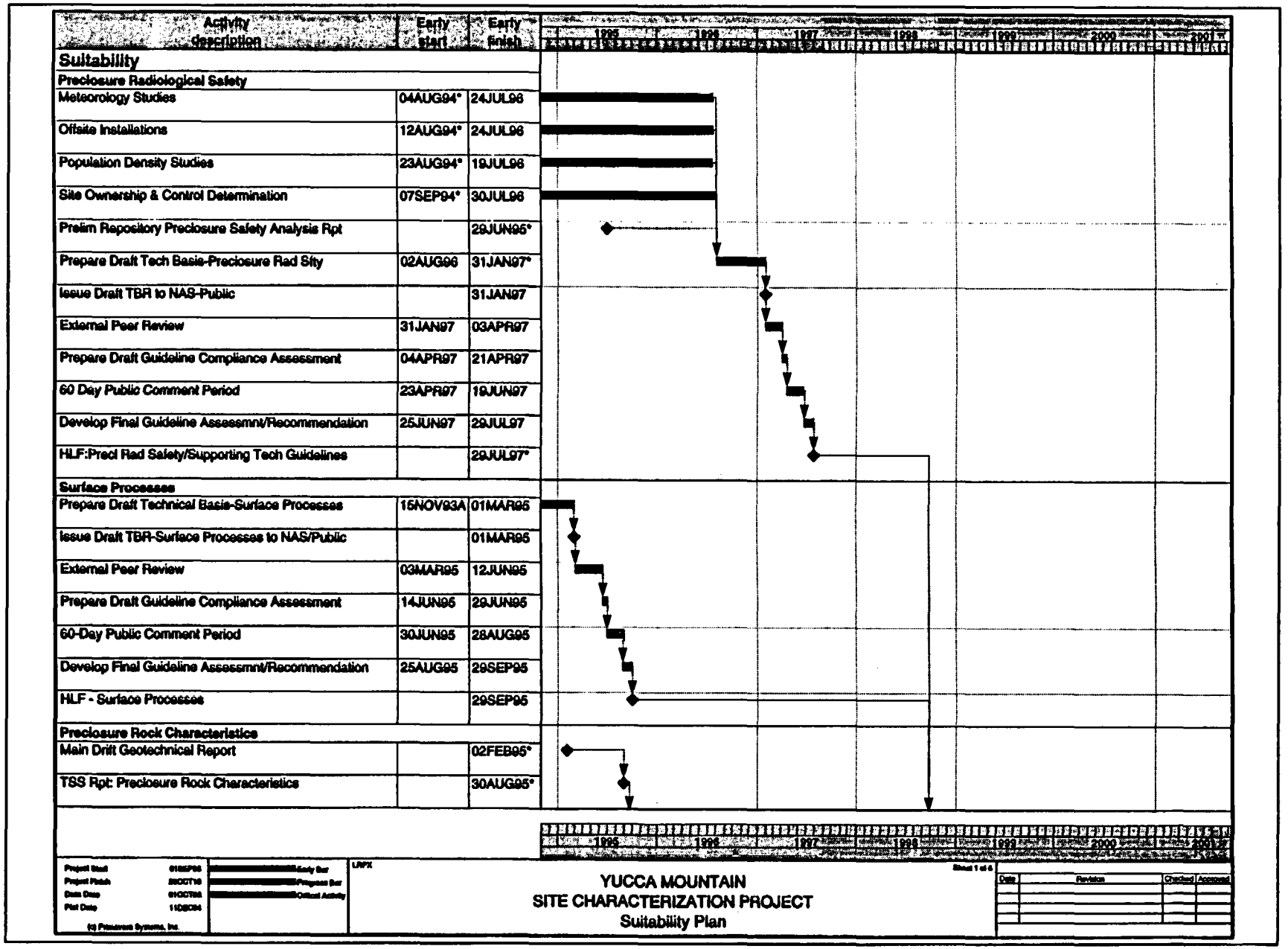
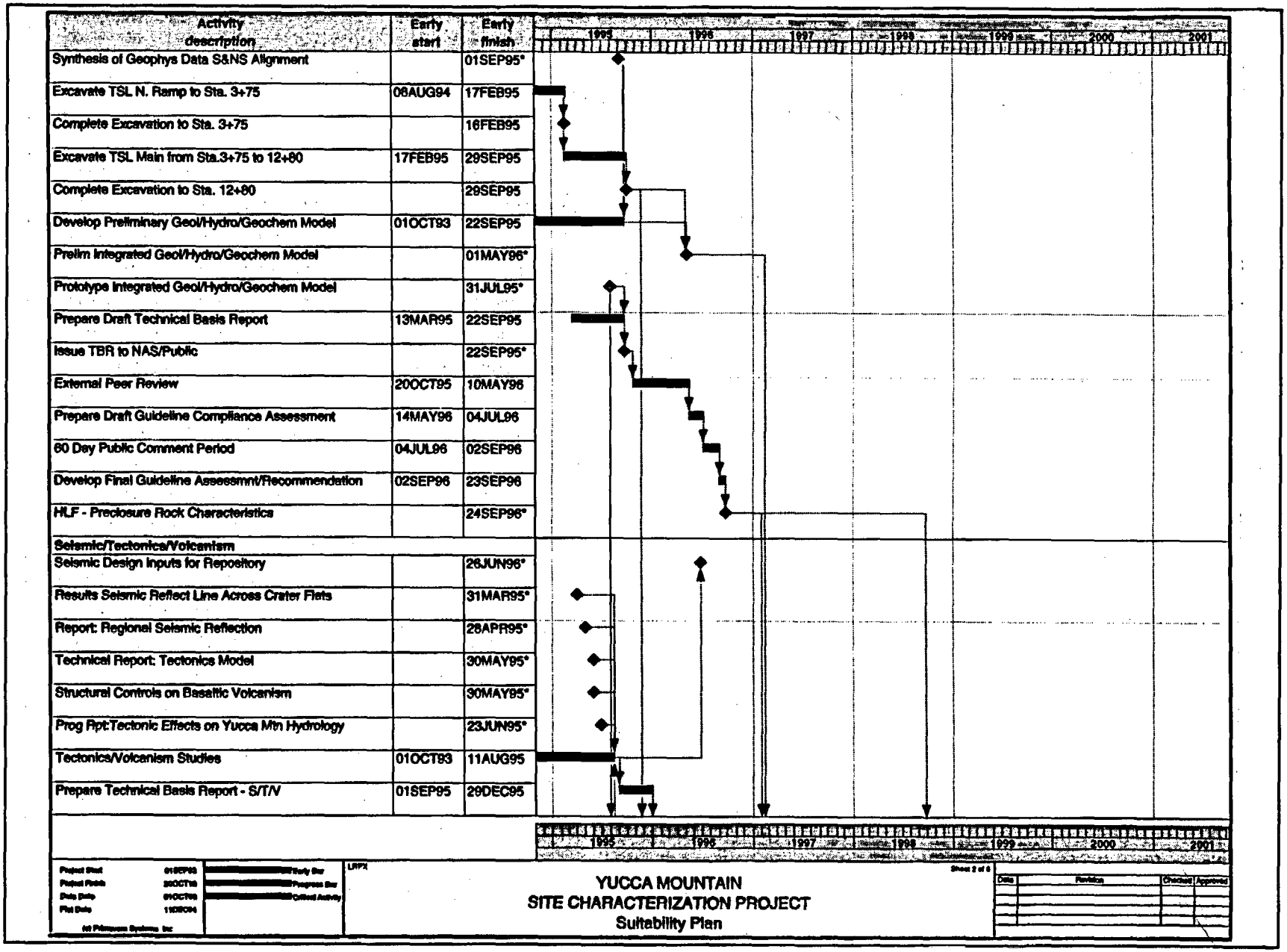


Figure 2-3. Technical Site Suitability Schedule



Activity description	Early start	Early finish
Synthesis of Geophys Data S&NS Alignment		01SEP95*
Excavate TSL N. Ramp to Sta. 3+75	08AUG94	17FEB95
Complete Excavation to Sta. 3+75		16FEB95
Excavate TSL Main from Sta.3+75 to 12+80	17FEB95	29SEP95
Complete Excavation to Sta. 12+80		29SEP95
Develop Preliminary Geol/Hydro/Geochem Model	01OCT93	22SEP95
Prelim Integrated Geol/Hydro/Geochem Model		01MAY96*
Prototype Integrated Geol/Hydro/Geochem Model		31JUL95*
Prepare Draft Technical Basis Report	13MAR95	22SEP95
Issue TBR to NAS/Public		22SEP95*
External Peer Review	20OCT95	10MAY96
Prepare Draft Guideline Compliance Assessment	14MAY96	04JUL96
60 Day Public Comment Period	04JUL96	02SEP96
Develop Final Guideline Assessmnt/Recommendation	02SEP96	23SEP96
HLF - Preclosure Rock Characteristics		24SEP96*
Seismic/Tectonics/Volcanism		
Seismic Design Inputs for Repository		26JUN96*
Results Seismic Reflect Line Across Crater Flats		31MAR95*
Report: Regional Seismic Reflection		28APR95*
Technical Report: Tectonics Model		30MAY95*
Structural Controls on Basaltic Volcanism		30MAY95*
Prog Rpt:Tectonic Effects on Yucca Mtn Hydrology		23JUN95*
Tectonics/Volcanism Studies	01OCT93	11AUG95
Prepare Technical Basis Report - S/T/V	01SEP95	29DEC95

Figure 2-3. Technical Site Suitability Schedule (Continued)

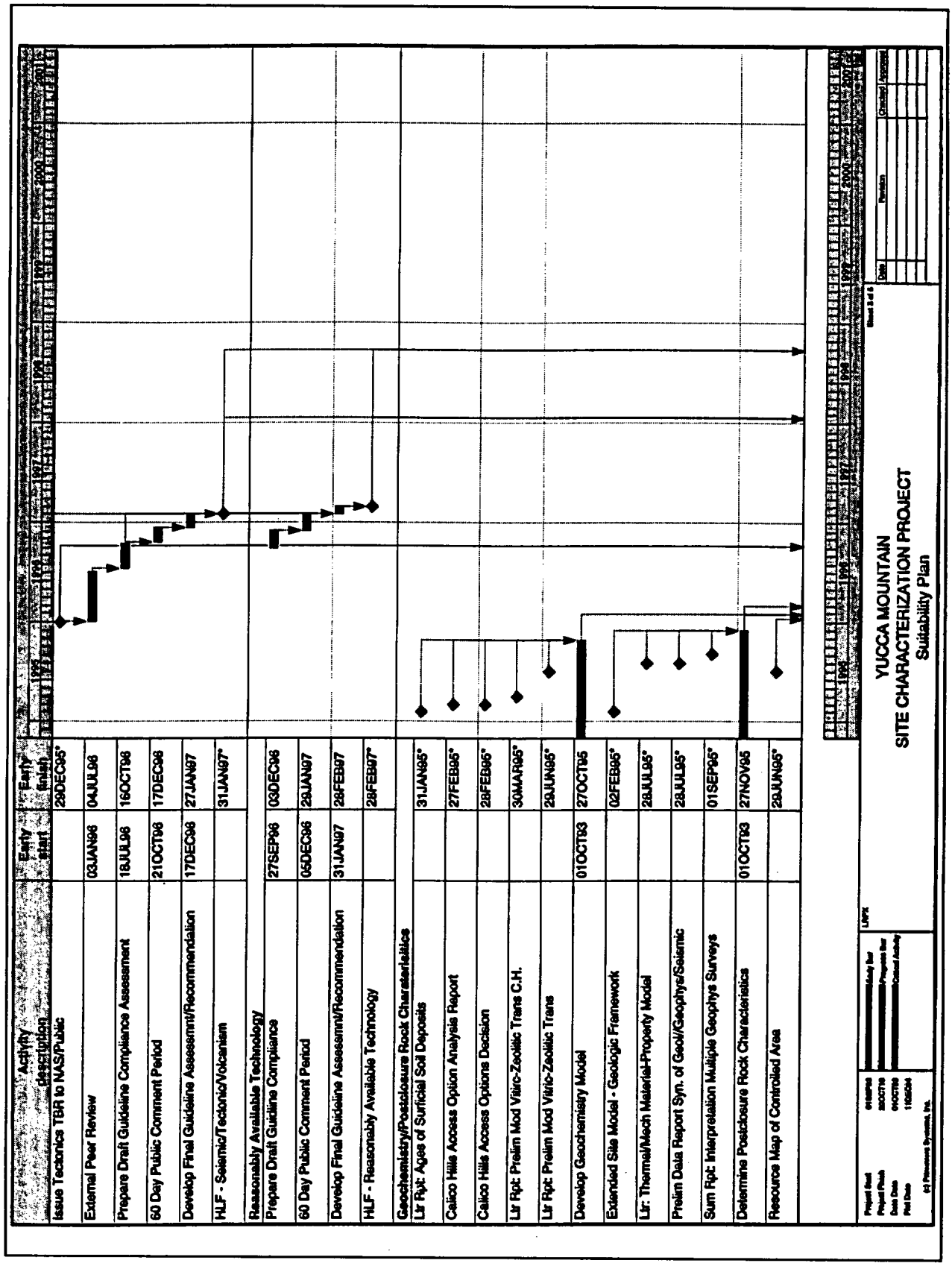


Figure 2-3. Technical Site Suitability Schedule (Continued)

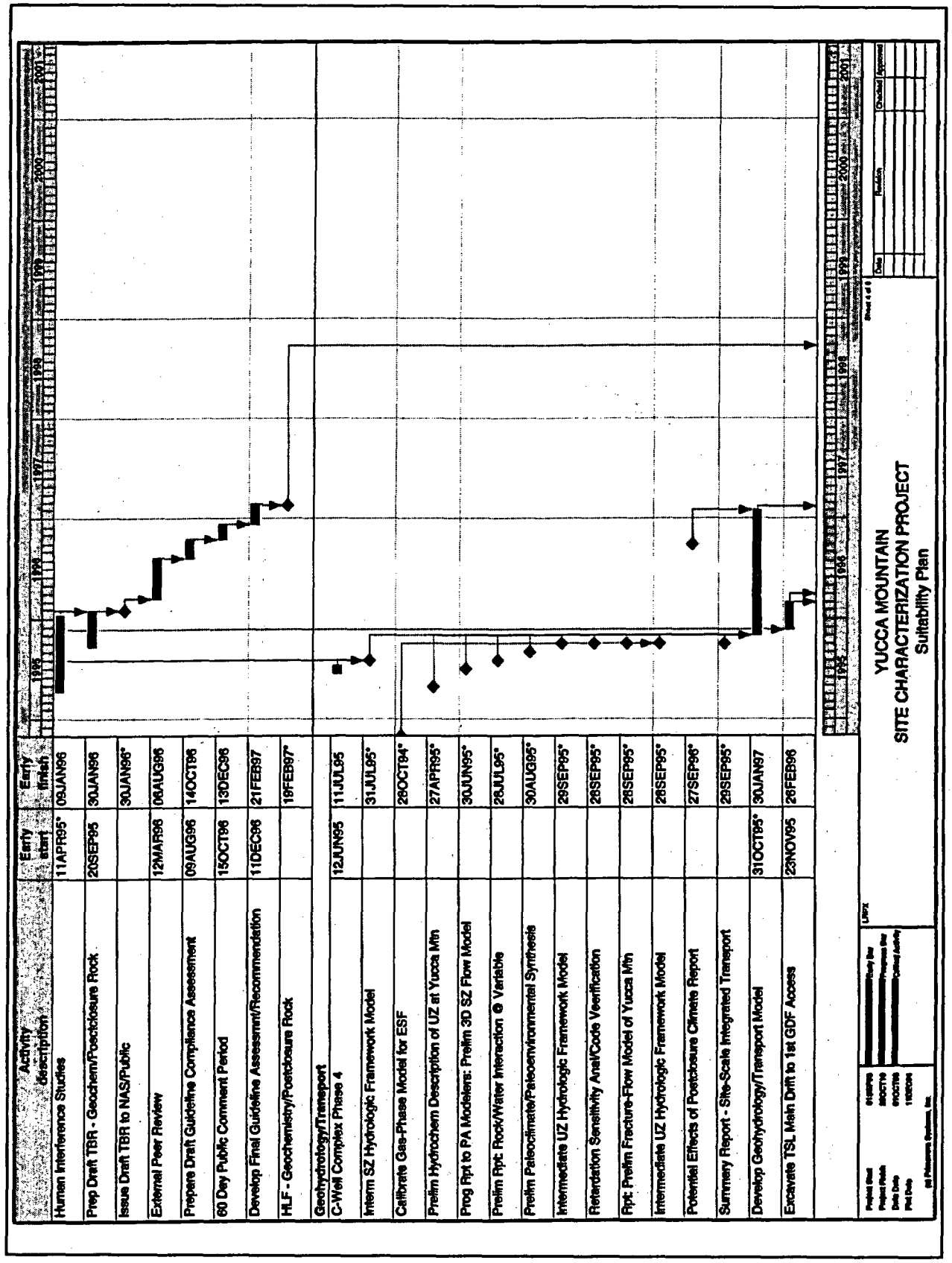


Figure 2-3. Technical Site Suitability Schedule (Continued)

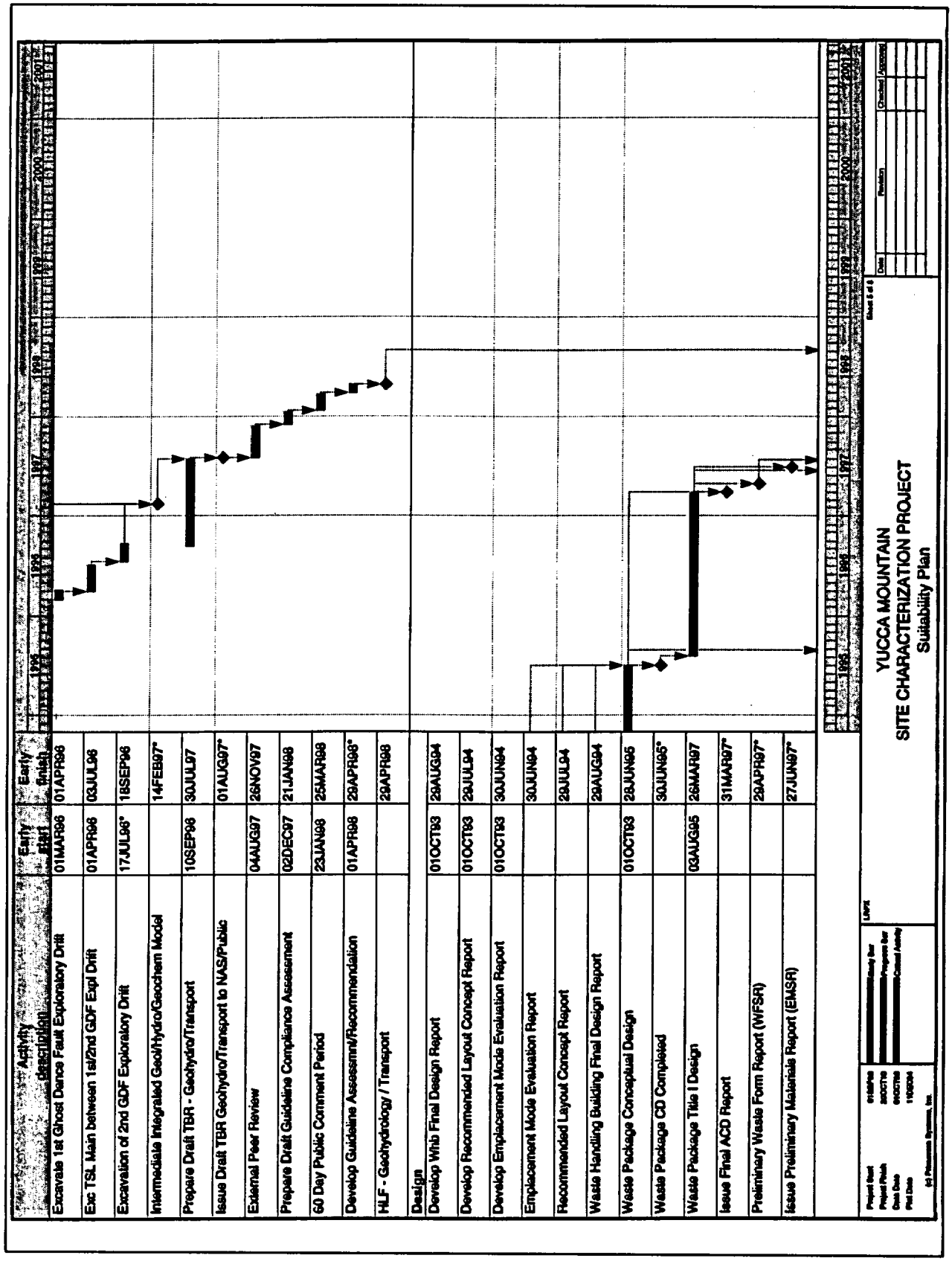


Figure 2-3. Technical Site Suitability Schedule (Continued)

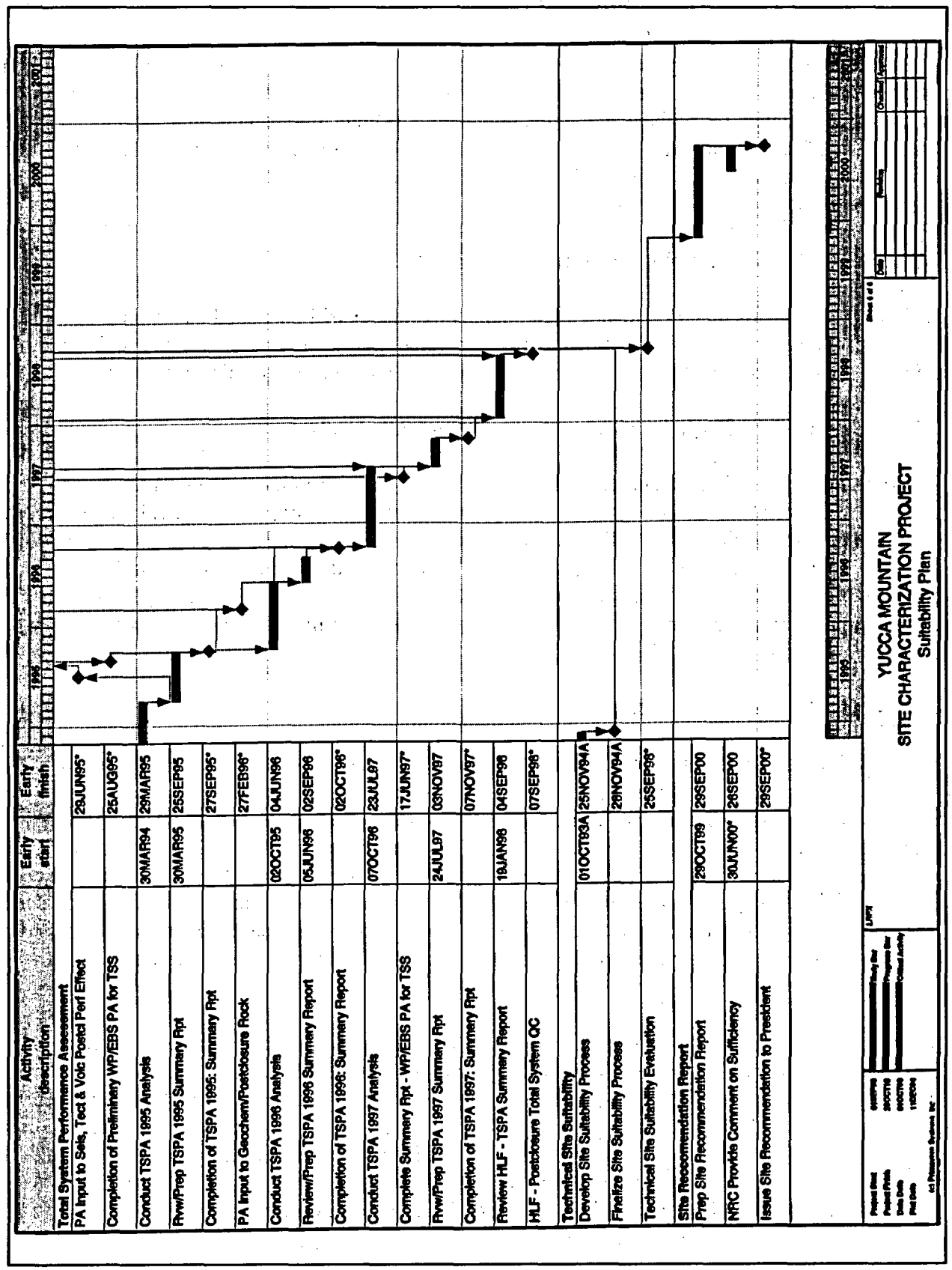


Figure 2-3. Technical Site Suitability Schedule (Continued)

2.5.1.1 Surface Processes (WBS 1.2.5)

A draft Technical Basis Report on the surface processes guideline group will be prepared and an external peer review conducted, followed by preparation of a draft guideline compliance assessment that will be revised if appropriate after a 60-day public comment period. At the conclusion of the comment period, a final guideline assessment and recommendation to the Director will be prepared, which will be the basis for the Director's decision as to whether a higher-level finding is appropriate.

2.5.1.2 Preclosure Radiological Safety (WBS 1.2.13)

A Preliminary Repository Preclosure Safety Analysis Report will be issued based on preliminary analyses of conceptual designs, atmospheric dispersion characteristics of the site and available information on offsite installations, population density, and site ownership and control.

2.5.1.3 Preclosure Rock Characteristics (WBS 1.2.3, 1.2.5)

Geologic mapping and geotechnical characterization of the rock units exposed in the north ramp will provide preliminary information to support development of the technical basis report. Ground support requirements will be refined as excavation proceeds, and the thermochemical response of the rock mass will be established. Drilling and logging, surface and subsurface geologic mapping, geophysical surveys, testing and studies in the laboratory, geotechnical observations and monitoring in the exploratory studies facility, analysis and modeling will provide the information for this technical basis report.

2.5.1.4 Tectonics (WBS 1.2.3, 1.2.5)

The Qualifying Condition for Preclosure Tectonics specifies that the tectonic or volcanic processes during the preclosure period will not require design features beyond reasonably available technology. Fault displacements have occurred during the Quaternary period in the controlled area as shown by the results of field investigations conducted in the 1980s and 1990s, including recurrence information from trenching and geologic mapping. The documented results of these field investigations form the basis for the characterization of potential earthquakes, ground motions, and fault displacements for the Yucca Mountain area. Results from a seismic reflection line across Crater Flat will be reported, and a report on regional seismic reflection will be completed.

In fiscal year 1995, data collection activities to characterize the spatial extent and orientation of Quaternary faults and their history of activity will be completed. Analysis of these data and synthesis of results will continue in fiscal year 1995 to support development of inputs for a seismic hazard analysis in fiscal year 1996. In particular, a ground motion attenuation relation will be developed and a workshop will be held to evaluate the different approaches to ground motion modelling that can be used at Yucca Mountain. The seismic hazard assessment process will be initiated through identification of experts to provide interpretations of the data that will serve as inputs and holding a workshop to familiarize the experts with the data available to support interpretations and evaluate their sufficiency.

To address igneous activity for the Postclosure Tectonics qualifying condition, volcanic hazard studies will continue. The probability bounds and risk simulation modeling for volcanic hazards will continue as required to assess the recurrence rate, the probability of disruption, and the probability of magmatic disruption of the repository, the controlled area, and the region. The magmatic evolution of individual volcanic centers and the Yucca Mountain region will continue to be evaluated. These studies are structured to ensure that probabilistic volcanic risk assessment incorporates geologic constraints on the time-space-volume evolution of basaltic volcanism in the Yucca Mountain region. Geochronologic and geochemical studies will continue. A report on structural controls on basaltic volcanism will be completed, and a progress report on tectonic effects will be provided to support performance assessment.

2.5.1.5 Geochemistry / Postclosure Rock Characteristics (WBS 1.2.1, 1.2.3, 1.2.5)

The qualifying condition for postclosure geochemistry specifies that the present and expected geochemical characteristics of a site will be compatible with waste containment and isolation taking into account the likely chemical interactions among radionuclides, the host rock, and the ground water. In addition, the qualifying condition for postclosure rock characteristics specifies that the present and expected characteristics of the host rock and surrounding units will be capable of accommodating the thermal, chemical, mechanical, and radiation stresses that are expected to be induced by repository construction, operation, and closure and by expected interactions among the waste, host rock, ground water, and engineered components. The qualifying conditions for human interference specify that the natural resources at the site will not be likely to give rise to human interference activities that will lead to releases greater than those allowable by applicable standards. Taken together, these qualifying conditions require information on the stratigraphy, mineralogy, rock properties, chemistry, and ground-water characteristics of the host rock and surrounding units.

An industry standard natural resource exploration study will be completed in fiscal year 1995, and will be supported by a resource map of the controlled area. Analyses of the potential for human intrusion into the repository will be initiated.

Compilation and integration of geologic information will continue to support development of the three-dimensional integrated geologic model of the site. Basic data supporting the model will include structural and lithologic logs for additional deep boreholes in and near the controlled area, results of surface and subsurface geologic mapping and fracture studies and results of surface geophysical studies. Surface-based and exploratory studies facility-based investigations for hydrologic, mineralogic/petrologic, geochemical, and thermal/mechanical characterization of the host rock and surrounding units and field and laboratory tests to examine thermal/mechanical/hydrologic/geochemical processes and their interactions will continue to provide information for the postclosure rock characteristics technical basis report. The prototype integrated model will be completed in fiscal year 1995, providing the geologic framework of the site. A letter report and preliminary model of the vitric-zeolitic transition (an important hydrologic and transport boundary) within the Calico Hills unit will be provided.

2.5.1.6 Geohydrology / Transport (WBS 1.2.3, 1.2.5)

The qualifying condition and disqualifying conditions for the postclosure geohydrology siting guideline are concerned with the compatibility of the geohydrologic system with waste isolation and containment. For the qualifying condition, the present and expected geohydrologic setting of a site shall be compatible with waste containment and isolation. The disqualifying condition specifies that the site will be disqualified if the pre-emplacement ground-water travel time from the disturbed zone to the accessible environment is less than 1,000 years along any pathway of likely and significant radionuclide travel.

To develop data to evaluate these guideline conditions, hydraulic testing in boreholes at the C-wells complex will be initiated and the results analyzed to provide hydrologic-property values for input to the ground-water flow and total-system performance-assessment computational models. Construction-phase testing will continue in the Exploratory Studies Facility and Exploratory Studies Facility alcoves at the Bow Ridge fault and upper contact of the Paintbrush nonwelded unit. Boreholes along the North Ramp and Exploratory Studies Facility construction phase testing will provide data on the hydrologic and chemical effects of excavation. The analysis of paleoenvironmental data collected in southern Nevada and adjacent areas will be completed to provide part of the basis for inferring the range of climatic conditions and the hydrologic effects of climate in the Yucca Mountain region during the Quaternary period.

Monitoring of previously instrumented boreholes in the unsaturated zone will continue, providing information on specific features that may control conditions or processes occurring in the unsaturated-zone hydrologic system. Other activities will include monitoring precipitation and soil moisture to support analysis of rates of infiltration and laboratory analyses of moisture content of core. The site-scale gas-phase model of the unsaturated zone will be calibrated using observed subsurface responses to barometric fluctuations in the atmosphere, and an intermediate saturated zone hydrologic framework model will be provided to support evaluations of ground-water travel time. A preliminary fracture-flow model of Yucca Mountain will be completed to address the issue of preferential flow pathways.

The climate program will provide a preliminary paleoclimate/paleoenvironmental evaluation, while continuing to collect and compile information on present and past climates.

Studies on radionuclide transport parameters will focus on those areas where there is the greatest uncertainty that the qualifying condition for the postclosure geochemistry siting guideline can be met. Investigation of neptunium, plutonium, and uranium will be emphasized. These are the radionuclides for which more refined transport parameters seem most critical due to their long half - lives, high solubility, low sorption, or high uncertainty in sorption mechanisms. Radionuclide sorption, solubility and speciation, colloidal behavior, and diffusion into the rock matrix pore space will be examined. Dynamic transport studies will be conducted to examine the applicability of basic parameters for describing the behavior of solutes in flowing systems in fractured and unfractured rock. Preliminary reports on rock-water interactions and retardation sensitivity analysis and code verification will be provided.

Development of transport models that combine hydrology and transport parameters for the key radionuclides will continue. This information is basic input needed to model the release of radionuclides to the accessible environment.

2.5.1.7 Total System Performance Assessment (WBS 1.2.5)

Important features of the prototype three-dimensional site model, which is to be available early in fiscal year 1995, will be incorporated into process-level and total system-level performance assessment models. Performance assessment will focus on critical site suitability uncertainties. Evaluations of planned surface-based and exploratory studies facility tests will continue. Documentation of scenario event trees and scenario models will continue. Limited detailed-process modeling for justifying assumptions of total system performance assessment codes will continue. Enhancement of fracture-flow capabilities in selected process-level codes will continue. Preparation of performance assessment computer codes for entry into the quality assurance software configuration system will begin. Benchmarking of performance assessment codes and models through participation in international cooperative efforts will continue. Sensitivity studies will be performed to verify appropriateness of higher level model abstractions based on the three-dimensional site model.

A subsystem performance assessment addressing the substantially complete containment and controlled release requirements of 10 CFR Part 60, as cited in 10 CFR 960, will be completed, and input will be provided to guideline evaluations of tectonic effects on expected performance.

2.5.1.8 Data Management (WBS 1.2.5)

Technical data management will continue to compile and assure the consistency and traceability of technical data for the technical site suitability evaluation activities. The Technical Data Management System and the Technical Data Parameter Dictionary will be updated and maintained. The Automated Technical Data Tracking system will be utilized and maintained. The controlled narrative Reference Information Base will be updated and maintained. The GEMBOCHS and Geologic and Environmental Nodal Information Study and Evaluation System components of the Technical Data Base will be updated and maintained. Spatial data analyses and map products will be provided in support of site characterization and design activities.

2.5.1.9 Support Activities: Exploratory Studies Facility Construction (WBS 1.2.6)

The tunnel boring machine will continue along the North Ramp (Figure 2-1). Design for the Topopah Spring Level main drift will be completed. Testing alcoves will be excavated in the vicinity of the Bow Ridge Fault and the upper contact of the Paintbrush nonwelded unit to support geologic and hydrologic evaluations.

2.5.1.9.1 Support Activities: Exploratory Studies Facility Construction Test Support (WBS 1.2.6)

Exploratory Studies Facility Construction Test Support will install and maintain test facilities as required by the testing community. Design for the north portal facilities will be completed, design for the Integrated Data and Control System will continue, and procurement of Integrated

Data and Control System components will be initiated. The balance of utility systems for the north portal pad will be constructed, and the change house/portal control building will be procured and constructed. Design and construction to upgrade the existing 69 kV power system from 10 MVA to 20 MVA capacity will be completed. Muck handling conveyor systems and the first segment of the muck storage area will be constructed. The north portal pad will be extended. Test planning, coordination and construction test support will continue. Ongoing Title III engineering support to construction will be provided. Overall project engineering, construction management and test support will be provided.

2.5.1.9.2 Support Activities: Exploratory Studies Facility Operations and Maintenance (WBS 1.2.6)

Exploratory Studies Facility Operations and Maintenance will take over completed sections of the Exploratory Studies Facility from construction in fiscal year 1995. The cost of Operations and Maintenance will then be carried in the operations budget for the facility. Exploratory Studies Facility equipment and facilities will be operated and maintained.

2.5.1.10 Support Activities: Test Facilities (WBS 1.2.7)

Site facilities and support services for all field activities supporting site characterization will be provided, including: Operations and Maintenance of all site buildings, roads, utilities, and services; access and visitor control services; bus transportation for all field activities; management of the Operations and Maintenance and capital asset systems; transportation and services for public tours; light duty vehicles; rehabilitation/upgrades required to existing facilities and utilities as required for compliance; direct and administrative support to Project participants at the site; field permitting programs; occurrence reporting; energy management programs; Geographic Information System; annual Site Development Plan; and general field engineering support.

2.5.1.11 Waste Package Design (WBS 1.2.2)

Waste package conceptual design will be completed, and waste package preliminary design initiated. Design activities will advance the level of maturity for the waste package design. Low-temperature oxidation and stress-corrosion cracking testing of metallic barrier materials will continue. Long-term corrosion testing and microbiologically-influenced corrosion test development will be initiated.

Degradation model development for metal barriers will continue. Thermogravimetric analysis testing will be performed to define spent fuel oxidation kinetics in the 190 C to 250 C temperature range. Spent fuel dissolution testing and high-level waste glass alteration testing will continue.

Waste package design activities will include detailed evaluations of waste package designs for spent nuclear fuel and defense high-level waste canister concepts. Evaluations will focus on multi-purpose canister and other multi-barrier design concepts for spent nuclear fuel and defense high-level waste. Analyses and evaluations of multi-purpose canister basket designs will be performed to ensure compliance with thermal limits and 10 CFR Part 60 criticality requirements.

Engineering development tasks will investigate remote closure, nondestructive examination/in-service-inspection methods, and stress reduction methods. Analysis/evaluation of waste container extensions to support likely handling procedures will be initiated.

2.5.1.12 Repository Design (WBS 1.2.4)

Advanced Conceptual Design and engineering studies to evaluate surface facilities layouts (nuclear-related), subsurface facilities configurations, thermal loading, emplacement modes, retrieval modes, excavation methods and transportation equipment will be conducted. Support for management, project engineering, and integration of repository Advanced Conceptual Design will be provided. Technical support for Exploratory Studies Facility design and construction will continue.

Design interfaces with surface-based testing and waste package engineering activities will be maintained. Design support for system studies, early site suitability analyses, environmental impact statement, total system life cycle cost, and Nuclear Regulatory Commission Site Characterization Analysis concerns will be provided. Site preparation alternatives and waste treatment process and facility concepts will be developed.

Development of computer codes for Exploratory Studies Facility design verification will continue. Design assumption substantiation analyses will be performed. Rock mechanics data summary reports will be prepared. An "As Low As Reasonably Achievable" analysis update report will be prepared.

2.5.1.13 Systems Engineering (WBS 1.2.1)

The systems engineering process for all exploratory studies facility, surface based testing and Advanced Conceptual Design activities will be implemented, managed and integrated. Systems engineering activities in support of in-process design packages for exploratory studies facility, waste package, and repository will continue.

A Calico Hills Access Options Analysis Report will be completed, providing the decision framework for subsequent characterization of the Calico Hills unit. A Systems Thermal Study will be ongoing, and will provide data to support the Preclosure Rock Characteristics and Geochemistry/Postclosure Rock Characteristics higher-level findings.

Designs will be reviewed to comply with requirements of applicable design requirements documents. Compliance verification and validation efforts will be performed on exploratory studies facility design to exploratory studies facility design requirements. Studies to resolve requirements identified as to be determined, to be resolved for design requirements documents and to be verified in design requirements documents will be conducted. Exploratory studies facility 50% and 90% design reviews will be conducted and integrated. Advanced Conceptual Design systems requirements review and systems design review will be conducted and integrated. Critical system studies will be performed and updated.

Technical requirements and designs for Advanced Conceptual Design and the exploratory studies facility will be analyzed in terms of human factors, reliability, availability, maintainability, system

safety, security and safeguards, and integrated logistics support. A safety analysis report for exploratory studies facility and Advanced Conceptual Design will be updated and maintained. Value engineering studies will be conducted and their results integrated in support of the exploratory studies facility and Advanced Conceptual Design. A process to continually input and update the Q-list and quality activities list will be provided.

Programmatic requirements critical to project success will be identified and reviewed. A Mined Geologic Disposal System Concept of Operations will be developed and maintained.

2.5.1.14 Metrics - Fiscal Year 1995

In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less-tangible progress such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions.

Outputs:

1. Excavation of 1300 meters of the North Ramp, installation of required utilities, conveyor, ground support, invert segments and equipment for the North Ramp; and excavation of test alcoves at Bow Ridge fault and at Paintbrush Tuff contact;

2. Technical Basis Report, guidelines assessment and recommendation to the Director on the surface processes guideline group;

3. Intermediate Unsaturated Zone Hydrologic Framework Model;

4. Results from a seismic reflection line across Crater Flat, and a report on regional seismic reflection;

5. Report on structural controls on basaltic volcanism;

6. Resource map of the controlled area;

7. Parameter estimates based on planned hydraulic testing at the C-wells complex;

8. Complete drilling of deep borehole SD-12 / begin SD-7 to collect data below repository horizon and geophysical logging of 11 boreholes for stratigraphic/hydrologic data;

9. Fiscal year 1995 iteration of total system and subsystem performance assessment, and provide recommendations report;

10. Preliminary Repository Preclosure Safety Analysis Report;

11. Final report from Calico Hills Data Needs and Access Study;

12. Calibration results for gas-phase model, intermediate saturated-zone hydrologic framework model, and preliminary fracture-flow model;

13. Integrated hydrological / geochemistry / radionuclide transport model based on prototype 3-D integrated geologic model;

14. Design assumption substantiation analyses;

15. Rock mechanics data summary reports;

16. Recommended Repository Layout Concepts Report;

17. Repository Emplacement Mode Evaluation;

18. Repository waste handling building final conceptual design report;

19. Waste package conceptual design report.

Outcomes:

1. Continue Systems Engineering activities in support of in-process design packages for Exploratory Studies Facility, waste package, and repository;

2. Conduct studies to resolve requirements identified as To Be Determined, or To Be Resolved for Design Requirements Documents and To be Verified in Design Requirements Documents;

3. Perform and update important system studies especially Calico Hills access, thermal loading and transportation;

4. Analyze technical requirements and designs for Advanced Conceptual Design and Exploratory Studies Facility in terms of human factors, reliability, availability, maintainability, system safety, security and safeguards, and integrated logistics support;

5. Complete Waste Package Conceptual Design to support Total System Life Cycle Cost, Total System Performance Assessment, technical site suitability evaluation, Multi-Purpose Canister design, and Repository Design;

6. Initiate container closure development in support of technical site suitability evaluation and Total System Performance Assessment;

7. Maintain on-going Waste Form Testing in support of Total System Performance Assessment and technical site suitability evaluation;

8. Initiate Metal Barriers long-term testing in support of Total System Performance Assessment and technical site suitability evaluation;

9. Develop Preliminary 3-D geologic frame work model for the site (qualified in mid-95), providing synthesis of available laboratory thermal and mechanical properties (North access Ramp Geologic and Systematic Drilling boreholes Exploratory Studies Facility), and geology of controlled area, evaluating all surface geologic data;

10. Exploratory Studies Facility Mapping and Construction Monitoring (collect irretrievable data; gather information for design verification);

11. Conduct data needs workshops for probabilistic seismic hazard analysis;

12. Conduct thermal effects studies including Altered Zone studies and near-field environment;

13. Conduct laboratory experiments on solubility sorption and retardation;

14. Develop saturated zone model (code) for use by Total System Performance Assessment in fiscal year 1996;

15. Develop intermediate unsaturated zone model (code) for use by Total System Performance Assessment in fiscal year 1996;

16. Conduct permeability tests in Exploratory Studies Facility alcoves at Bow Ridge fault and Paintbrush Tuff and collect ambient pressure data to evaluate underground air movement characteristics;

17. Conduct testing of ambient pneumatic conditions at Yucca Mountain prior to excavation of Exploratory Studies Facility;

18. Conduct Advanced Conceptual Design, engineering studies to evaluate surface facility layouts (nuclear-related), subsurface facilities configurations, thermal loading, emplacement modes, retrieval modes, excavation methods and transportation equipment;

19. Support interactions with Nuclear Regulatory Commission, Nuclear Waste Technical Review Board, Advisory Committee on Nuclear Waste, and similar organizations;

20. Continue limited detailed-process evaluation and abstraction to refine total system Performance Assessment codes;

21. Begin preparing Performance Assessment computer codes for entry into Quality Assurance software configuration system;

22. Continue benchmarking of Performance Assessment codes and models through participation in international cooperative efforts;

23. Construct 16 acres of the muck storage area and the conveyor service road. Refurbish and install 2 diesel generators;

24. Complete construction of the water system from well J-13 to the north portal pad, including the booster pump building, storage tanks and associated piping;

25. Complete procurement and construction of the switchgear building, change house and underground access control building;

26. Install mined rock conveyor system;

27. Procure and install the initial Integrated Data and Control System components;

28. Complete design of the Topopah Spring Level Main Drift (Package 8A) and the Ghost Dance Alcoves; and

29. Finalize the Site Suitability Process.

2.5.2 Fiscal Year 1996 ($248.7M)

The evaluation of site suitability in fiscal year 1996 will produce a guideline compliance assessment on the Preclosure Rock Characteristics guideline. This will entail preparation of a technical basis report giving the data, interpretations, and analyses that will support the guideline compliance assessment. An external technical review will be conducted to assess the adequacy of the technical basis report. In addition, the preparation of technical basis reports on tectonics, geochemistry, postclosure rock characteristics, human intrusion, geohydrology, and preclosure radiological safety siting guidelines will be ongoing.

Drilling activities (WBS 1.2.3.5) will include drilling of one combined unsaturated zone/water table borehole to provide hydrologic information from the saturated and unsaturated zones, one systematic drilling borehole to provide rock characteristics information, one geologic borehole (up to 15,000 feet deep) to provide geologic control for geophysical investigations and to explore the carbonate aquifer, three vertical south ramp geologic boreholes and one angle borehole to support design of the south ramp of the Exploratory Studies Facility, three volcanism boreholes to investigate magnetic anomalies in Crater Flat, instrumentation of four boreholes for unsaturated zone pneumatic testing, geophysical logging, and well cleanout and reconfiguration activities and support for cross-hole tracer experiments at the C-well complex.

Site characterization activities previously supporting evaluation of siting guidelines for preclosure hydrology, erosion, and surface characteristics will be redirected to support license application as needed. New information from these activities may require review with respect to site suitability to affirm previous findings.

2.5.2.1 Preclosure Radiological Safety Technical Basis (WBS 1.2.13)

Meteorological monitoring will continue to provide data on baseline weather conditions that are required to refine models which will be used to characterize the atmospheric dispersion characteristics of the site. Information on offsite installations, population density, and site ownership and control will be compiled to provide input to a Probabilistic Risk Assessment of preclosure radiological safety.

2.5.2.2 Preclosure Rock Characteristics Technical Basis (WBS 1.2.3, 1.2.5)

A technical basis report will be prepared for Preclosure Rock Characteristics using existing rock property data from borehole samples, together with an evaluation of the rock characteristics of the repository host rock exposed in the main drift of the Exploratory Studies Facility. Geologic mapping and geotechnical characterization of the repository host rock exposed in the main drift will support development of the technical basis report. An external review will be conducted on the adequacy of this technical basis. A guideline compliance assessment for the preclosure rock characteristics guideline will be completed with recommendations to the Director. This assessment will evaluate: (1) whether or not the rock characteristics of the site are suitable for accommodation of the underground facility using reasonably available technology; and (2) whether or not repository construction, operation, and closure would be unduly hazardous to personnel.

2.5.2.3 Tectonics Technical Basis (WBS 1.2.3, 1.2.5)

Results of field investigations of Quaternary faults will be documented in a report which will summarize the effects of alternative tectonic models for the Yucca Mountain region. These models will be developed, in part, from the assessment of geophysical surveys and seismic monitoring. The results of two probabilistic seismic hazard assessments will be reported in fiscal year 1996. Using these results and a topical report completed in fiscal year 1995 (Seismic Design Methodology for a Geologic Repository at Yucca Mountain), the seismic design basis for strong ground motion and fault displacement for both surface and subsurface facilities will be prescribed for Advanced Conceptual Design. Structures, systems, and components of the repository that are important to seismic safety will be defined and categorized. Finally, a determination of whether the seismic design basis can be accommodated by reasonably available technology will be documented for use in the technical basis report supporting guideline compliance assessment of the Preclosure Tectonics Qualifying Condition and Disqualifying Condition.

The results of the tectonic studies will be integrated with hydrologic modeling studies to address the postclosure tectonic effects on the hydrologic system in support of Total System Performance Assessment-1997.

To address igneous activity for the Postclosure Tectonics qualifying condition, volcanic hazard studies will continue. The probability bounds and risk simulation modeling for volcanic hazards have been completed for the recurrence rate, the probability of disruption, and the probability of magmatic disruption of the repository, the controlled area, and the region. A year-end update of the probability estimates will be completed and will incorporate new results of ongoing site characterization studies. Work on estimating bounding values for parameters describing the magmatic evolution of individual volcanic centers and the Yucca Mountain region will be completed. These studies are structured to ensure that probabilistic volcanic risk assessment incorporates geologic constraints on the time-space-volume evolution of basaltic volcanism in the Yucca Mountain region. Geochronologic and geochemical studies will be completed. The results of these studies will be integrated with the chronology and spatial development of faulting and documented in the technical basis report.

An external review of the technical adequacy of technical basis report will be initiated.

2.5.2.4 Geochemistry/Postclosure Rock Characteristics Technical Basis (WBS 1.2.3, 1.2.5)

To address the relevant qualifying conditions, an update of the three-dimensional integrated geologic model of the site using data collected in fiscal year 1995-1996 will be completed to support Advanced Conceptual Design and Total System Performance Assessment-1997. The update of the model will incorporate structural and lithologic logs for additional deep boreholes in and near the controlled area, results of surface geophysical surveys, results of surface mapping and fracture studies, and results of geologic mapping in the exploratory studies facility. This model will provide the geologic framework of the site that will be used for some of the process modeling activities and for subsystem and total system performance assessment. It will also provide estimates of the spatial distribution of porosity, permeability, water content, and other parameters that are required for hydrologic modeling and design analyses. Geotechnical data on the material and thermal properties of the host rock and geologic mapping and rock deformation studies in the Exploratory Studies Facility will also support Advanced Conceptual Design.

A summary report will be produced on the bulk and fracture mineral distribution in Yucca Mountain. This information will provide a basis for the distribution of sorption, rock mechanical properties, and ground-water chemistry. This also provides some of the initial information for near-field environment and altered zone studies. Mechanical changes due to geochemical processes and the thermal load will be investigated through laboratory testing. Changes in hydrologic properties resulting from silica redistribution and other mineral-water reactions will be examined. A report on geochemical alteration will summarize current knowledge of mineral alteration history, including discussion of any evidence for Quaternary alteration. The findings will be discussed as a possible analog for alteration under repository conditions. Future alteration will be predicted. An understanding of mineral alteration is required to determine if conditions exist or could exist that would degrade the ability of the site to isolate waste. A report on a ground-water chemistry model for Yucca Mountain will be produced to support the evaluation of the postclosure geochemistry qualifying condition. This model will examine the mechanisms that control ground-water chemistry and establish the expected range of water chemistry.

A technical basis report providing the geotechnical data and interpretation that will support a guideline compliance assessment of the guidelines for human intrusion, postclosure rock characteristics, and geochemistry will be completed in fiscal year 1996. This report will include the results of an industry standard natural resource exploration study that will have been completed in fiscal year 1995, current site characterization data on geochemistry and rock characteristics, and the preliminary three-dimensional geologic model of the controlled area. An external review will be initiated on the technical adequacy of the technical basis report.

2.5.2.5 Geohydrology/Transport Technical Basis (WBS 1.2.3, 1.2.5)

To develop data to evaluate these guideline conditions, hydraulic and tracer testing in boreholes at the C-wells complex will be completed and the results analyzed to provide hydrologic and transport-property values for input to the ground-water flow and total-system performance-assessment computational models. Construction-phase testing will continue in the Exploratory Studies Facility and existing Exploratory Studies Facility alcoves. Boreholes along the North

Ramp and Exploratory Studies Facility construction phase testing will provide data on the hydrologic and chemical effects of excavation. The analysis of paleoenvironmental data collected in southern Nevada and adjacent areas will be completed to provide part of the basis for inferring the range of climatic conditions and the hydrologic effects of climate in the Yucca Mountain region during the Quaternary period.

Monitoring at previously instrumented boreholes in the unsaturated zone will continue. Additional unsaturated-zone boreholes will be completed and tested to provide more data and information on specific features that may control conditions or processes occurring in the unsaturated-zone hydrologic system. Other activities will include monitoring precipitation and soil moisture to support analysis of rates of infiltration and laboratory analyses of moisture content of core. One water-table borehole will be drilled and tested to provide additional data and information on the large hydraulic-gradient zone to the north of the site. The development and testing of the site-scale, three-dimensional unsaturated-zone and saturated-zone ground-water flow models will be advanced sufficiently to support ground-water travel-time evaluations required by the disqualifying condition for the postclosure geohydrology siting guideline.

Studies on radionuclide transport parameters will focus on those areas where there is the greatest uncertainty that the qualifying condition for the postclosure geochemistry siting guideline can be met. Radionuclide sorption, solubility and speciation, colloidal behavior, and diffusion into the rock matrix pore space will be examined. Dynamic transport studies will be conducted to examine the applicability of basic parameters for describing the behavior of solutes in flowing systems in fractured and unfractured rock.

Investigation of neptunium, plutonium, and uranium will be emphasized. These are the radionuclides for which more refined transport parameters seem most critical due to their long half - lives, high solubility, low sorption, or high uncertainty in sorption mechanisms. Development of transport models that combine hydrology and transport parameters for the key radionuclides will continue. This information is basic input needed to model the release of radionuclides to the accessible environment.

Preparation of the technical basis report on hydrology/transport providing the geotechnical data and interpretation necessary to support a guideline compliance assessment for the postclosure geohydrology, geochemistry, and climate technical guidelines will be initiated.

2.5.2.6 Total System Performance Assessment (WBS 1.2.5)

Performance Assessment will evaluate postclosure effects for tectonics, geochemistry, and rock characteristics to support the evaluation of the postclosure qualifying conditions for tectonics, geochemistry, and rock characteristics. Preparations will be initiated for a major total systems performance assessment to be conducted and completed in fiscal year 1997. An update of the fiscal year 1995 subsystem performance assessment addressing the substantially complete containment and controlled release requirements of 10 CFR Part 60, as cited in 10 CFR 960, will be completed as direct support to the Advanced Conceptual Design report.

2.5.2.7 Data Management (WBS 1.2.5)

Technical data management will continue to compile and assure the consistency and traceability of technical data for the technical site suitability evaluation activities into the Reference Information Data Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems. A summary report will be prepared that describes the major results, conclusions and recommendations of Total System Performance Assessment-1995 as they relate to data management and quality.

2.5.2.8 Support Activities: Exploratory Studies Facility Construction (WBS 1.2.6)

The tunnel boring machine will complete the North Ramp by turning to the south and beginning excavation of the main Topopah Spring drift. The tunnel boring machine will reach the location of the southernmost Ghost Dance fault exploratory drift by the end of 1996 (Figure 2-1). Two access drifts to the Ghost Dance fault will be completed to support testing that will assess the hydrologic and pneumatic properties of this fault. The results of this testing will be used to evaluate the hypotheses that the Ghost Dance fault may provide a preferential flow path to the unsaturated zone.

2.5.2.8.1 Support Activities: Exploratory Studies Facility Construction Test Support (WBS 1.2.6)

Exploratory Studies Facility Construction Test Support will install and maintain test facilities as required by the testing community.

2.5.2.8.2 Support Activities: Exploratory Studies Facility Operations and Maintenance (WBS 1.2.6)

Exploratory Studies Facility Operations and Maintenance will take over completed sections of the Exploratory Studies Facility from construction in fiscal year 1996. The cost of Operations and Maintenance will then be carried in the operations budget for the facility.

2.5.2.9 Support Activities: Test Facilities (WBS 1.2.7)

Site facilities and support services for all field activities supporting site characterization will be provided as described in section 2.5.1.10.

2.5.2.10 Waste Package Design (WBS 1.2.2)

Design activities will advance the level of maturity for the waste package design. This activity will support the preclosure radiological safety higher level finding for technical site suitability evaluation and will provide the design basis to support Total System Performance Assessment-1997. Waste package design advancement is also necessary to allow specification of Multi-Purpose Canister physical interfaces. Waste package preliminary designs will be reported in Section 6 of the interim Advanced Conceptual Design Report. The waste package design concept currently focuses on two to three containment barriers around a Multi-Purpose Canister containing either the spent fuel or vitrified high level waste forms. Characterization of waste

forms, and engineered materials testing, will continue in limited scope to support this focused waste package design concept and will be used to refine predictive performance models. Predictive modeling includes defining waste package container degradation, the Engineered Barrier System source term and long term criticality analyses. In addition, activities continue on the development of techniques for containment barrier closure, critical waste package component fabrication, non-destructive examination and in-service inspection, as well as stress reduction. These design activities are important to defining preclosure system radiological risk and postclosure system containment performance.

2.5.2.11 Repository Design (WBS 1.2.4)

Limited design activities will emphasize the waste handling area of the surface facilities. Defining the waste handling areas in terms of processes and major equipment types is needed to support the guideline compliance assessment of the preclosure radiological safety guidelines for technical site suitability evaluation. The surface design for nuclear facilities and the entire subsurface design will be at the final conceptual design phase. The results of these surface design activities will be reported in Section 7 of the interim Advanced Conceptual Design Report; the results of subsurface design activities will be specified in Section 8. These repository design activities will attempt to examine various repository operational scenarios that may affect design features and provide the basis for refining the repository requirements and concepts that will be utilized to evaluate higher level findings, including the preclosure and postclosure system guidelines.

2.5.2.12 Systems Engineering (WBS 1.2.1)

Systems Engineering will produce revisions to the Repository Design Requirements baseline to reflect the results of the surface facility conceptual design activities. A Design Summary Report to validate waste package preliminary design efforts will also be prepared. An analysis to investigate alternative concepts of achieving preclosure radiological safety will be performed to support the Preclosure Radiological Safety higher-level finding. A Systems Thermal Study will be ongoing, and will provide data to support the technical basis reports needed to evaluate the Preclosure Rock Characteristics and Geochemistry/Postclosure Rock Characteristics guidelines.

2.5.2.13 Metrics - Fiscal Year 1996

Outputs:

1. Complete Preclosure Rock Characteristics guideline compliance assessment and make recommendations to Director;

2. Complete probabilistic seismic hazard analysis report;

3. Complete report on bulk and fracture mineral distribution;

4. Complete report on geochemical alteration;

5. Complete report on a ground-water chemistry model;

6. Complete technical basis report human intrusion, postclosure rock characteristics, and geochemistry supporting the associated guideline compliance assessment;

7. Complete planned hydraulic and tracer testing at the C-wells complex;

8. Complete planned unsaturated-zone and water table boreholes;

9. Update the fiscal year 1995 subsystem performance assessment;

10. Complete excavation of the Exploratory Studies Facility North Ramp and turn south and start excavation of the Topopah Spring Level main drift;

11. Excavate two access drifts to the Ghost Dance fault;

12. Complete Total System Performance Assessment-1995 summary report; and

13. Specification of Multi-Purpose Canister physical interfaces.

Outcomes:

1. Continue meteorological monitoring;

2. Update three dimensional integrated geologic model;

3. Continue testing in the Exploratory Studies Facility;

4. Continue monitoring in previously instrumented unsaturated-zone boreholes;

5. Continue to develop and test site-scale three-dimensional unsaturated-zone and saturated-zone ground-water flow models to support evaluations;

6. Continue studies on radionuclide transport parameters;

7. Continue development of models that combine hydrology and transport parameters for key radionuclides.

8. To support the suitability function, limited design activities will emphasize the waste handling area of the surface facilities. Subsurface design will be at the final conceptual design phase.

9. Results of surface and subsurface design activities will be reported in Sections 7 and 8, respectively, of the final Advanced Conceptual Design Report to close out numerous alternative design features and provide the basis for refining the repository requirements and concepts that will be utilized to evaluate higher level findings with respect to site suitability.

10. Waste package design will advance in maturity, supporting the preclosure radiological safety higher level finding for technical site suitability evaluation and providing the

design basis to support the key Total System Performance Assessment in 1997 for suitability.

11. Characterization of waste forms, and engineered materials testing, will continue in limited scope to support this focused waste package design concept and will be used to refine the predictive performance models.

2.5.3 Fiscal Year 1997 ($136.2M)

Site characterization activities supporting evaluation of preclosure tectonics, rock characteristics, and radiological safety siting guidelines and the postclosure siting guidelines for geohydrology, geochemistry, human interference, and rock characteristics will be redirected to support the license application as needed. Any new information from these activities may require review with respect to site suitability to affirm previous findings.

Drilling activities (WBS 1.2.3.5) will include drilling of one combined unsaturated zone/water table borehole to provide hydrologic information from the saturated and unsaturated zones, to provide rock characteristics information, two water table boreholes to support characterization of the uppermost saturated zone, instrumentation of three unsaturated zone and two systematic drilling boreholes, geophysical logging, and well cleanout and reconfiguration activities.

2.5.3.1 Preclosure Radiological Safety Technical Basis (WBS 1.2.2, 1.2.4, 1.2.5)

A Repository Advanced Conceptual Design Preclosure Safety Analysis Report containing preclosure radiological safety analyses results will be prepared to support evaluation of the preclosure system guideline for Radiological Safety. A technical basis report to support the evaluation of the technical guidelines for population density, meteorology, offsite installations, and site ownership and control will be completed, and an external review of the technical basis report will be completed.

The technical basis report will include updated 1990 census information to address population density and current data from the meteorological monitoring program. It will incorporate refined models to characterize the dispersion characteristics of the site and to provide input to dose assessment calculations that are required to address the system guideline for preclosure radiological safety with respect to offsite installations. The report will specify a source term and also provide an evaluation of planned offsite facility effects on the repository and effects of the repository on atomic energy defense activities. Mitigation measures will be evaluated and the results compared with applicable standards. Existing information will be used to evaluate the site ownership and control technical guideline. Finally, a guideline compliance assessment of preclosure radiological safety systems guideline and the supporting technical guidelines will be completed (Table 2-2). This assessment will evaluate whether or not preclosure exposures meet applicable safety standards.

2.5.3.2 Tectonics Technical Basis (WBS 1.2.3, 1.2.5)

Postclosure tectonics effects studies in support of Total System Performance Assessment-1997 will continue. Modeling studies will be initiated to examine coupled processes of volcanism and

faulting on the hydrologic system (unsaturated and saturated zone). An assessment of the potential tectonic effects on the ground-water table will be completed.

Activities for volcanic hazard studies are planned to conclude and the study emphasis will switch to an assessment of the risk of volcanism. Final cumulative probability distributions of the recurrence rate of volcanic events and the probability of disruption will be compiled as input to Total System Performance Assessment-1997. These distributions will incorporate the results of expert judgment. If required by any new results from geophysical studies of the region and refinements of tectonic models of the region, these distributions will be updated.

An external review of the technical basis for tectonics will be completed and comments from the review addressed. A regulatory assessment of the higher level findings for the postclosure tectonics disqualifying condition and the preclosure qualifying and disqualifying conditions will be completed.

2.5.3.3 Reasonably Available Technology Higher Level Finding (WBS 1.2.5)

A guideline compliance assessment of the qualifying condition for the preclosure system guideline concerning ease and cost of siting, construction, operation, and closure will be completed. This assessment will combine the results of guideline compliance assessments for the supporting preclosure technical guidelines for surface characteristics, rock characteristics, tectonics, and hydrology.

2.5.3.4 Geochemistry / Postclosure Rock Characteristics Technical Basis (WBS 1.2.3, 1.2.5)

The three-dimensional integrated geologic model will be updated to include new data collected in fiscal year 1996 from boreholes, surface and borehole geophysics, and underground mapping.

The external review of the technical adequacy of the technical basis report for geochemistry and postclosure rock characteristics will be completed. A guideline compliance assessment of the disqualifying conditions for the postclosure human intrusion technical guideline will be completed.

2.5.3.5 Geohydrology/Transport Technical Basis (WBS 1.2.3, 1.2.5)

A technical basis report for geohydrology, geochemical transport parameters, and climate will be completed. The report on the geohydrology of the site and region will be based on the completion of intermediate geohydrologic framework models for the site unsaturated-zone and saturated-zone hydrologic systems. The site-scale unsaturated-zone and saturated-zone ground-water flow models will provide the technical bases for conducting ground-water travel time evaluations. The geochemical transport input to the report will consist of an integration of radionuclide transport data with the results derived from radionuclide transport modeling. The results derived from paleoclimate studies will be synthesized to produce a description of climatic conditions and climate change during the Quaternary period, providing essential calibration records for models of future climatic change in the Yucca Mountain region.

Construction-phase testing will continue in the Exploratory Studies Facility. Hydrologic testing and sampling and pneumatic testing will be conducted in the Exploratory Studies Facility accesses to the Ghost Dance fault to determine representative hydrologic and pneumatic properties at two locations within the fault zone and to evaluate the hypothesis that this structural feature may provide a preferential flow pathway in the unsaturated zone.

Studies on radionuclide transport parameters will continue to focus on areas where there is the greatest uncertainty that the qualifying condition for the postclosure geochemistry siting guideline can be met. Transport parameters being studied to support evaluation of site suitability are sorption, solubility and speciation, colloidal behavior, and diffusion into the rock matrix pore space. Dynamic transport studies will be conducted to examine the applicability of basic parameters for describing the movement of solutes in flowing systems in both fractured and unfractured rock. The behavior of neptunium and plutonium, and the potential for colloid facilitated transport are being emphasized to support site suitability evaluations. These are radionuclides that can form colloids and for which more refined transport parameters seem most critical due to high solubility, low sorption, or high uncertainty in sorption mechanisms.

Altered zone and near-field environment summary reports will be completed in 1997 to support performance assessment activities that in turn support evaluation of the qualifying conditions for the geochemistry and rock characteristics postclosure guidelines and the postclosure system guideline. Development and application of transport models that combine hydrology and transport parameters will continue. This information provides basic input needed to model the release of radionuclides to the accessible environment.

An external review of the technical adequacy of the technical basis report for geohydrology/transport will be initiated. A regulatory assessment of the disqualifying condition for the postclosure geohydrology siting guideline will also be initiated.

2.5.3.6 Total Systems Performance Assessment (WBS 1.2.5)

Performance Assessment will complete Total System Performance Assessment-1997 that addresses the post-closure system performance guideline of 10 CFR 960.4-1(a). This total system performance assessment will support the guideline compliance assessment the postclosure system guideline and the postclosure qualifying conditions for the geohydrology, geochemistry, rock characteristics, climate, and tectonics siting guidelines.

An Engineered Barrier Subsystem Performance Assessment report will be issued describing a focused set of performance assessment calculations for the License Application Design report, including the results and qualitative descriptions of the uncertainty in the assessment and results. The report will be incorporated into the License Application Design report. The performance requirements to be addressed in these calculations are the substantially complete containment, and the controlled release subsystem performance requirements of 10 CFR 60.113. The results of these analyses will also be used to improve the definition of the source term for the ongoing Total System Performance Assessment.

A new subsystem performance assessment addressing the substantially complete containment and controlled release requirements of 10 CFR Part 60, as cited in 10 CFR Part 960, will also be

completed. An assessment of the pre-emplacement ground-water travel time, addressing another 10 CFR Part 960 , disqualifying condition is to be completed and documented. These subsystem performance assessments will contain uncertainty analyses specifically targeting the qualifying conditions for the postclosure geohydrology, geochemistry, and rock characteristics siting guidelines.

2.5.3.7 Data Management (WBS 1.2.5)

Technical data management will continue to compile and assure the consistency and traceability of technical data for the technical site suitability evaluation activities into the Reference Information Data Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems.

2.5.3.8 Support Activities: Test Facilities (WBS 1.2.7)

Site facilities and support services for all field activities supporting site characterization will be provided as described in Section 2.5.1.10.

2.5.3.9 Waste Package Design (WBS 1.2.2)

Design activities for the waste package will enter the final design phase. Results of these activities will directly support the postclosure system and the postclosure tectonics higher level findings, as well as Multi-Purpose Canister interface activities. Preliminary waste form characteristics and engineered materials characteristics reports will be prepared to document and substantiate assumptions used in the designs and in addressing higher level findings. These waste package design activities will be reported in Section 6 of the final Advanced Conceptual Design Report in March 1997. In addition, the design activities will provide the basis for refinement of repository interface requirements and lead to development of a Request For Proposal for prototype waste package development.

Specifically, testing will continue on containment barrier material and degradation tests on materials to be used for the basket. Waste package/engineered barrier degradation predictive models will continue to be refined. Revisions of the Preliminary Engineered Materials and Waste Form Characteristics Reports will be issued to support substantially complete containment compliance analyses and prediction of the Engineered Barrier System source term. These analyses and predictions address subsystem portions of the postclosure system technical guidelines.

2.5.3.10 Repository Design (WBS 1.2.4)

Limited design activities will continue on the surface facilities directly related to high level waste activities, and all subsurface areas. Conceptual designs of nuclear surface facilities and the subsurface facilities will be completed. Results will be used to support the postclosure system guideline higher level finding, the Multi-Purpose Canister interface refinement and procurement activities, and will provide input to the postclosure tectonics higher level finding. Emphasis will be placed on the surface facilities design activities related to waste handling aspects. In addition, the repository design activities (surface and subsurface) will provide additional input for the

higher level finding on preclosure radiological safety. The surface facility design activities will be reported in Section 7 of the final Advanced Conceptual Design report whereas the subsurface design activities will be reported in Section 8.

The final Advanced Conceptual Design report documenting the conceptual designs for subsurface and the nuclear-related facilities, as well as the 80% stage of the waste package preliminary design will be completed. The preliminary Waste Form Characteristics Report, Revision 1, the preliminary Engineered Materials Characteristics Report will also be completed. The initial Repository License Application Design/Waste Package and Preliminary Design report, documenting the initial preliminary designs for subsurface facilities and surface nuclear facilities and the complete preliminary design for the waste package will be completed.

2.5.3.11 Systems Engineering (WBS 1.2.1)

Systems Engineering will revise the Site Design and Test Requirements and Repository Design Requirements baselines to reflect the results of Exploratory Studies Facility and subsurface design activities. A Thermal Loading Study will be ongoing and provide data to support the Geohydrology Transport higher-level finding. Systems Engineering will also develop a Performance Framework Study/Analysis to support the Total System Performance Assessment. This study will provide design safety guidelines.

2.5.3.12 Metrics - Fiscal Year 1997

Outputs:

1. Complete the Advanced Conceptual Design Preclosure Safety Analysis Report;

2. Complete the technical basis report supporting evaluation of the technical guidelines for population density, meteorology, offsite installations, and site ownership and control;

3. Complete a guideline compliance assessment for the preclosure radiological safety system guideline and supporting technical guidelines;

4. Complete a guideline compliance assessment for postclosure tectonics disqualifying condition and preclosure qualifying and disqualifying conditions;

5. Complete a guideline compliance assessment of the qualifying condition for the preclosure system guideline on ease and cost of siting, construction, operation, and closure with subsequent recommendation to the Director;

6. Complete a guideline compliance assessment of the disqualifying conditions for the postclosure human intrusion technical guideline;

7. Testing in the Exploratory Studies Facility access to the Ghost Dance fault will be initiated;

8. A technical basis report for geohydrology, geochemical transport parameters, and climate will be completed;

9. Total System Performance Assessment-97 will be completed;

10. A new subsystem (waste package/Engineered Barrier System) performance assessment addressing substantially complete containment and controlled releases will be completed;

11. A guideline compliance assessment of pre-emplacement ground-water travel time will be completed;

12. Waste package final design will be initiated and

13. Reports will be completed on final Advanced Conceptual Design, Preliminary Waste Form Characteristics (Rev 1), Preliminary Engineered Materials Characteristics, and Initial Repository License Application Design/Waste Package Preliminary Design.

Outcomes:

1. Technical basis report for tectonics will be externally reviewed;

2. The technical basis report for geochemistry and postclosure rock characteristics will be externally reviewed;

3. Studies on radionuclide transport parameters will continue;

4. An external review of the technical basis report on geohydrology, geochemical transport parameters, and climate will be initiated; and

5. Limited repository design activities will continue.

2.5.4 Fiscal Year 1998 ($18.6M)

The evaluation of site suitability will address higher-level findings on the 10 CFR Part 960 postclosure system guideline and all remaining postclosure qualifying conditions. In addition, the assessment of the higher level finding for the postclosure geohydrology disqualifying condition will be completed. All outstanding issues identified in the peer review process will be addressed and the Department of Energy will issue the technical site suitability evaluation report. The completeness and favorability of higher-level findings embodied in the technical site suitability evaluation report will support a fundamental decision: whether or not to continue characterization of Yucca Mountain.

Site characterization activities supporting site suitability may be continued to support license application. Any new data or analyses from the site characterization program may require suitability review to affirm previous findings.

2.5.4.1 Total Systems Performance Assessment (WBS 1.2.5)

An external review of the total system performance assessment and the natural and engineered barrier subsystem performance assessments of fiscal year 1997 will be initiated. Performance assessment will prepare a Total System Performance Assessment 1997 report to support preparation of the technical site suitability evaluation report including preparation of the final documentation of analyses that are direct input into the technical suitability report.

2.5.4.2 Data Management (WBS 1.2.5)

Data management will produce a description of the technical data that was compiled for use in the technical site suitability evaluation effort. The Reference Information Data Base and the Geologic and Environmental Nodal Information Study and Evaluation System databases are to be the depositories of all site, design and performance assessment data used in the technical site suitability evaluation. The objective of this effort is to ensure data consistency and traceability.

2.5.4.3 Systems Engineering (WBS 1.2.1)

Systems Engineering will support preparation of the technical site suitability evaluation report in the area of requirements compliance.

2.5.4.4 Metrics - Fiscal Year 1998

Outputs:

1. Complete a guideline compliance assessments of the remaining qualifying conditions from 10 CFR Part 960 for the postclosure geohydrology guideline.

2. Issue the technical site suitability evaluation report.

3. Complete the Total System Performance Assessment-1997 Summary Report.

Outcomes:

1. An external review of the Total System Performance Assessment-97 and natural and engineered barrier subsystems will be initiated.

2.5.5 Fiscal Year 1999 ($10.9M)

If the Yucca Mountain site appears to be suitable through the technical site suitability evaluation, a draft of the Site Recommendation Report will be produced. Guideline compliance assessments for the National Environmental Policy Act related guidelines will also be conducted.

2.5.5.1 Metrics - Fiscal Year 1999

Outputs:

1. Draft Site Recommendation Report.

2.5.6 Fiscal Year 2000 ($7.2M)

The final Site Recommendation Report will be developed and issued, including Nuclear Regulatory Commission's sufficiency comments (See section 4.5.6.1).

2.5.6.1 Metrics - Fiscal Year 2000

Outputs:

1. Issue final Site Recommendation Report.

Outcomes:

1. None.

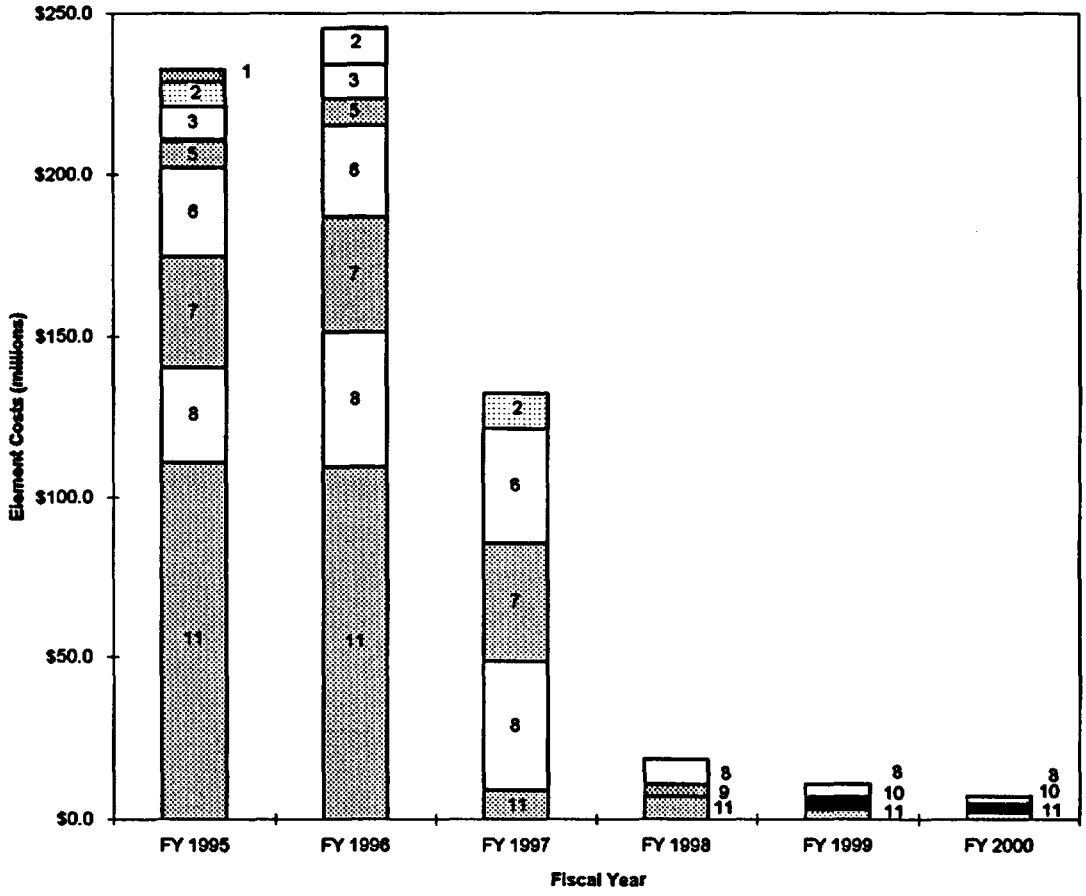
2.6 SITE SUITABILITY COST ESTIMATE

2.6.1 Site Suitability Cost Estimate Assumptions and Methodology

The cost profile for individual elements of the suitability product area is provided in Figure 2-4, in terms of total costs and percentage distributions of these element costs for fiscal year 1995 through fiscal year 2000. Additional detail on distribution of element cost estimates to lower level Work Breakdown Structure is in Appendix A.

2.6.1.1 Assumptions

Allocation of costs between suitability and licensing is not clear cut because activities often support both products and there is no clear way to delineate support. Therefore assumptions used for the allocation are as noted below. The cost estimates for the suitability section of this five-year plan were developed in a "tops-down" manner as follows: (1) Workscope necessary to support the fiscal year 1998 technical site suitability evaluation was identified. This has been presented in the previous sections; (2) a detailed schedule of milestones that show progress toward the technical site suitability evaluation were then prepared (3) Work Breakdown Structure third level costs were estimated tops-down based on historical costs, with increases over fiscal year 1995 as appropriate to meet the suitability milestones; and (4) these Work Breakdown Structure third level control totals were allocated to the suitability sub-elements. Specific assumptions that were cost-drivers for selected Work Breakdown Structure elements are discussed below.



Site Suitability (millions)		Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1	Surface Processes	$2.9	$.0	$.0	$.0	$.0	$.0	$2.9
2	Preclosure Radiological Safety	$6.3	$14.5	$10.6	$.0	$.0	$.0	$31.4
3	Preclosure Rock Characteristics	$10.2	$10.7	$1.0	$.0	$.0	$.0	$21.9
4	Reasonably Available Technology	$.7	$.0	$1.8	$.0	$.0	$.0	$2.5
5	Tectonics	$8.1	$8.3	$1.0	$.0	$.0	$.0	$17.4
6	Geochemistry, Postclosure Rock Characteristics	$27.4	$28.3	$35.9	$.0	$.0	$.0	$91.6
7	Geohydrology/Transport	$34.3	$35.6	$37.1	$.0	$.0	$.0	$107.0
8	Total System Performance Assessment	$29.5	$41.8	$39.6	$7.9	$3.9	$2.1	$124.8
9	Technical Site Suitability Evaluation	$.0	$.0	$.0	$3.7	$.0	$.0	$3.7
10	Site Recommendation Report	$.0	$.0	$.0	$.0	$4.0	$3.1	$7.1
11	Support Activities	$110.9	$109.5	$9.1	$7.0	$3.0	$2.0	$241.5
	Total:	$230.3	$248.7	$136.1	$18.6	$10.9	$7.2	$651.8

Figure 2-4. Site Suitability: Preliminary Cost Profile

2.6.1.2 Exploratory Studies Facility (WBS 1.2.6)

The Exploratory Studies Facility (Figure 2-1) is an underground network of tunnels and alcoves which will be excavated to provide access to the potential repository horizon in the Topopah Spring Level to conduct tests (see Work Breakdown Structure 1.2.3 for description of testing in the Exploratory Studies Facility). Construction of a number of surface facilities is required at the north portal to support the operation and maintenance of the Tunnel Boring Machine. Approximately two-thirds of the excavation in the Exploratory Studies Facility loop will directly support suitability. This includes the north ramp from the surface to the Topopah Spring Level, and the main Topopah Spring Level drift to the second, or southernmost, Ghost Dance fault drift (see Figure 2-1). This section of the Exploratory Studies Facility will provide the access necessary for geologic mapping of the exposed rock and direct examination and testing of the Ghost Dance fault to support the higher level findings on Preclosure Rock Characteristics and Geohydrology/Transport. Costs associated with excavation of the main drift beyond the second Ghost Dance fault access and excavation of the south ramp are allocated to licensing.

2.6.1.3 Site Investigations (WBS 1.2.3)

The Site Investigations program includes all surface based geology, hydrology, geochemistry, and climatology investigations, and modeling, as well as the drilling program. It also includes subsurface testing in the Exploratory Studies Facility. Fiscal year 1995 costs are based on actual budget allocations.

Workscope is generally allocated between site suitability and licensing as follows: approximately 70 percent-30 percent, respectively, in fiscal year 1996 and fiscal year 1997 based on information needs related to higher-level findings. In fiscal year 1998 and thereafter, all site investigations workscope was allocated to licensing based on the assumption that all scheduled technical basis reports will have been completed.

The Site Investigations Program must provide information and analyses to support both higher level findings required by 10 CFR Part 960, and a subsequent Safety Analysis Report required by 10 CFR Part 60. One of the distinguishing features of the Program approach is an accelerated effort to reach higher level findings early, in some cases several years prior to the final Safety Analysis Report. Consequently, the Safety Analysis Report will contain information and analyses that will not be available for technical site suitability evaluation. In particular, the entire cost of thermal effects evaluations are allocated to the licensing element.

The unsaturated zone hydrology program is relatively mature and will benefit greatly from observations and tests in the exploratory studies facility. A site-scale moisture flow model has been developed and was distributed to participants responsible for radionuclide transport modeling and performance assessment in fiscal year 1994. An adequate unsaturated zone hydrologic description, including gas flow and the role of major faults, is expected to be available to support the technical site suitability evaluation. Therefore, unsaturated zone costs for fiscal year 1996-97 are allocated to the suitability program. In contrast, a three-dimensional site-scale model of the saturated zone will be available in only preliminary form for the technical site suitability evaluation. Costs of field activities at the site and site-scale saturated zone modeling and synthesis activities are allocated to the suitability program to develop the model needed to

support higher level findings related to hydrology. Costs of additional regional studies to refine site boundary conditions, sensitivity/uncertainty analyses, and analyses of dilution to support dose estimates are allocated to licensing to support Safety Analysis Report performance assessments.The climate program is subdivided into efforts to characterize past, present, and future climates. The technical site suitability evaluation will utilize evidence of past climate from the geologic record and meteorological data to bound estimates as required by the postclosure qualifying condition for climate siting guidelines. The climate record is exceptionally complete in the southern Nevada region, and higher level findings based on this record will be quite robust. Therefore, the past and present climate programs are allocated to suitability. The future climate program is allocated to licensing to develop reasonable assurance that the magnitude of future climate change has been adequately bounded.

Costs for collection of three-dimensional geologic framework information such as stratigraphy, structure, mineral distributions, and fracturing patterns is allocated to the suitability program for fiscal year 1996-97 to support higher level findings on rock characteristics, geohydrology/transport, and tectonics. Development and implementation of a spatial data analysis system and interfaces to the process-modeling community to provide a capability for mapping framework information to simulation grids is considered to be a licensing function supporting the more mature performance assessments required for the Safety Analysis Report.

2.6.1.4 Waste Package and Repository Design (WBS 1.2.2 and 1.2.4)

Design workscope allocated to suitability is the minimum needed to support the preclosure safety evaluations. The other design workscope is allocated to licensing and focuses on that needed to support the containment performance objectives and safety assessments.

3. PROJECT NATIONAL ENVIRONMENTAL POLICY ACT ACTIVITIES

3.1 INTRODUCTION

The United States Department of Energy Office of Civilian Radioactive Waste Management is charged with developing the nation's first repository for the permanent storage of civilian high-level radioactive waste and spent nuclear fuel. The Nuclear Waste Policy Act of 1982, as amended, requires that the recommendation for repository development be accompanied by an Environmental Impact Statement. This plan outlines the roadmap for compliance with the National Environmental Policy Act provided by Congress in the Nuclear Waste Policy Act. The plan focuses on tasks necessary to compile data needed for an Environmental Impact Statement as well as preparation of the Environmental Impact Statement and supporting documentation. The scope of work integrates necessary data from design, site suitability, licensing, transportation, system safety and reliability activities, systems engineering, and on-going environmental monitoring data collection to prepare an adequate Environmental Impact Statement, as described below. The Repository Environmental Impact Statement will be prepared consistent with the overall Office of Civilian Radioactive Waste Management National Environmental Policy Act compliance strategy, as described in Volume I of this Program Plan.

The Nuclear Waste Policy Act of 1982, as amended, directed the Department of Energy to characterize only one site, Yucca Mountain in Nevada. The Act, as amended, excludes Yucca Mountain site characterization from the requirement of preparing an Environmental Impact Statement. In accordance with the Act, an Environmental Assessment was prepared in 1986 which concluded that no significant environmental impacts would occur as a result of the characterization of the Yucca Mountain site. An environmental program was also established to monitor and mitigate any adverse environmental impacts of site characterization. Environmental monitoring activities began in December 1985 and site characterization activities began in July 1991. If, after site characterization, the Yucca Mountain site appears to be suitable, the Secretary of Energy may submit to the President a recommendation that he approve the site for development as a repository. In accordance with the Nuclear Waste Policy Act, this recommendation must be accompanied by an Environmental Impact Statement which need not consider the need for the repository, alternatives to geologic disposal, or alternative sites to the Yucca Mountain site.

3.2 NATIONAL ENVIRONMENTAL POLICY ACT OBJECTIVES

The primary Project National Environmental Policy Act objective is to prepare an Environmental Impact Statement that can be adopted by the United States Nuclear Regulatory Commission in connection with its issuance of a construction authorization for the repository.

The major elements of the Environmental Impact Statement include the following:

- Notice of Intent;
- Public Scoping meetings;
- Implementation Plan;
- Draft Environmental Impact Statement;
- Draft Environmental Impact Statement Public meetings;

- Final Environmental Impact Statement;
- Record of Decision;
- Mitigation Action Plan, if necessary.

To support completion of these major Environmental Impact Statement elements, the Yucca Mountain Site Characterization Project may prepare various types of internal planning documents or engage in data gathering, as appropriate. Examples include:

- an Environmental Impact Statement Management Plan;
- an Environmental Impact Statement Public Participation Plan;
- an Environmental Impact Statement Scoping Plan;
- on-going data collection programs as part of site characterization; and
- baseline data reports describing existing conditions for each technical discipline in the Environmental Impact Statement that are then used to support preparation of the impact analyses.

3.3 STRATEGY FOR ACHIEVING NATIONAL ENVIRONMENTAL POLICY ACT OBJECTIVES

As noted earlier, the Office of Civilian Radioactive Waste Management Program approach will ensure that the realities of near-term management of spent nuclear fuel are addressed, that efficient, rapid progress is made toward determining the suitability of the Yucca Mountain site, and that the technical approach and schedules are both realistic and consistent with increased funding levels being sought by the Administration, as well as stakeholder expectations.

One of the primary elements of the Office of Civilian Radioactive Waste Management National Environmental Policy Act strategy is the preparation of a repository Environmental Impact Statement. This section describes the primary milestones and deliverables for this Project objective. In addition to the primary milestones and deliverables required for the repository Environmental Impact Statement, Figure 3-1 also depicts other internal planning steps and activities that may be necessary in order for the Project to accomplish the primary milestones. There may be numerous other activities and deliverables of a planning nature that must also occur in order to successfully achieve a more significant milestone or deliverable. The scope of this planning effort does not include capturing all of these other activities, although they would become part of the Project's internal deliberations and planning process in developing the repository Environmental Impact Statement.

As noted earlier (in Volume I), an important underlying premise for the project National Environmental Policy Act objective is that the repository Environmental Impact Statement will draw on the characterization information, including environmental support, that is already being developed for site suitability evaluations, ongoing site characterization, and license application studies. Much of this data will be relevant to the analyses required by National Environmental Policy Act in the Environmental Impact Statement.

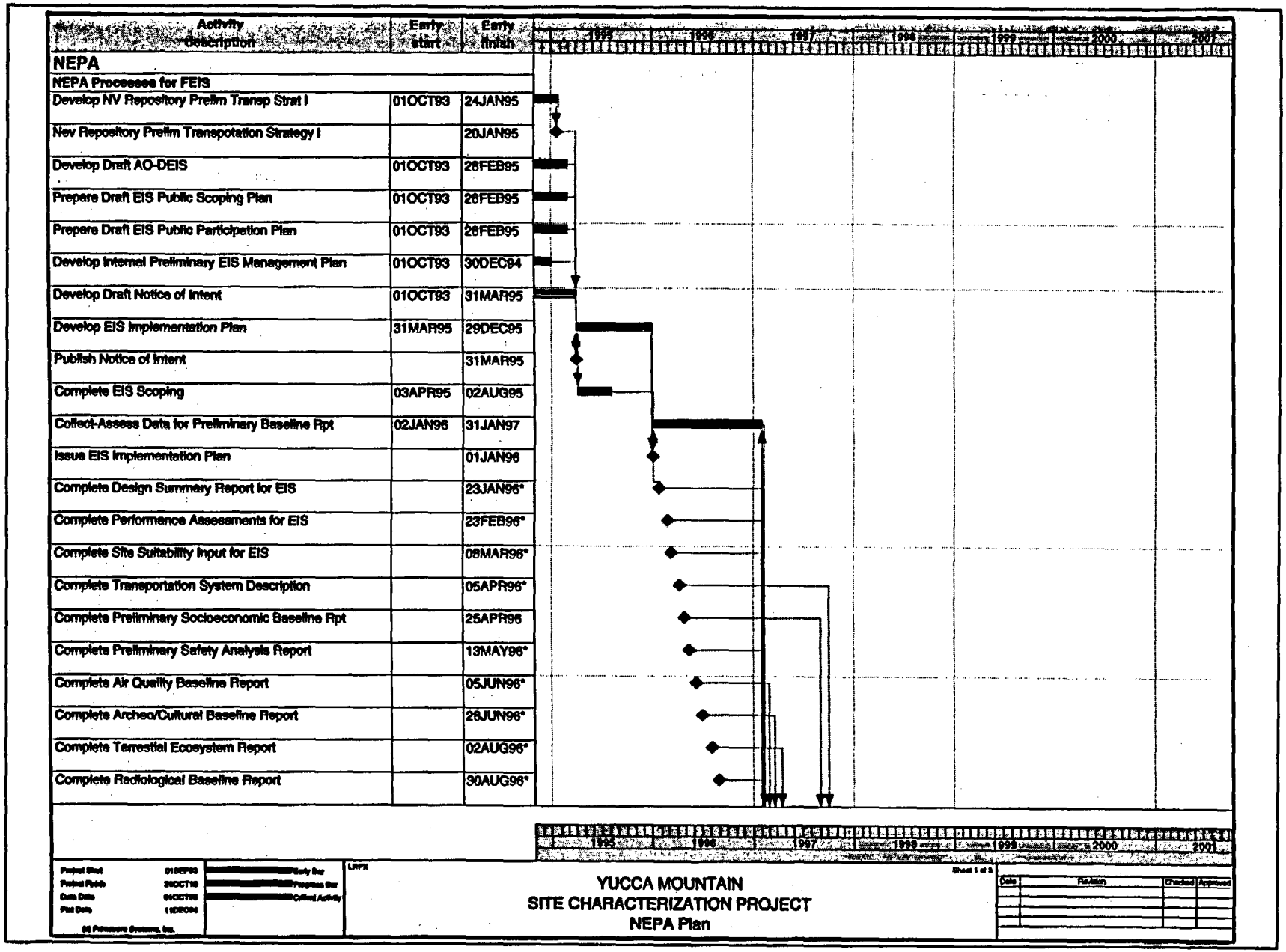


Figure 3-1. National Environmental Policy Act Plan [Schedule]

Figure 3-1. National Environmental Policy Act Plan [Schedule] (Continued)

Activity description	Early start	Early finish
Complete Water Resources Baseline Report		19SEP96*
Complete Landuse Baseline Reports		25OCT96*
Complete Soils Baseline Report		26NOV96*
Complete Noise Baseline Report		06DEC96*
Complete Aesthetics Baseline Report		25DEC96*
Complete Thermal Loading Ecosystem Study Report		22JAN97*
Perform EIS Impact Analyses	12FEB97	15JAN98
Complete Preliminary Baseline Data Reports		11FEB97*
Complete Air Quality Impact Report		28FEB97*
Complete Archeo/Cultural Impact Report		20MAR97*
Complete Terrestrial Ecosystem Impact Reqmnt		15APR97*
Complete Water Resource Impact Report		05MAY97*
Complete Noise Impact Report		30MAY97*
Complete Land Use Impact Report		06JUN97*
Complete Aesthetics Impact Report		20JUN97*
Complete Soils Impact Report		24JUL97*
Complete Socioeconomics Impact Report		02SEP97*
Complete Transportation Impact Report		03OCT97*
Prepare Preliminary DEIS	16JAN98	30MAR98
Complete EIS Impact Analyses		16JAN98*
Internal Review Preliminary DEIS	31MAR98	01JUL98
Prepare Final DEIS	02JUL98	31AUG98
EPA's Cert. of Avail. / DOE's Notice of Avail.		21SEP98

Activity description	Early start	Early finish
Issue DEIS		25SEP98*
Prepare Preliminary Final EIS	29SEP98	25FEB00
Develop Preliminary Comment/Response Document	29SEP98	22NOV99
Receive/Track Comments	29SEP98	24MAY99
DEIS Public Review Period	29SEP98	29MAR99
Compl Cmmnt/Rspnse Document for Internal DOE Rvw	26NOV99	03MAR00*
Draft Record of Decision	06MAR00	28SEP00
FEIS Internal DOE Review	06MAR00	09MAY00
Develop Final EIS	06MAR00	25AUG00
File FEIS with EPA		25AUG00*
30 Day No Action Period	28AUG00	22SEP00
Issue Final EIS- Include CRD		25AUG00
Issue Notice of Availability		25AUG00
Secretary Approval - Final Record of Decision		22SEP00
Publish Record Of Decision		28SEP00
Prepare Mitigation Plan	29SEP00*	30JAN01
Issue Mitigation Action Plan		30JAN01*
Continue Impact Monitoring	06FEB01	01DEC04

1995 1996 1997 1998 1999 2000 2001

1996 1996 1997 1998 1999 2000 2001

Early Bar
Progress Bar
Critical Activity

LRPX

YUCCA MOUNTAIN
SITE CHARACTERIZATION PROJECT
NEPA Plan

Sheet 3 of 3

Date	Revision	Checked	Approved

Figure 3-1. National Environmental Policy Act Plan [Schedule] (Continued)

The Repository Environmental Impact Statement will address potential impacts associated with construction and operation of a Repository. If the site appears to be suitable, this Environmental Impact Statement will support any repository development recommendation made by the Secretary to the President, as required by the Nuclear Waste Policy Act. The Repository Environmental Impact Statement is scheduled to commence with issuance of a Notice of Intent in mid-fiscal year 1995, and would be completed upon issuance of a Record of Decision in late fiscal year 2000 (see Figure 3-1). The impacts of postclosure performance of the repository and waste transport will be examined to the extent that they are known at the time the Environmental Impact Statement is being compiled. The Department of Energy will also, as appropriate and feasible, examine various repository operational scenarios that may affect design features. This may assist Department decision makers and provide a meaningful basis for comparison of the potential environmental impacts associated with the proposed action.

As performance confirmation and licensing efforts proceed, information and data will increase over time. This may result in a need to update the initial Repository Environmental Impact Statement to include any significant new circumstances or information relevant to environmental concerns. Both Council on Environmental Quality guidance and Department of Energy National Environmental Policy Act regulations support periodic evaluations to determine whether an existing Environmental Impact Statement remains adequate or needs to be updated. Updates allow Department of Energy to augment initial Environmental Impact Statement analyses based on the most current stage of operational activities and information resulting from confirmatory studies and data collection, to the extent such information is relevant to environmental concerns addressed in the Environmental Impact Statement. Any updates would be prepared consistent with current Department of Energy and Council on Environmental Quality National Environmental Policy Act guidelines.

The Repository Environmental Impact Statement will incorporate by reference and update, as appropriate, the methodologies and analyses from the national transportation impact assessments (including both highway and rail analyses) conducted for the Multi-purpose Canister Environmental Impact Statement and the programmatic Spent Nuclear Fuel Environmental Impact Statement. In addition, it is anticipated that the Repository Environmental Impact Statement will identify likely alternative transportation corridors in Nevada for eventual construction of a rail spur to Yucca Mountain. Transportation analyses will likely focus on the following:

1. Review of existing information for each alternative transportation corridor to determine: (a) social and economic impacts; (b) technical feasibility and direct costs; (c) land use and access impacts; (d) likely environmental impacts of constructing and operating a rail spur; and (e) population dose assessments.

2. Determining the feasibility of using a particular corridor for a rail spur to transport high-level waste to Yucca Mountain. Criteria will be developed to rank each corridor. This analysis will assist Department of Energy with determining the most preferred transportation corridor for eventual rail spur construction. It is anticipated that actual rail spur construction would be timed close to the point when waste would actually need to be shipped.

Preparation of the Repository Environmental Impact Statement will be consistent with the regulations that implement the procedural provisions of National Environmental Policy Act (40 CFR Parts 1500-1508), as modified by the Nuclear Waste Policy Act [Section 114(f)(1-3)]:

1. The need for the repository does not have to be considered in the Environmental Impact Statement;
2. Alternatives to geologic disposal do not have to be considered in the Environmental Impact Statement;
3. Alternative sites do not have to be considered in the Environmental Impact Statement;
4. The time of initial access to the repository does not have to be considered in the Environmental Impact Statement.

The Environmental Impact Statement must be developed on a schedule that will ensure its availability as part of the basis for any recommendation of development of a repository site by the Secretary of Energy to the President.

If necessary, following issuance of the Repository Environmental Impact Statement Record of Decision, the Department of Energy will also develop and issue a Mitigation Action Plan, pursuant to its own National Environmental Policy Act program regulations (10 CFR 1021.331) to address mitigation commitments made by the Department of Energy in the Repository Environmental Impact Statement Record of Decision.

3.4 NATIONAL ENVIRONMENTAL POLICY ACT PROGRAM ASSUMPTIONS

The information presented in this section assumes that:

1. The baseline data for the Repository Environmental Impact Statement (environmental, design, performance assessment, site suitability, transportation, and safety data) will be available in January 1997 to analyze potential environmental impacts in the Repository Environmental Impact Statement.

2. The scope of the Environmental Impact Statement as identified in Section 3.3 will not change significantly based on the results of the public scoping comments.

3. Data gathered during the confirmatory studies after release of the draft and final Environmental Impact Statements will not significantly change any of the projected impacts and conclusions in the Repository Environmental Impact Statement.

4. The Repository Environmental Impact Statement will evaluate at a feasibility level, likely alternative rail spur corridors to the site. The Repository Environmental Impact Statement Record of Decision will identify the preferred rail spur corridor for eventual construction of a rail spur to Yucca Mountain.

3.5 NATIONAL ENVIRONMENTAL POLICY ACT PLAN

This section summarizes the plan for the Project's National Environmental Policy Act objectives. The major milestones and other internal planning activities that support the National Environmental Policy Act program plan are shown in Figure 3-1.

There are National Environmental Policy Act activities that may occur after fiscal year 2000 as part of potential impact mitigation and to satisfy environmental permit conditions for ongoing environmental monitoring during site characterization at Yucca Mountain. After fiscal year 2000 environmental monitoring will focus on detecting potential significant adverse impacts to satisfy permit conditions and to maintain compliance with applicable environmental laws and regulations.

3.5.1 Project National Environmental Policy Act Activities for Fiscal Year 1995 ($15.1M)

A substantial amount of the environmental data that will be needed for the repository Environmental Impact Statement already exists through ongoing environmental impact monitoring data-collection programs. These programs have been gathering data, and will continue to gather data in fiscal year 1995, on the air quality and meteorology at the site, terrestrial ecosystems, cultural resources, regional water quality and quantity, radiological monitoring, and regional socioeconomics. Additional studies of soils, noise, and aesthetics are scheduled to begin in fiscal year 1995 and continue through fiscal year 1998. In accordance with the Nuclear Waste Policy Act, the Project maintains a continuous environmental monitoring data collection program at Yucca Mountain. This program is used to support the data needs anticipated for the Environmental Impact Statement as well as to satisfy environmental permit conditions and the requirements of Section 113(a) of the Nuclear Waste Policy Act. This section requires that site characterization activities be performed in a manner that minimizes significant adverse environmental impacts.

The information collected (both existing data and new data) will be used for: (1) baseline data reports covering the various environmental disciplines that will be included in the Environmental Impact Statement (e.g., air quality, terrestrial ecosystems, cultural resources, socioeconomics); (2) site suitability and performance assessment (e.g., geology, surface and ground-water hydrology, tectonics, climatology, as well as a report on Total System Performance Assessment); (3) examination of various repository operational scenarios that may affect design features. This may assist the Department of Energy decision makers and provide a meaningful basis for comparison of potential environmental impacts associated with the proposed action; (4) system safety and reliability; and (5) evaluation of alternative transportation corridors in Nevada. Updated national transportation analyses from the Multi-purpose Canister Environmental Impact Statement and programmatic Environmental Impact Statement will also be developed, as appropriate, and incorporated into the information compiled for the draft Repository Environmental Impact Statement.

3.5.1.1 Environmental Impact Statement

The major activities planned for fiscal year 1995 include: the development and issuance of an Environmental Impact Statement Notice of Intent, conduct of public scoping meetings, and collection and categorization of all public comments received. The Environmental Impact

Statement Notice of Intent is the Department of Energy's public announcement that the Department intends to initiate development of an Environmental Impact Statement for a potential repository at Yucca Mountain. This announcement is published in the Federal Register. The public scoping meetings schedule will be announced in the Notice of Intent. Public scoping meetings provide an opportunity for the public to comment on the scope of the Environmental Impact Statement. Planning for development of a preliminary draft Implementation Plan will be conducted in the latter part of fiscal year 1995. This will include developing an annotated outline for the Draft Environmental Impact Statement as well as categorizing the comments received by the Department during scoping. Proposed responses to these comments will also be developed.

3.5.1.2 Systems Engineering

Systems Engineering will identify, define, perform, and/or initiate special studies necessary to resolve National Environmental Policy Act issues that cross functional activities. In addition, support to program and project interface control will be provided in support of environmental activities.

3.5.1.3 Metrics - Fiscal Year 1995

In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less-tangible progress such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions.

Outputs: Environmental Impact Statement Notice of Intent

Outcomes: (1) Complete Environmental Impact Statement scoping; (2) develop plans for preparing preliminary draft Environmental Impact Statement Implementation Plan and categorize public comments; (3) write Environmental Field Activity Plans and initiate survey and monitoring programs for new studies such as aesthetics, soils and noise; (4) continue ongoing environmental monitoring for air quality, radiological, terrestrial ecosystems, archaeological and water quality and quantity in support of environmental compliance program and in support of the Environmental Impact Statement impact analysis process.

3.5.2 Project National Environmental Policy Act Activities for Fiscal Year 1996 ($25.2M)

In support of the National Environmental Policy Act function, responses to the Environmental Impact Statement scoping comments will be prepared as part of the public involvement process. Ongoing environmental monitoring and preparation of baseline reports will continue. Environmental data collection for noise, soils, aesthetics and any other parameters required as a result of the scoping process will be initiated.

3.5.2.1 Environmental Impact Statement Implementation Plan

The first major milestone in fiscal year 1996 will be completion of the Environmental Impact Statement Implementation Plan. This plan will discuss, among other things, the planned scope

and content of the Environmental Impact Statement; the purpose and need for the action; the scoping process and the results, including the disposition of comments; and expected consultation with other agencies. The disposition of comments will provide the Department of Energy's responses to the public comments on the scope of the Environmental Impact Statement and will summarize the issues raised through the scoping process. This effort will commence with the first comments received from the public during scoping and will continue after scoping until all comments have been addressed. A preliminary draft Implementation Plan will be completed in early fiscal year 1996, which will undergo internal review at appropriate offices within the Department of Energy. All comments generated from this internal review will be addressed in preparing a final Implementation Plan. A distribution list for the Implementation Plan will be prepared, a Notice of Availability for publication in the Federal Register and other media will be developed, and plans for printing, packaging, and distributing the document to all interested parties will be finalized. The Environmental Impact Statement Implementation Plan will be made available to the public for information purposes. Upon the Department of Energy's determination of the final scope of the Environmental Impact Statement, as identified in the Implementation Plan, the availability of existing data will be assessed, data gaps will be identified, and data-collection programs will be designed and conducted to fill the identified data gaps. Toward the end of fiscal year 1996, preliminary drafts of various chapters for the Environmental Impact Statement will be prepared.

3.5.2.2 Systems Engineering

Systems Engineering will initiate studies to support the National Environmental Policy Act program requirements for evaluating various repository operational scenarios. These studies include an analysis/evaluation of operational scenarios that may affect design features; a Nevada Transportation Corridor Study; and a system safety and reliability study. These studies will support the development of the baseline data reports.

3.5.2.3 Metrics - Fiscal Year 1996

Outputs: Environmental Impact Statement Implementation Plan

Outcomes: (1) Continue public involvement in Environmental Impact Statement process (e.g., responding to scoping comments); (2) Compile baseline data as required for the Environmental Impact Statement; (3) Initiate Systems Engineering studies to support National Environmental Policy Act program requirements; (4) Continue ongoing environmental monitoring for air quality, radiological, terrestrial ecosystems, archaeological, and water quality and quantity. These data are part of the environmental compliance program for site characterization activities at Yucca Mountain; the data will also be used to compile baseline data reports to support the Environmental Impact Statement impact analysis process; and, (6) Initiate environmental data collection for noise, soils, aesthetics, and any other studies required as a result of scoping.

3.5.3 Project National Environmental Policy Act Activities for Fiscal Year 1997 ($28.1M)

Day-to-day management of Environmental Impact Statement preparation, and internal Department of Energy coordination of the Environmental Impact Statement process, will continue through fiscal year 1997. In early fiscal year 1997, a summary of the results of geotechnical studies

associated with site suitability will be compiled for the Environmental Impact Statement. The Environmental Impact Statement will not duplicate the site suitability analyses but simply provide sufficient information to allow for assessing impacts. These studies include such topics as tectonic and volcanic hazards at Yucca Mountain, regional ground-water flow, and possible long-term climatic changes. By January 1997, the results of these geotechnical studies will be assembled for the Environmental Impact Statement in the form of an assessment of "total system performance," to the extent that information is available. A final summary of the Advanced Conceptual Design of the repository, various repository operational scenarios that may affect design features, and information on system safety and reliability will be compiled for the Environmental Impact Statement, as well as identification and comparison at the feasibility level of several likely alternative transportation corridors in Nevada. By January 1997, preliminary baseline data reports will be completed and impact analyses will be initiated for each Environmental Impact Statement discipline.

Preliminary impact analyses will begin in early-to mid-fiscal year 1997 and will consider results of a "total system performance" assessment of the Repository. Additional studies of system performance will continue to be conducted at Yucca Mountain, even after the release of the draft Environmental Impact Statement.

Toward the end of fiscal year 1997, preliminary drafts of the Environmental Impact Statement chapter on Impact Analyses and Environmental Consequences will be developed. Where necessary or appropriate, possible mitigation measures will be identified. Initial plans will be prepared for managing the public comment process for the draft Environmental Impact Statement. The draft chapter on the Purpose and Need, Affected Environment, and Regulatory Requirements will be updated on the basis of any new data and from reviewer comments.

3.5.3.1 Archaeology/Cultural Resources Baseline Report/Impact Analysis

The Archaeology/Cultural Resources Baseline Report will incorporate data from ongoing environmental monitoring as part of site characterization at Yucca Mountain. Activities that could damage or destroy archaeological sites and artifacts will be analyzed. In addition, potential impacts to prehistoric archaeological sites that may affect the values and heritage of Native Americans will be addressed.

3.5.3.2 Water Resources Baseline Report/Impact Analysis

The baseline conditions of water quality and quantity at and in the vicinity of Yucca Mountain will be addressed in the preliminary water resources baseline report. Impact analyses will also be conducted. Effects to existing local and regional surface and groundwater resources and existing users will be evaluated.

3.5.3.3 Land Use Baseline Report/Impact Analysis

Baseline data will be compiled and a preliminary report prepared to describe the existing land uses and land commitments in and around the vicinity of Yucca Mountain. The data will be used to address the direct uses of resource lands and the property being considered for development, surrounding areas that might be affected, current and future land use and growth trends in the

area, and land use plans, policies, and ordinances. Land use impact analysis will also be conducted.

3.5.3.4 Air Quality Baseline Report/Impact Analysis

Evaluation of potential repository impacts will focus on the prediction of the net changes in concentrations of atmospheric pollutants resulting from project emission sources. Data for the preliminary baseline report will include data collection through ongoing environmental monitoring as part of the environmental compliance program for site characterization activities at Yucca Mountain. Atmospheric dispersion models will be used to predict the resulting concentrations of various pollutants in the atmosphere and effects to the surrounding environment.

3.5.3.5 Terrestrial Ecosystem Baseline Report/Impact Analysis

Data from ongoing terrestrial ecosystem monitoring as part of site characterization will be included in the preliminary baseline report for terrestrial ecosystems. Impact evaluations on flora (vegetation) and fauna (wildlife) will include assessment of importance (e.g., legal, ecological, scientific, commercial) of the resource; amount of the population or habitat affected by the proposed repository; total size or areal extent of the population or habitat in the project area; and duration and/or ecological ramifications associated with the effect.

To the extent that the proposed repository affects biodiversity, and to the extent that it is possible to both anticipate and evaluate those effects, this will be addressed as part of the impact analysis.

3.5.3.6 Socioeconomics Baseline Report/Impact Analysis

A preliminary socioeconomic baseline report and impact analysis will address populations (including demographics, density, distribution, and environmental justice considerations), employment, income and economic structure; housing; transportation; community services and facilities; and public finance.

3.5.3.7 Radiological Baseline Report/Impact Analysis

Radiological monitoring data will be compiled into a preliminary baseline report using data collected as part of ongoing environmental and radiological monitoring during site characterization. Impact analysis will also be conducted.

3.5.3.8 Noise Baseline Report/Impact Analysis

Baseline data on noise will be compiled for the preliminary noise baseline report. Subsequent analysis of potential impacts to the public and wildlife will be performed.

3.5.3.9 Aesthetics Baseline Report/Impact Analysis

An aesthetics preliminary baseline report and impact analysis will address the visual character of the resources, the level of public interest and concern over changes in the quality of the resources, and the frequency with which the resources are viewed.

3.5.3.10 Soils Baseline Report/Impact Analysis

Soils data will be collected in the Yucca Mountain area to support the terrestrial ecosystem effects studies in the Repository Environmental Impact Statement. As necessary, this data will also be used to support any reclamation studies used as part of any Mitigation Action Plan developed by Department of Energy subsequent to the Record of Decision. Potential impacts to soils as a result of removing or compacting soils or other similar construction activities would be evaluated.

3.5.3.11 Thermal Loading Ecosystem Study

Potential effects to the ecosystem from the high-level waste heating the subsurface rock (i.e., thermal loading) and eventually affecting surface temperatures will be evaluated. An ecological modeling approach will be used to thoroughly understand the functional relationships in the ecosystem (e.g., soil moisture, soil temperature, nutrient levels, plant water use and productivity). Developing these models will require site-specific studies to ensure that these efforts reflect the repository system under study.

3.5.3.12 Transportation System Description

The Repository Environmental Impact Statement will incorporate by reference and update, as appropriate, the methodologies and analyses from the national transportation impact assessments (including both highway and rail analyses) conducted for the Multi-purpose Canister Environmental Impact Statement and the programmatic Spent Nuclear Fuel Environmental Impact Statement. Both highway and rail transportation scenarios will be evaluated for potential risks to the public or potential environmental impacts, taking into account technical, social, economic, and environmental factors.

The Repository Environmental Impact Statement will identify likely alternative transportation corridors in Nevada for eventual construction of a rail spur to Yucca Mountain. Transportation analyses will likely focus on the following:

1. Review of existing information for each alternative transportation corridor to determine (a) social and economic impacts; (b) technical feasibility and direct costs; (c) land use and access impacts; (d) likely environmental impacts of constructing and operating the rail spur; and, (e) population dose assessments.

2. Determining the feasibility of using a particular corridor for a rail spur to transport high-level waste to Yucca Mountain. Criteria will be developed to rank each corridor. This analysis will assist Department of Energy with determining the most preferred transportation corridor for eventual rail spur construction. It is anticipated that actual rail spur construction would be timed close to the point when waste would need to be shipped.

3.5.3.13 Repository Design Summary

The design concepts for the repository including various repository operational scenarios that may affect design features must be sufficiently complete in order to evaluate the likely environmental consequences from construction and operation. Anticipated environmental impacts during the postclosure period will be evaluated to the extent that they are known at the time the Repository Environmental Impact Statement is being compiled.

3.5.3.14 Total System Performance Assessment

A Total System Performance Assessment will be conducted for the draft Environmental Impact Statement which will address Repository performance assessment measures to be scoped through environmental and performance assessment consultations, and results will be made available for Environmental Impact Statement impact analyses. The draft report will describe the Total System Performance Assessment including the results and qualitative description of the uncertainty in the assessment and results. This Total System Performance Assessment draft report will provide part of the technical basis of the draft Environmental Impact Statement. This is intended to be an improvement over the Total System Performance Assessment 1995 iteration in terms of the data and information allowing more specific calculations.

3.5.3.15 Site Suitability Input

Numerous geotechnical studies are being performed to determine the suitability of the Yucca Mountain site for a repository. Data and conclusions from these studies will be presented in reports to support the technical site suitability evaluation. By January 1997, information that is available from these studies will be compiled as part of the Repository Environmental Impact Statement preliminary baseline reports and be used for evaluating environmental impacts. These reports would be finalized for purposes of providing references to support the environmental impact analyses in the Environmental Impact Statement.

3.5.3.16 Safety Analysis Report (System Safety and Reliability)

A Safety Analysis Report on system safety and reliability during repository construction and operation, and during preclosure, will cover potential radiological and non-radiological impacts under normal and reasonably-foreseeable accident conditions.

3.5.3.17 Systems Engineering

Systems Engineering will support the confirmatory studies of System Performance, by providing outputs from the Thermal Loading Study. Systems Engineering will also evaluate various repository operational scenarios and develop a site - generated waste disposal strategy in support of the Environmental Impact Statement impact analysis process.

3.5.3.18 Metrics - Fiscal Year 1997

Outputs: The preliminary baseline reports and technical information identified in Sections 3.5.3.1 through 3.5.3.17 will be generated in early fiscal year 1997.

Outcomes: (1) Ongoing environmental monitoring for air quality, radiological, terrestrial ecosystems, archaeological, and water quality and quality data is part of the environmental compliance program for site characterization activities at Yucca Mountain. The data will be compiled in preliminary baseline reports and used in the Environmental Impact Statement impact analysis process. (2) Initiation of impact analyses for the technical areas identified in Sections 3.5.3.1 through 3.5.3.17 will occur in fiscal year 1997 for ultimate inclusion in the draft Environmental Impact Statement.

3.5.4 Project National Environmental Policy Act Activities for Fiscal Year 1998 ($26.8M)

Environmental Impact Statement management and public interaction will continue in fiscal year 1998. Two Project milestones and one Program milestone will be accomplished in fiscal year 1998. The first Project milestone is the compilation and circulation of the preliminary draft Environmental Impact Statement for internal Department of Energy review. The reviews will focus on the technical adequacy of the Environmental Impact Statement as well as identification of management and policy level issues. A process for addressing internal Department of Energy comments will be developed, the preliminary draft Environmental Impact Statement will be revised, and the draft Environmental Impact Statement will be developed. The draft Environmental Impact Statement will be submitted for a final internal Department of Energy review. A distribution list for the draft Environmental Impact Statement will be completed, a Notice of Availability will be prepared, and final plans will be developed for printing, packaging, and distributing the document to all interested parties. In addition, plans will be finalized for conducting public information briefings and hearings.

The second Project milestone is the Department of Energy's filing of the draft Environmental Impact Statement with the Environmental Protection Agency, upon which the Environmental Protection Agency will issue a Notice of Availability of the draft Environmental Impact Statement in the Federal Register. This notice, along with the distribution of the draft Environmental Impact Statement, begins a six-month public comment period on the draft Environmental Impact Statement. The data base for tracking the public comments, which was initially developed in fiscal year 1997, will be operational in the fiscal year. The accuracy and completeness of the Administrative Record will also be assessed.

3.5.4.1 Preliminary Draft Environmental Impact Statement

The preliminary draft Environmental Impact Statement will be distributed for internal Department of Energy review in early fiscal year 1998. All comments received from this internal review will be compiled and dispositioned. Revisions to the Preliminary Draft Environmental Impact Statement will be made, and the document reviewed for overall internal consistency as part of preparing the Final Draft Environmental Impact Statement.

3.5.4.2 Environmental Protection Agency Notice of Availability and Department of Energy Notice of Availability

The Environmental Protection Agency Notice of Availability of the draft Environmental Impact Statement and the Department of Energy's Notice of Availability of the draft Environmental Impact Statement will be published in the Federal Register and other forms of media.

3.5.4.3 Draft Environmental Impact Statement

The draft Environmental Impact Statement will be published in late fiscal year 1998 and disseminated for public review and comment.

3.5.4.4 Systems Engineering

In fiscal year 1998, to support the final Environmental Impact Statement, Systems Engineering will be involved in updating several sections of the Draft Environmental Impact Statement in response to internal Department of Energy comments and input, and performing any necessary updated studies in response to Department of Energy and public comments received on the Draft Environmental Impact Statement.

3.5.4.5 Metrics - Fiscal Year 1998

Outputs: (1) preliminary internal review version of the draft Environmental Impact Statement; (2) Environmental Protection Agency's Notice of Availability and Department of Energy's Notice of Availability; and (3) draft Environmental Impact Statement.

Outcomes: (1) Prepare for the six-month public review of the draft Environmental Impact Statement in late fiscal year 1998 and early fiscal year 1999 (e.g., define public hearing dates and locations, secure facilities and administrative support); (2) Assure public comment tracking system is in place to handle the extensive comments expected on the draft Environmental Impact Statement; (3) Ongoing environmental monitoring will occur in fiscal year 1998 as part of site characterization for Yucca Mountain.

3.5.5 Project National Environmental Policy Act Activities for Fiscal Year 1999 ($24.0M)

The public review and comment period for the draft Environmental Impact Statement will be conducted commencing with publication of the Notice of Availability in the Federal Register in September 1998 and continuing for six months, until March 1999. The Department of Energy will hold public hearings on the draft Environmental Impact Statement in the state of Nevada and elsewhere. All comments received on the draft Environmental Impact Statement will be entered into a computerized data base for tracking, and initial responses to comments will be developed.

3.5.5.1 Systems Engineering

In fiscal year 1999, Systems Engineering will continue its support to the development of the final Environmental Impact Statement by completing updates to several sections of the Draft Environmental Impact Statement in response to internal Department of Energy and public comments, and completing any necessary updated studies in response to such comments.

3.5.5.2 Metrics - Fiscal Year 1999

Outputs: None.

Outcomes: (1) Continue the public interaction process (e.g., draft Environmental Impact Statement public review period); (2) Conduct public hearings on the draft Environmental Impact Statement; (3) Receive and track the public's oral and written comments on the draft Environmental Impact Statement; (4) Prepare responses to public comments; (5) Revise the draft Environmental Impact Statement in response to public comments; and, (6) Ongoing environmental monitoring will occur in fiscal year 1999 as part of site characterization activities for Yucca Mountain.

3.5.6 Project National Environmental Policy Act Activities for Fiscal Year 2000 ($17.0M)

A preliminary draft Comment Response Document will be prepared in early fiscal year 2000. The draft Comment Response Document will form the basis for making revisions to the draft Environmental Impact Statement based on the public comments received by the Department and preparation of the final Environmental Impact Statement in fiscal year 2000. The reviews of the draft Environmental Statement will focus on the technical adequacy of the revisions. A preliminary final Environmental Impact Statement will be compiled in early fiscal year 2000 for internal Department of Energy review. Based on internal comments received, a final Environmental Impact Statement will be developed. The final Environmental Impact Statement will be submitted for a final internal Department of Energy review and Secretarial approval. A distribution list for the final Environmental Impact Statement will be updated from the list developed for the draft Environmental Impact Statement, and plans will be developed for printing, packaging, and distributing the document to all interested parties. The final Environmental Impact Statement will be filed with the United States Environmental Protection Agency and a notice announcing the availability of the final Environmental Impact Statement will be published in the Federal Register. The distribution of the Final Environmental Impact Statement is a Program milestone. A 30-day no action period will then commence, after which the Department of Energy will publish a Record of Decision in the Federal Register. If necessary, following issuance of the Record of Decision, work will continue into fiscal year 2001 on preparation and implementation of any required Mitigation Action Plan and environmental monitoring for significant adverse environmental impacts.

3.5.6.1 Comment Response Document

The preliminary draft Comment Response Document will be completed in November 1999. It will summarize and respond to the comments raised by the public on the draft Environmental Impact Statement. The draft Comment Response Document will be included with the preliminary final Environmental Impact Statement package that is prepared for internal Department of Energy review. Any internal comments received on the Comment Response Document will be addressed, and a final version of the document prepared. The final Comment Response Document will be included as an appendix or as a separate volume to the final Environmental Impact Statement.

3.5.6.2 Preliminary Final Environmental Impact Statement

A preliminary final Environmental Impact Statement will be completed in February 2000 and distributed for internal Department of Energy review. Any internal comments received from the Department of Energy will be addressed and a final version of the final Environmental Impact Statement prepared. This final version will undergo one more round of internal review, for

concurrence purposes, at the Department of Energy, followed by submission to the Secretary of Energy for final approval.

3.5.6.3 Final Environmental Impact Statement and Notice of Availability

After preparation of the preliminary final Environmental Impact Statement, and on the basis of the Department of Energy's internal review and the Secretary's approval, the final Environmental Impact Statement will be filed with the United States Environmental Protection Agency and a Notice of Availability of the final Environmental Impact Statement will be published in the Federal Register, upon which a 30-day waiting period must elapse before the Department of Energy can make a decision on the action examined in the Environmental Impact Statement. Copies of the final Environmental Impact Statement will be distributed to all interested parties.

3.5.6.4 Record of Decision

After the 30-day waiting period, the Department of Energy will publish a Record of Decision in the Federal Register describing the final decision on the repository and any determination regarding a waste transportation corridor in Nevada. In addition, if mitigation measures are committed to by the Department of Energy in the Record of Decision, the Department will subsequently prepare a Mitigation Action Plan to identify how mitigation measures adopted in the Record of Decision will be implemented.

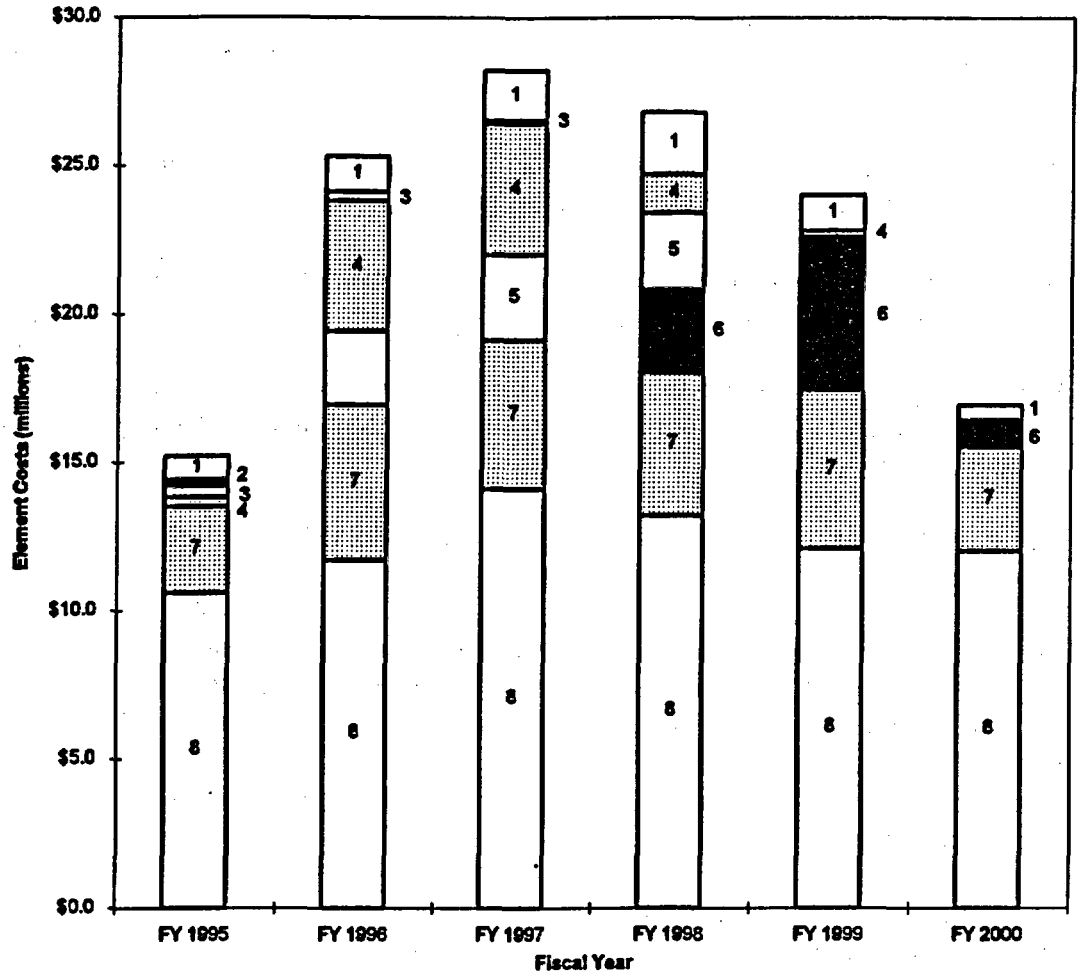
3.5.6.5 Metrics - Fiscal Year 2000

Outputs: (1) preliminary final Comment Response Document; (2) preliminary final Environmental Impact Statement; (3) final Environmental Impact Statement and Notice of Availability; and (4) Record of Decision.

Outcomes: (1) Ongoing environmental monitoring as part of the environmental compliance program for Yucca Mountain site characterization will occur in fiscal year 2000; and, (2) Tracking implementation of mitigation measures adopted in the Record of Decision.

3.6 NATIONAL ENVIRONMENTAL POLICY ACT COST ESTIMATE

Because of the difficulty in separating out the portion of information or data that is generated directly to support the National Environmental Policy Act analyses as opposed to that generated to support the technical site suitability evaluations, or potential license application, all environmental data collection efforts have been included and costed as part of the Environmental Impact Statement product for purposes of this plan. The cost profile for individual elements of the National Environmental Policy Act product area is provided in Figure 3-2, in terms of total costs and percentage distributions of these costs for fiscal year 1996 through fiscal year 2000. The cost profile for fiscal year 1995 is based on actual budget allocation. Additional detail on distribution of sub-element cost estimates to lower level Work Breakdown Structure is in Appendix A.



National Environmental Policy Act (millions)		Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1	Manage Environmental Impact Statement Activities	$0.8	$1.2	$1.7	$2.1	$1.2	$0.5	$7.5
2	Issue Notice of Intent	$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.2
3	Issue Environmental Impact Statement Implementation Plan	$0.4	$0.3	$0.1	$0.0	$0.0	$0.0	$0.8
4	Prepare Baseline	$0.3	$4.4	$4.4	$1.3	$0.2	$0.0	$10.6
5	Write Preliminary Environmental Impact Statement / Draft Environmental Impact	$0.0	$2.5	$2.9	$2.6	$0.0	$0.0	$8.0
6	Write Final Environmental Impact Statement / Record of Decision	$0.0	$0.0	$0.0	$2.8	$5.2	$0.9	$8.9
7	Associated Environmental Impact Statement Studies / Efforts	$2.9	$5.2	$5.0	$4.8	$5.3	$3.5	$26.7
8	National Environmental Policy Act Related Activities	$10.6	$11.7	$14.1	$13.2	$12.1	$12.0	$73.7
	Total:	$15.2	$25.3	$28.2	$26.8	$24.0	$16.9	$136.4

Figure 3-2. Cost Profile for Individual Elements of the National Environmental Policy Act Plan

3.6.1 National Environmental Policy Act Cost Assumptions and Methodology

The cost estimates for the National Environmental Policy Act section of this five year plan were developed in a tops-down manner as follows:

1. Workscope necessary to support the National Environmental Policy Act process was identified. This has been presented in the previous sections.

2. A detailed schedule of milestones that show progress toward the Final Environmental Impact Statement were then identified.

3. Work Breakdown Structure third level costs were estimated tops-down, with increases over fiscal year 1995, as appropriate to meet the National Environmental Policy Act process milestones.

4. These work breakdown structure third level control totals were allocated to the National Environmental Policy Act sub-elements.

5. The National Environmental Policy Act program will use environmental data collected for existing impact monitoring and permitting programs that support the ongoing site characterization suitability studies. The cost of collecting these data is included in the National Environmental Policy Act cost estimate even though these monitoring and permitting activities must continue as long as site characterization of future confirmatory studies continue.

6. The National Environmental Policy Act program will use data from ongoing activities that are included in the cost estimates for Suitability and Licensing.

7. Some new environmental data collection and performance assessment activities will be necessary to prepare the Repository Environmental Impact Statement.

8. The National Environmental Policy Act cost estimate was based on estimates made for each activity based on the cost of doing similar activities for other Department of Energy Environmental Impact Statements. Costs for preparing the Environmental Impact Statement also reflect the high visibility and controversial nature of the proposed repository project. Conducting scoping, resolving the many expected comments, and performing the numerous document reviews will lengthen the Repository Environmental Impact Statement process. Costs were estimated based on average costs for professional staff expected through the five year period.

4. LICENSING PROGRAM

4.1 INTRODUCTION

The Nuclear Waste Policy Act of 1982, as amended, directs the U.S. Department of Energy to characterize Yucca Mountain, Nevada as a candidate site for the first geologic repository. It also directs the U.S. Nuclear Regulatory Commission to promulgate and enforce regulations to protect the health and safety of the public. Consequently, the Department of Energy and the Nuclear Regulatory Commission are engaged in a pre-licensing process as potential applicant and regulator, respectively. The pre-licensing process proceeds continuously from Nuclear Regulatory Commission review of the Site Characterization Plan to submittal of the license application, should the site be determined suitable for development as a repository. During the pre-licensing phase, interactions between the Department of Energy and the Nuclear Regulatory Commission are conducted pursuant to applicable regulatory requirements. Although many related activities occur much earlier, formal licensing begins with the submittal of the license application and proceeds continuously until termination of the license by Nuclear Regulatory Commission. During this time, the Department of Energy must be prepared to perform the role of potential applicant during site characterization, applicant during the licensing proceedings, and licensee during operation, decommissioning, and permanent closure.

The licensing program outlined in the Program approach and presented in this plan has the primary objective of developing a successful license application for submittal to the Nuclear Regulatory Commission in June 2001. The sequence of events that must occur prior to the submittal of the license application is specified in the Nuclear Waste Policy Act, as amended, and in regulations implementing it. The following is a discussion of the chronology of major events planned to occur during the pre-licensing phase:

- Department of Energy conducts site characterization in accordance with Nuclear Waste Policy Act Section 113.

- Department of Energy requests certification from the Nuclear Regulatory Commission Licensing Support System Administrator that Department of Energy has sufficiently complied with the requirements in 10 CFR 2 Subpart J related to the submission of material to the licensing support system. According to 10 CFR 2 Subpart J, the Licensing Support System Administrator must provide this certification at least six months before submittal of the license application.

- Department of Energy requests preliminary comments from the Nuclear Regulatory Commission related to the extent to which at-depth site characterization analysis and the waste form proposal seem to be sufficient for inclusion in any license application. The Department of Energy must also request comments from the Nuclear Regulatory Commission related to the Environmental Impact Statement. These comments must be included in the Site Recommendation Report pursuant to Nuclear Waste Policy Act Section 114(a)(1), Subparagraphs D and E.

- Department of Energy incorporates the Nuclear Regulatory Commission's comments on sufficiency into the Site Recommendation Report.

- The Secretary of Energy notifies the Governor and the legislature of the State of Nevada of the decision to recommend the site to the President. According to Nuclear Waste Policy Act Section 114(a), such notification must occur at least 30 days before submittal of the Site Recommendation Report to the President.

- The Secretary of Energy submits the Site Recommendation Report to the President. The Site Recommendation Report contains all the information specified in Nuclear Waste Policy Act Section 114 (a)(1), Subparagraphs A-G, which includes the Environmental Impact Statement.

- If the President submits a site recommendation to Congress, the Program approach assumes it is to take place two months after the Department of Energy recommendation.

- The State of Nevada may submit a "notice of disapproval" to the Congress. The Governor and the legislature can take 60 days, allowed under Nuclear Waste Policy Act Section 115(b), to submit their "notice of disapproval" to the Congress.

- If the Congress passes a joint resolution of siting approval, it must occur within 90 days of continuous session after Congress receives "notice of disapproval" from the State of Nevada, as specified in Nuclear Waste Policy Act Section 115(f). The Department of Energy's milestone is to incorporate Congressional Resolution of Site Approval into the license application.

- The Secretary of Energy submits the Mined Geologic Disposal System license application to the Nuclear Regulatory Commission. This must occur no later than 90 days after Congress passes a joint resolution of siting approval, as required in Nuclear Waste Policy Act Section 114 (b). The license application must contain the general information and the Safety Analysis Report specified in 10 CFR 60.21. The license application must also be accompanied by the Environmental Impact Statement. The Mined Geologic Disposal System includes the site and its geologic setting, the underground and surface repository facilities, the waste package, and the transportation links on the site.

After the submittal of a license application, Department of Energy would assume the role of applicant. The following is a discussion of the chronology of major events that occur during the formal licensing process:

- Formal licensing proceedings start with the submittal of the license application. Nuclear Waste Policy Act Section 114(d) provides a period of three years for the Nuclear Regulatory Commission review of the license application, with a possible one year extension. During that period, the Nuclear Regulatory Commission will conduct a technical/regulatory review of the license application and issue a Safety Evaluation Report. Before issuance of the Safety Evaluation Report, Department of Energy anticipates it will respond to numerous requests for additional information from the Nuclear Regulatory Commission. The Nuclear Regulatory Commission's Atomic Safety and Licensing Board will then conduct an adjudicatory public hearing and issue an opinion. The findings of the board may be appealed to the Commission. If the board

finds that the license application satisfies all the regulatory requirements, construction could commence while the administrative or judicial appeals are pending, if the Nuclear Regulatory Commission so authorizes.

- After initiation of (a substantial) construction of the repository the Secretary of Energy must submit an updated license application to the Nuclear Regulatory Commission. The Nuclear Regulatory Commission would review the application and issue a license to receive and possess radioactive waste, if its findings are favorable, in accordance with the provisions of 10 CFR 60.41.

- After the waste has been emplaced and the performance confirmation period has been completed, the Secretary of Energy may submit an application to the Nuclear Regulatory Commission for a license amendment to decommission and permanently close the repository, in accordance with the provisions of 10 CFR 60.51.

- After permanent closure and the decommissioning or dismantlement of surface facilities, Department of Energy may apply for an amendment to terminate the license in accordance with the provisions of 10 CFR 60.52.

The previous list of events accentuates the relationship between site suitability, National Environmental Policy Act compliance, and licensing. The Site Recommendation Report to the President and the license application must be accompanied by the Environmental Impact Statement. The license application cannot be submitted to the Nuclear Regulatory Commission unless Congress approves the site. The interdependency of the Site Recommendation Report, the Environmental Impact Statement, and the license application, and the Nuclear Waste Policy Act requirement that the Nuclear Regulatory Commission review information provided in all three reports, clearly demonstrates the significance of product integration. Since each report requires information from the site characterization program, obtaining the information needed in each of these reports is required for the submittal of a successful license application.

4.2 LICENSING OBJECTIVES

The primary objective of the licensing program, if the site appears to be suitable for development of a repository, is to prepare a license application for submittal to the Nuclear Regulatory Commission. The content and quality of the license application information should be such that the Nuclear Regulatory Commission would accept it for docketing upon submittal, and be able to grant a construction authorization after the three-year review period mandated by the Nuclear Waste Policy Act. This section presents a discussion of objectives to implement the Program approach.

Consistent with the goals of the Program approach of both promoting efficiency within programmatic funding constraints and proceeding with on-site activities with minimal risk to public health and safety, the licensing activities will be conducted in a fashion that supports stepwise regulatory acceptance of the project. These activities include early substantive technical exchanges with the Nuclear Regulatory Commission during Department of Energy's site suitability evaluation, during the process of preparing a license application for the proposed

construction of a repository, during preclosure repository operation, and during other prospective licensing activities.

These licensing activities would provide sufficient information in the licensing documentation to support Nuclear Regulatory Commission's reasonable assurance findings required by 10 CFR 60 Subpart E concerning technical criteria. The Program approach emphasizes findings in the following areas:

1. Repository operations for a significant preclosure period.

2. Regulatory confidence that the waste package will contain wastes for at least 1,000 years after closure.

3. Acceptable bounding analyses of radionuclide releases and total system performance for 10,000 years.

4. An adequate testing program to support the design and bounding analyses, particularly with respect to establishing thermal effects on waste isolation.

The licensing program will be conducting performance assessments of relevant repository characteristics to identify actions which will further improve protection of public health and safety. Those analyses may be modified either in response to Nuclear Regulatory Commission comments during pre-licensing and licensing processes or in response to Nuclear Regulatory Commission license conditions.

The potential repository must isolate spent nuclear fuel and high-level radioactive waste (radioactive waste) from the accessible environment. For at least 1,000 years, this isolation is to be accomplished primarily through containment of the radioactive waste in engineered waste packages. Over longer times, continued isolation is to be achieved through assuring that the rate at which the radioactive components of the waste are released to the environment are well below applicable standards. The basis of that assurance is the long-term performance of the multiple natural barriers of the waste isolation system (arid climate, thick layers of unsaturated rock, additional rock layers which adsorb radionuclides, and long flow paths in the regional ground water system) in concert with the designed characteristics of engineered barriers.

Although most site investigations needed for the suitability evaluation are planned to continue in support of licensing, several will be completed, or nearly so, at the time the technical site suitability evaluation is made in 1998. The results of these investigations will be incorporated in the license application as prescribed in 10 CFR 60.21. Additional data collection, designs, and analyses will be focused on the primary objective of the licensing program, the submittal of a successful license application to the Nuclear Regulatory Commission in 2001.

4.3 LICENSING STRATEGY

The licensing strategy being implemented to achieve the above objectives is timely acquisition of information needed to support each step in the licensing process and early resolution of regulatory issues with the Nuclear Regulatory Commission.

The licensing strategy is implemented by: (1) identifying licensing information needed during site characterization and presenting issues to the Nuclear Regulatory Commission to facilitate their oversight of and guidance to the program by use of the license application annotated outline process; (2) submittals of licensing topical reports on key issues to the Nuclear Regulatory Commission for staff safety evaluation and acceptance so that results of those evaluations can be used during any potential licensing hearing; and (3) adherence to the procedural process mandated by the Nuclear Waste Policy Act.

To demonstrate progress in developing a viable license application, major milestones have been established for annual submittals of the license application annotated outline in order to: (1) enable the Department of Energy to assess when it has sufficient information to present to the Nuclear Regulatory Commission to resolve issues or to decide that site characterization in a specific technical area is complete; (2) present the Office of Civilian Radioactive Waste Management interpretation of the Nuclear Regulatory Commission's Draft Regulatory Guidelines DG-3003, Format and Content Guide for the License Application for the High-Level Waste Repository (1990), in increasing detail and understanding, for those areas consistent with Program approach goals; (3) track specific information needed for licensing from the various Project technical efforts in site characterization, design, and performance assessments, as well as from quality assurance; and, (4) enable the preparation and submittal of the actual license application, if the site appears to be suitable for development of a repository.

The activities supporting license application development directly implement the Nuclear Regulatory Commission regulatory guidance for a high-level waste repository license application as shown in Figure 4-1. Selected guidance chapter titles are shown in that figure and the complete table of contents from that guidance is reproduced in Appendix A. The licensing product plan thus provides the data gathering, design and analysis activities and knowledge necessary to support the license application milestone in June 2001.

To demonstrate progress in achieving issue resolution with timely Nuclear Regulatory Commission safety evaluation reports, major milestones, as shown in Figure 4-2, have been established for periodic submittals of topical reports on key issues for Nuclear Regulatory Commission review and evaluation. The results of those evaluations are critical to Department of Energy's understanding of the site characterization efforts required to address Nuclear Regulatory Commission's regulations. Subjects for topical reports are currently identified in areas of: (1) design and performance assessments methodologies; and (2) (3) mathematical models for performance assessments.

To demonstrate progress in achieving regulatory compliance, the following major milestones, as shown in Figure 4-2, have been established: (1) request Nuclear Regulatory Commission comments on data sufficiency for the Site Recommendation Report; (2) request for Licensing Support System certification from its Nuclear Regulatory Commission Administrator; and, (3) preparation and submittal of the license application. With the license application, Department of Energy's Environmental Impact Statement for the repository will be made available to the Nuclear Regulatory Commission.

The repository licensing program builds on the information and analyses that are required by 10 CFR Part 960 for the Department of Energy site suitability evaluation. The criteria that address

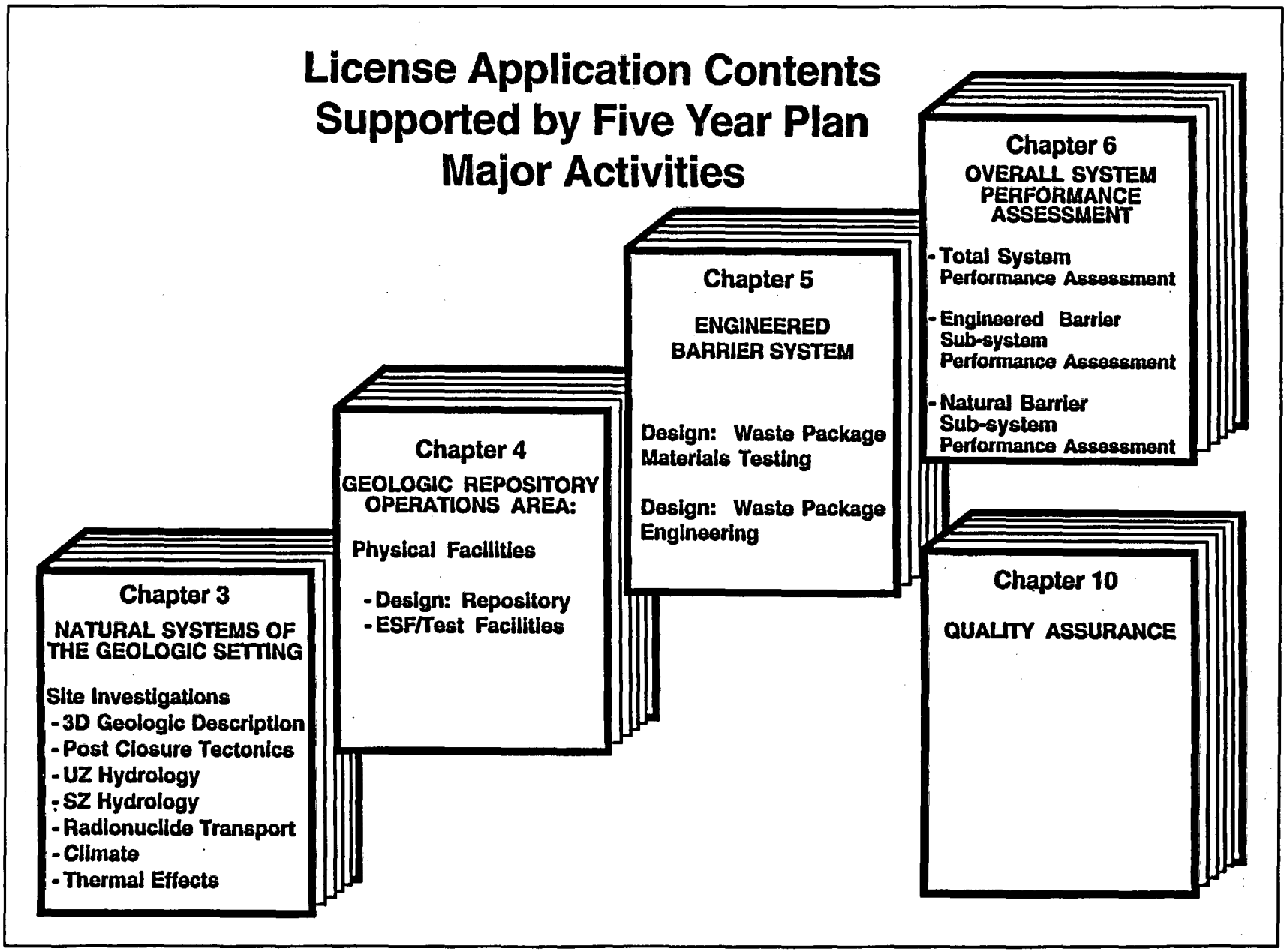


Figure 4-1. Activities Supporting License Application Activities

site conditions in 10 CFR Part 960 are similar to those of 10 CFR Part 60 and require similar data sets and analyses, although additional site information is required to support some aspects of design that do not significantly affect considerations of site suitability. The evaluations relative to Nuclear Regulatory Commission licensing criteria, however, will reflect the more extensive data base and more mature analyses gained in the period between the suitability evaluation and preparation of the license application. Consequently, in the following plan, the scientific program allocated to licensing is limited in scope until the technical site suitability evaluation is made in fiscal year 1998. Then many of the scientific investigations that supported suitability continue or expand in scope within the licensing context in order to develop greater confidence in the site data, in the repository system design, and in predictions of subsystems and system performance.

One particular aspect of repository design and licensing concerns the concentration of heat generated underground by spent nuclear fuel. This consideration is called "thermal loading." The licensing strategy for thermal loading at the time of repository construction license application submittal is based on the Multi-Purpose Canister concept and will ensure that the repository and waste package designs are flexible and robust. Analyses for that license application will be conducted in terms of a low thermal loading selected from the range of loading encompassed by the flexible design. In this case, the lowest thermal loading addressed in the repository advanced conceptual design is selected.

If the Yucca Mountain site is determined to be suitable and is approved for repository development, higher thermal loadings will be evaluated to improve cost and performance. In-situ heater tests operating for progressively longer times and at higher temperatures will reduce site thermal response uncertainty and demonstrate the basis for any proposed increase in safe repository thermal loading limits. The Program will consider this information and will select a thermal design before the license application update in 2008. It is expected that the license to receive and possess waste will contain loading and testing conditions that reflect the above strategy as implemented in the updated license application.

The short-range goal of the strategy is to identify an adequate thermal loading with uncertainty acceptable to the licensing process. The long-range goal of the strategy is to achieve the highest safe thermal loading. The approach described above has been selected because it provides the most flexibility in the design and the best means of exploring the full range of thermal loading options.

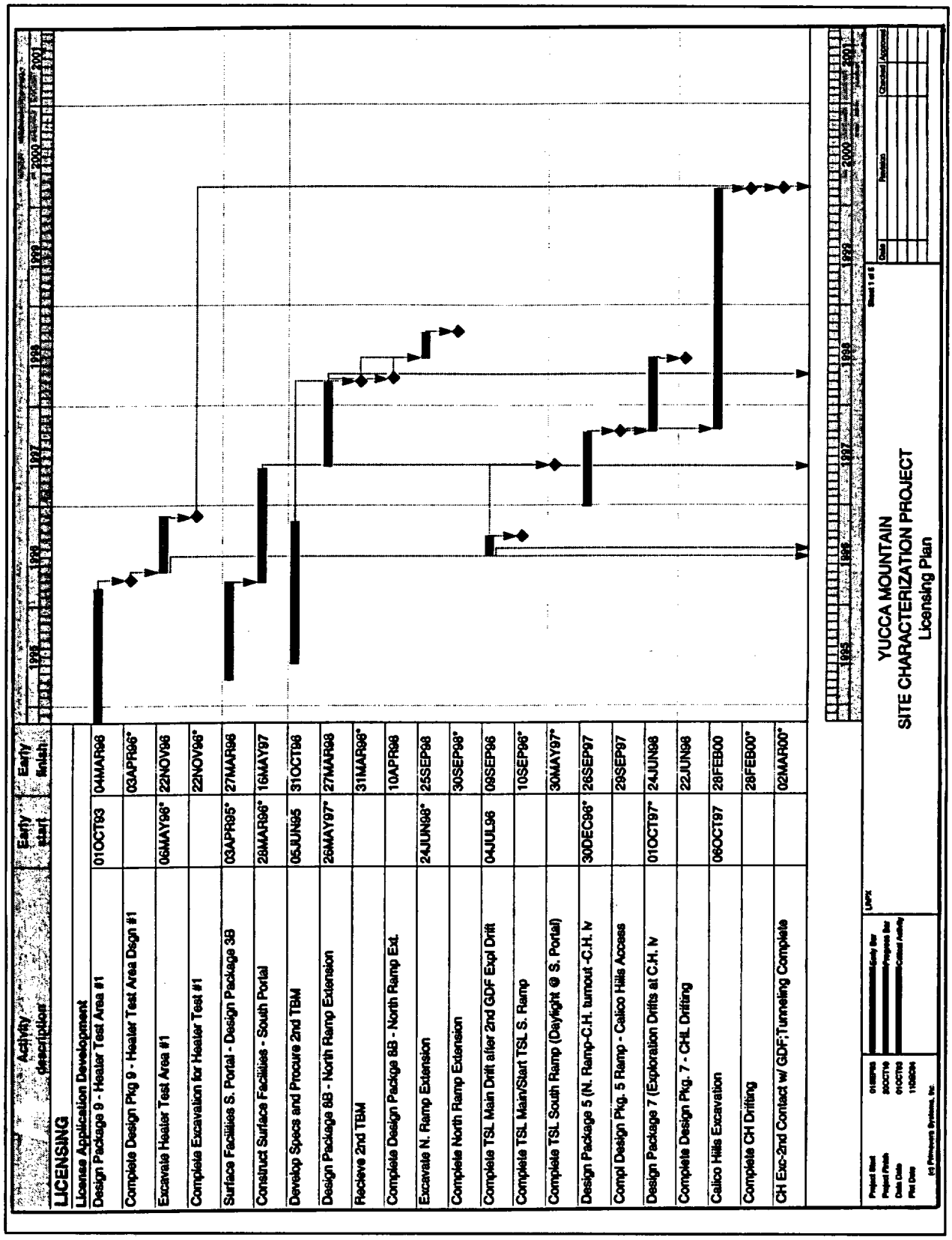


Figure 4-2. Major Milestones for Demonstrating Progress in Achieving Regulatory Compliance

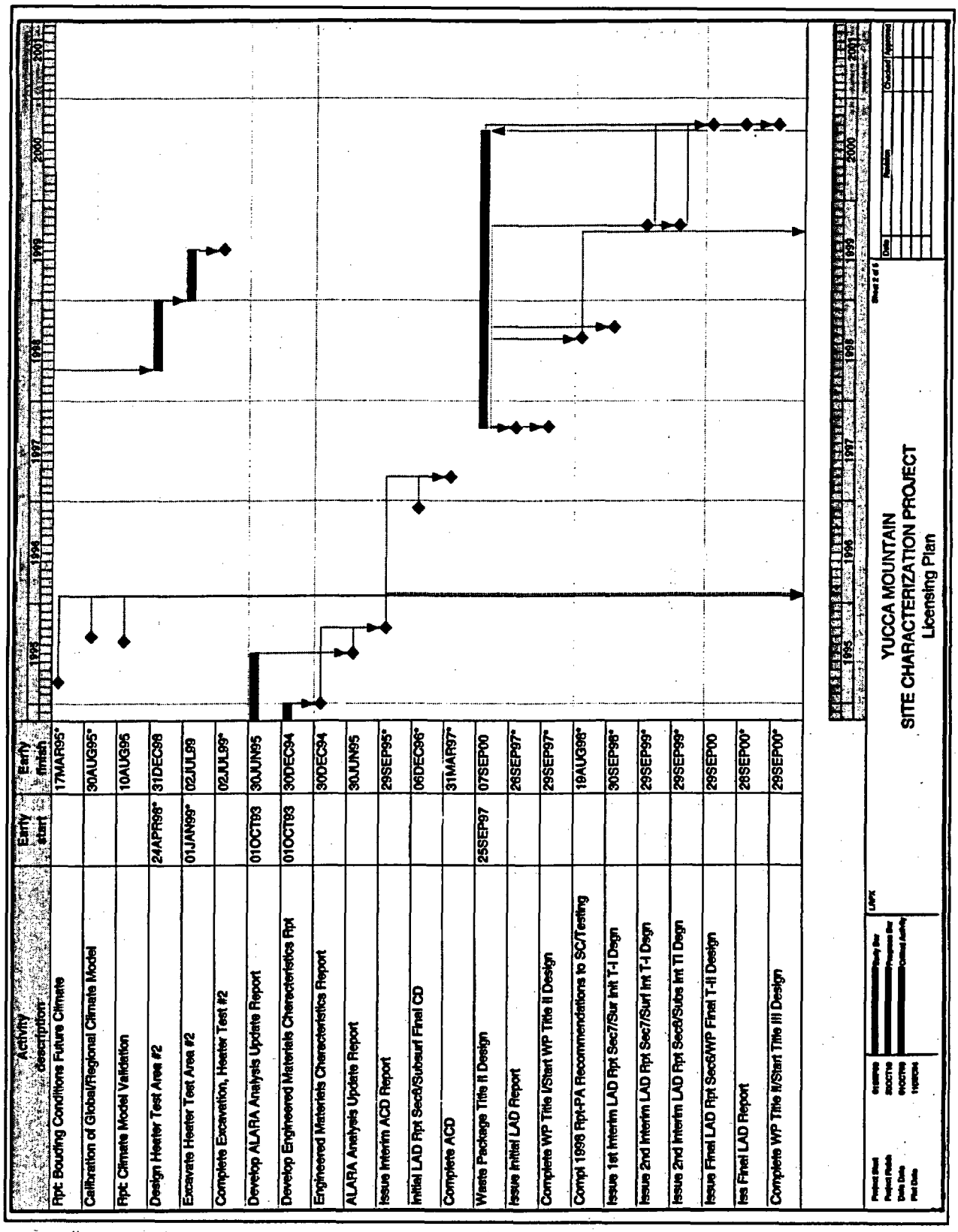


Figure 4-2. Major Milestones for Demonstrating Progress in Achieving Regulatory Compliance (Continued)

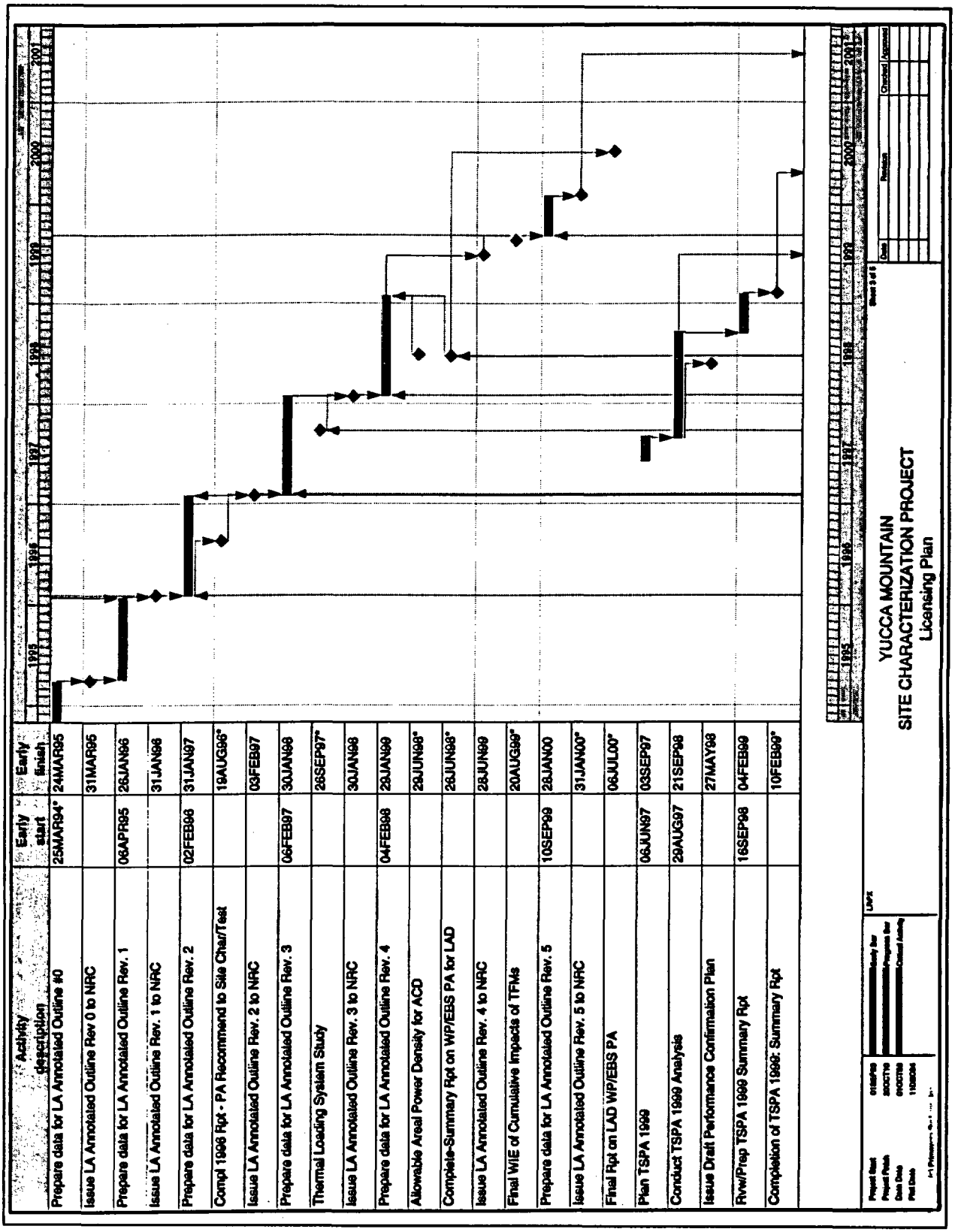


Figure 4-2. Major Milestones for Demonstrating Progress in Achieving Regulatory Compliance (Continued)

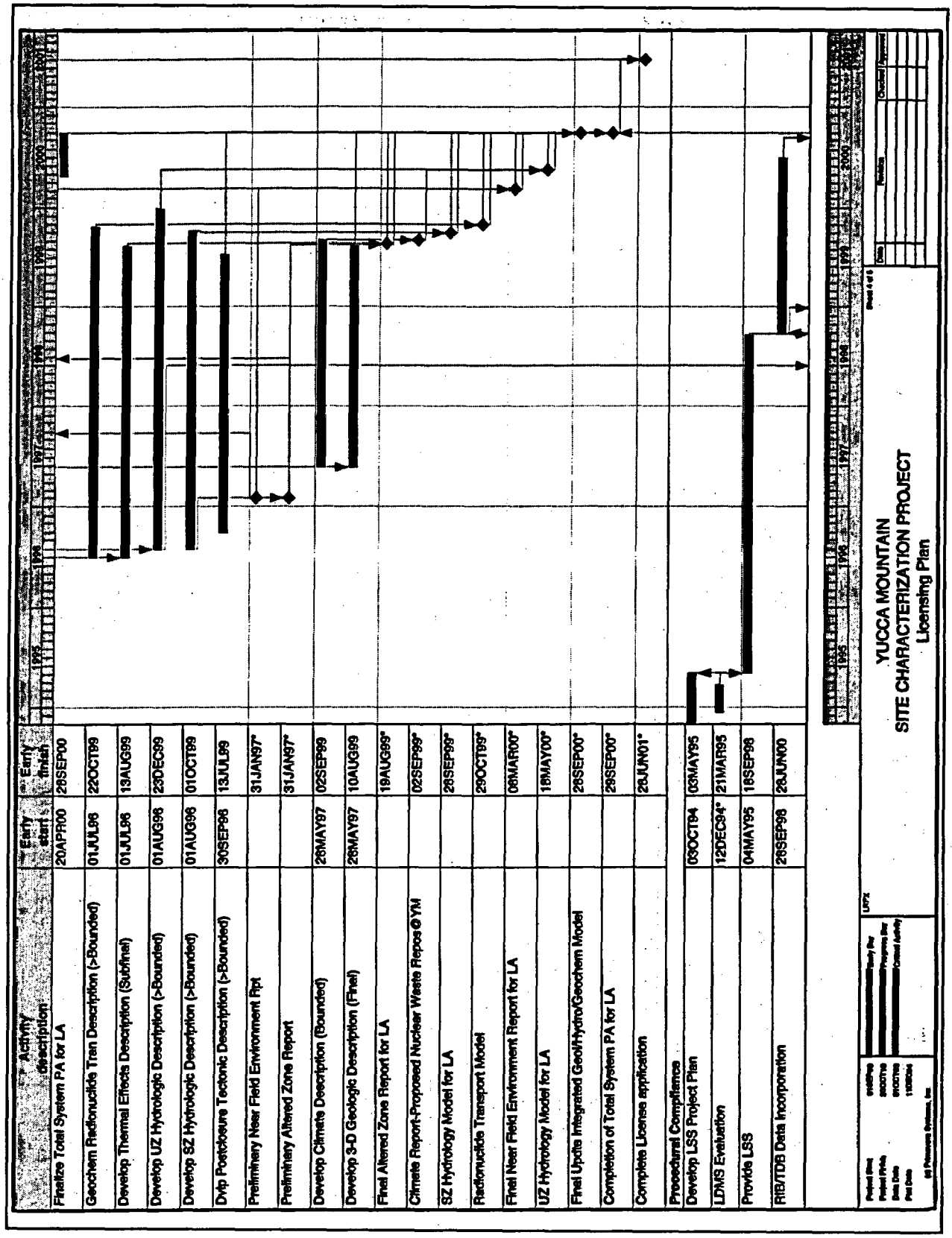


Figure 4-2. Major Milestones for Demonstrating Progress in Achieving Regulatory Compliance (Continued)

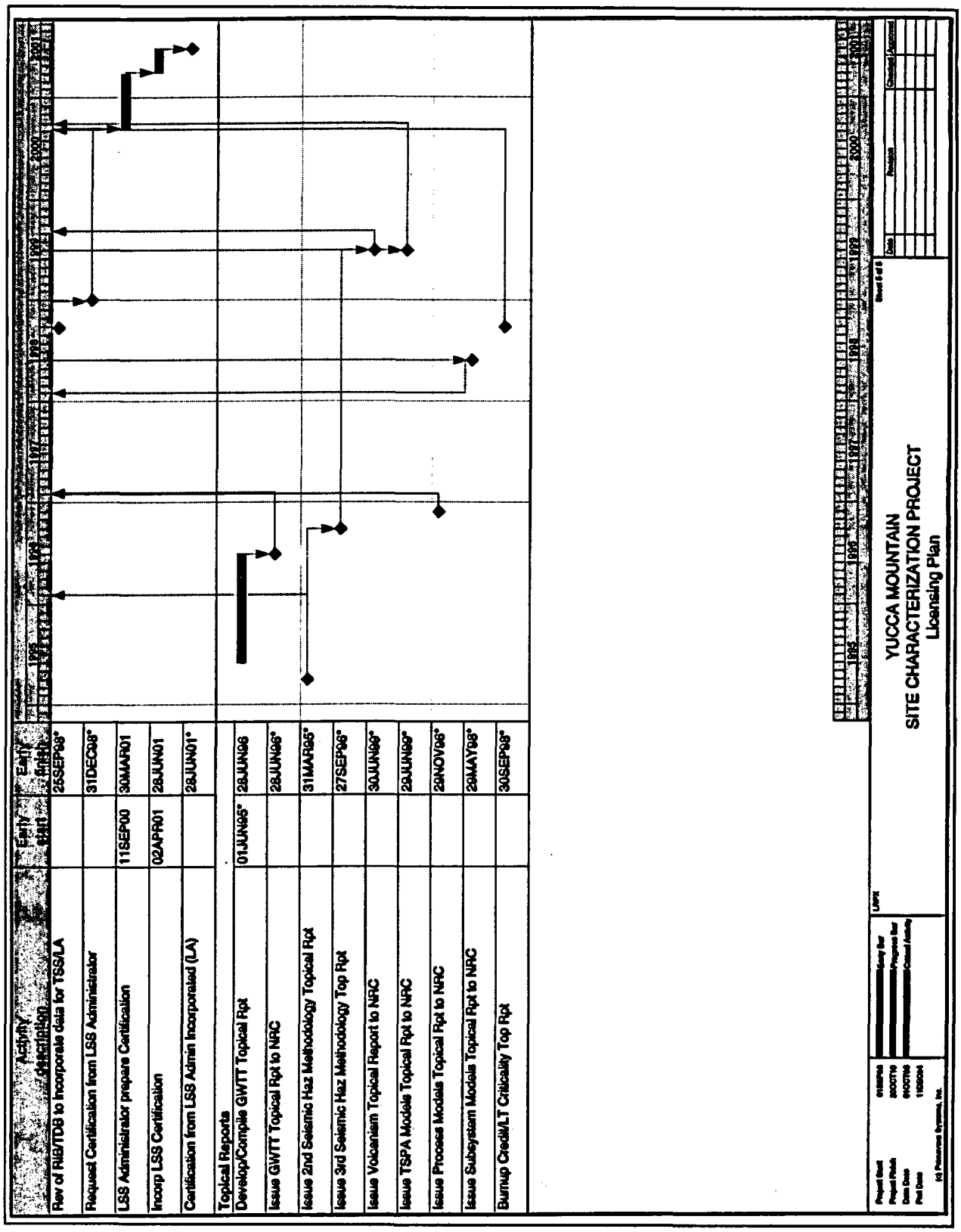


Figure 4-2. Major Milestones for Demonstrating Progress in Achieving Regulatory Compliance (Continued)

4.4 LICENSING ASSUMPTIONS

The plan for the licensing program is based on the following assumptions:

1. The new Environmental Protection Agency Standard will be similar to the remanded standard, 40 CFR Part 191 (Code of Federal Regulations), 1985: Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste. The new standard will enable compliance with a reasonable repository design and performance analysis. The National Academy of Sciences will make recommendations including reasonable consideration of Department of Energy suggestions. No changes to the Nuclear Waste Policy Act are considered. The Nuclear Regulatory Commission will modify 10 CFR Part 60, if required, to conform to the new Environmental Protection Agency standard. In the event the Environmental Protection Agency proposes a dose standard for a potential Yucca Mountain repository, adjustments may need to be made in the site investigations and performance assessments programs in the areas of flow, transport and dose modeling. No adjustments related to change in time frame, modification or elimination of release limits, modification or elimination of subsystem requirements, application of groundwater limits, etc. are reflected in this plan.

2. The Nuclear Regulatory Commission will accept and review licensing topical reports submitted by Department of Energy. Further, Nuclear Regulatory Commission will issue safety evaluations of those topical reports such that those evaluations may be referenced in any potential repository licensing hearing.

3. The Nuclear Regulatory Commission will promulgate 10 CFR 60 Subpart I, Emergency Planning Criteria, when it modifies 10 CFR Part 60 to conform to the new Environmental Protection Agency standard. Subpart I is currently reserved.

4.5 LICENSING PLAN

This section summarizes the plan for acquiring the information needed to achieve the objectives of the licensing program during the fiscal years 1995-2000. The schedule for the major milestones in the licensing program is presented in Figure 4-2.

In addition to the discussion of activities that directly support the licensing program's primary objective of developing a successful license application, progress in procedural compliance and support activities is discussed for each fiscal year. These activities include procedural compliance such as compliance with the requirements of 10 CFR 2 Subpart J related to the Licensing Support System as well as quality assurance requirements. Development of Exploratory Studies Facility surface and underground test facilities necessary to gather data for use in licensing is classified in the support subelement.

4.5.1 Fiscal Year 1995 ($28.7M)

Revision 0 of the license application annotated outline and two topical reports will be submitted to the Nuclear Regulatory Commission in fiscal year 1995. The scope of these deliverables is

discussed in Sections 4.5.1.1 and 4.5.1.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessments activities being performed to provide the necessary supporting information. Progress in the areas of procedural compliance and support activities is discussed in section 4.5.1.3.

4.5.1.1 License Application Annotated Outline Revision 0 (WBS 1.2.5.2)

The license application annotated outline process will continue in fiscal year 1995 in two efforts. The first is completion of Revision 0 which will complete Chapter 3, "The Natural Systems of the Geologic Setting," as well as update Chapter 6, "Overall System Performance Assessment," to incorporate the results of Total System Performance Assessment-1993. The second is the preparation of material for Revision 1 to fully implement the license application annotated outline process. Since Revision 1 will be submitted to the Nuclear Regulatory Commission in fiscal year 1996, details of that effort are presented in that year's portion of this plan.

The license application annotated outline process facilitates Nuclear Regulatory Commission staff's careful examination of any reductions in the Site Characterization Plan site characterization program that may result from the Program approach. It also ensures that information needed from site characterization, design, and performance assessments activities will be available when needed to support the licensing process.

The major information that will be incorporated into license application annotated outline Revision 0 is identified by chapter in this section. Also addressed are the supporting investigations and analyses for Revision 1. In addition, Nuclear Regulatory Commission's comments on previous license application annotated outline submittals will be incorporated, as appropriate.

A request to initiate changes to the Project plans may be necessary as a result of license application annotated outline development. Similarly, a request may be initiated to defer or eliminate studies that are no longer needed in support of licensing. The feedback provided by this phase of the process focuses site characterization activities on the acquisition of information needed to support the unified licensing approach embodied in the license application annotated outline.

4.5.1.1.1 Chapter 1 - General Information

General information will be developed from detailed information presented in the Safety Analysis Report (Chapters 2-11).

4.5.1.1.2 Chapter 2 - General Information for the Safety Analysis Report

Chapter 2 is not updated in Revision 0 of the license application annotated outline.

4.5.1.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

Chapter 3 presents the data from tests and predictive models that are supported by such measures as field and laboratory tests, monitoring data, and natural analog studies to demonstrate

compliance with the siting criteria in 10 CFR 60.122 and to support demonstration of compliance with long term performance objectives. Additional information needs will be identified to ensure that information in the context of 10 CFR Part 60 needed to support licensing (beyond that needed to reach higher-level findings), is obtained.

The following is a summary of the activities that are planned to support the development of Chapter 3 in fiscal year 1995:

4.5.1.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

Chapter 3 will be completed by incorporating the updated Project Site Description.

4.5.1.1.3.2 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

The hydrogeologic attributes of the thick unsaturated zone rocks will need to be quantified in terms of flux, velocity, and the effects of heat and potential climate change on these variables for both suitability and licensing evaluations. Investigations of fluid pathways in the unsaturated zone are essential to credible performance analyses of both the engineered and natural components of the geologic repository system.

4.5.1.1.3.3 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

A preliminary regional three dimensional hydrogeologic framework model will be completed which provides boundary conditions for site-scale analyses. Because of its important role in supporting analyses of flow and transport in the saturated zone, the regional hydrology program is considered to be a licensing activity.

4.5.1.1.3.4 Site Investigations: Radionuclide Transport (WBS 1.2.3)

The radionuclide transport program is a multi-year effort which will provide analyses of how ground water would carry radionuclides from the repository to the accessible environment, or biosphere, and whether numerous physical and chemical processes would retard this migration.

Because of their abundance in high-level waste and their long half-lives, radionuclides being studied include neptunium, plutonium, selenium, and technetium. Transport studies will focus on the types of information needed to support computer models of the hydrologic system and its capacity to transport radionuclides. Specifically, transport parameters describe limits on the solubility of key radionuclides in water, and how effectively the radionuclides would be removed from solution as they diffuse through the pores of the rock.

4.5.1.1.3.5 Site Investigations: Climate (WBS 1.2.3)

The future climate program will use computer models to simulate regional climate for a range of global conditions and provide comparisons between predictions and geologic observations for current and past climates. Through these analyses, bounds on the magnitude and duration of future climate conditions that may threaten repository integrity will be developed and supplied for use in establishing limits on water influx for site scale performance modeling. In fiscal year

1995, the regional climate model will be calibrated. Because of the uncertain effects of man's activities on future climate, and because these uncertainties are not likely to be resolved for technical site suitability evaluation, the future climate program is considered to be a licensing activity.

4.5.1.1.3.6 Site Investigations: Thermal Effects (WBS 1.2.3)

The effects of repository heat on the hydrologic system, mineral-water interactions, engineered systems, and fracture characteristics must be understood to support repository design and Total System Performance Assessment. In fiscal year 1995, the thermal effects program will continue characterization of the rock around the waste package, the effects of man-made materials on that environment, and impacts of the heat-affected zone surrounding a repository on repository performance and geochemical transport. Because of the long lead times required to obtain results from in-situ heater experiments, thermal effects studies are considered to be licensing activities.

4.5.1.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

Chapter 4 presents a description of the repository physical facilities and assesses their compliance with Nuclear Regulatory Commission regulations. A preliminary design for the repository that is flexible enough to accommodate a range of thermal loads will be outlined. Information needs for further design development will be identified to focus these activities on compliance with the preclosure performance objectives in 10 CFR 60.111. In addition, the seismic design basis for strong ground motion and fault displacement for both surface and subsurface facilities will be incorporated into the design criteria sections by reference to the Seismic Hazards Methodology Topical Report # 2, which will be sent to the Nuclear Regulatory Commission in fiscal year 1995. The following is a summary of the activities that are planned to support the development of Chapter 4 in fiscal year 1995:

4.5.1.1.4.1 Systems Engineering (WBS 1.2.1)

A Mined Geologic Disposal System Concept of Operations will be developed and maintained. This document will address physical facilities.

4.5.1.1.5 Chapter 5 - Engineered Barrier System

The following is a summary of fiscal year 1995 activities that are planned to support the development of Chapter 5:

4.5.1.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Activities will continue on the development of techniques for containment barrier closure, critical waste package component fabrication, non-destructive examination and in-service inspection, as well as stress reduction. Waste Package Title I design will continue, including providing waste package design information for development of Multi-Purpose Canister final design. These results will support Revision 1 of the license application annotated outline, but are allocated in fiscal

year 1995 to the site suitability product to support its needs for Advanced Conceptual Design information.

4.5.1.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.2)

The waste package materials testing in fiscal year 1995 supports Advanced Conceptual Design waste package design and review and definition of the Engineered Barrier System source term. These results will support Revision 1 of the license application annotated outline, but are allocated in fiscal year 1995 to the site suitability product to support its needs for Advanced Conceptual Design information.

4.5.1.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

Work completed on waste package and Engineered Barrier System performance assessments in support of Advanced Conceptual Design will be described in a report. This summary report will become a chapter of the draft Advanced Conceptual Design Report. The performance requirements to be addressed in these calculations are the substantially complete containment, and the controlled release subsystem performance requirements of 10 CFR 60.113. The results of these analyses will be used to refine the source term for Total System Performance Assessment.

4.5.1.1.6 Chapter 6 - Overall System Performance Assessment (WBS 1.2.5)

The results from Total System Performance Assessment-1993 will be incorporated into Chapter 6. The following is a summary of the activities that are planned to support the development of Chapter 6 in fiscal year 1995:

4.5.1.1.6.1 Total System Performance Assessment (WBS 1.2.5)

The performance assessment function will formally prepare the first annual update of recommendations, based on modeling and analyses, to help focus site characterization and testing on major uncertainties.

An estimate is to be made of the potential cumulative waste isolation effects of tracers, fluids and materials used in excavation, construction and testing. Computer code testing, model development, uncertainty and sensitivity studies, as well as selected laboratory and natural analogue studies to address process model validity are ongoing performance assessment activities every year for the Total System Performance Assessment effort.

4.5.1.1.7 Chapter 7 - Conduct of Repository Operations

The following is a summary of the activities that are planned to support the development of Chapter 7 in fiscal year 1995:

4.5.1.1.7.1 Systems Engineering (WBS 1.2.1)

A Mined Geologic Disposal System Concept of Operations will be developed and maintained.

4.5.1.1.8 Chapter 8 - Performance Confirmation Program

Performance confirmation activity is generally planned to commence in fiscal year 2001 when testing results are not available for the license application, or when those testing results are used to confirm the natural and engineered systems and components are functioning as intended and anticipated. The data collected during this plan will be sufficient to reasonably support the bounding and conservative analyses used in the license application. Data collected after that time and until permanent repository closure will provide an increased understanding of the site with reduced uncertainty and more accurate measurement and prediction of performance.

4.5.1.1.9 Chapter 9 - Land Ownership and Control

Chapter 9 is not updated in Revision 0 of the license application annotated outline.

4.5.1.1.10 Chapter 10 - Quality Assurance

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.1.3; however, Chapter 10 is not updated in Revision 0 of the license application annotated outline.

4.5.1.1.11 Chapter 11 - Emergency Plan

Chapter 11 will remain a planning package pending issuance of 10 CFR 60, Subpart I, Emergency Planning Criteria, which is currently reserved.

4.5.1.2 Topical Reports

The second seismic hazards assessment licensing topical report is planned to be submitted in fiscal year 1995 to resolve issues with the Nuclear Regulatory Commission. The Ground Water Travel Time topical report will be initiated.

The purpose of the second seismic hazards assessment licensing topical report is to gain Nuclear Regulatory Commission review and acceptance of the methodology for defining seismic inputs to repository design and containment performance assessment. The report will establish seismic safety categories for systems, structures and components at Yucca Mountain, and it will address the associated seismic safety performance goals and risk reduction factors.

The purpose of the ground-water travel time topical report is to develop a methodology for demonstrating compliance with Nuclear Regulatory Commission's requirement in 10 CFR 60.113(a)(2) and receive Nuclear Regulatory Commission acceptance. Hydrologic modeling and synthesis activities, experimental results from tracer tests at the C-well complex, and environmental isotope studies will comprise the technical basis for this report. A further objective is to obtain a clarification of the requirement from the Nuclear Regulatory Commission which would be consistent with characterizing an unsaturated site. While ground-water travel time has assumed singular importance as a regulatory issue, the need for this topical report has not imposed any requirements for site investigations activities beyond those designed to address performance issues.

4.5.1.2.1 Performance Assessment (WBS 1.2.5)

The performance assessment function is to prepare the content of the ground-water travel time Topical Report. The ground-water travel time criterion being addressed is to be defined, the technical approach is to be outlined, and sufficient detail is to be given to allow the Nuclear Regulatory Commission staff to evaluate the adequacy of the effort. The primary computer codes to be used in calculations are to be described, by reference if such codes were previously developed and documented. Any code development undertaken to support this effort will be described, as will any verification and testing either completed or planned. However, the emphasis of this topical report will be on the technical approach.

4.5.1.3 Procedural Compliance and Support Activities

Licensing program procedural and support activities are discussed in this section. Compliance with the procedural requirements in 10 CFR 2 Subpart J related to the Licensing Support System requires comprehensive information and technical data management systems. Compliance with the requirements of 10 CFR 60 Subpart G and requirement documents related to quality assurance that are incorporated by reference requires the implementation, compliance and enforcement of quality assurance program controls. In addition, test facilities must be developed and maintained to acquire the data necessary to support the site descriptions, designs, and performance assessments needed in licensing.

The following procedural compliance and support activities will be performed in fiscal year 1995:

4.5.1.3.1 Technical Data Management (WBS 1.2.5)

The technical data management function will continue to compile and assure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems and the Automated Technical Data Tracking System.

The Technical Data Base contains information which is used to prepare technical or scientific reports such as total system performance assessments, models, and design calculations and drawings, all of which eventually become licensing documentation. The Technical Data Base contains both appropriately qualified as well as unqualified information from which licensing documentation (e.g., topical reports) is prepared. Specifically, in fiscal year 1995, the Technical Data Base will support preparation of the topical reports identified in Section 4.5.1.2.

Essential to the licensing process is the identification and qualification of any existing data relied upon to demonstrate radiological safety and waste isolation and which were generated external to the approved quality assurance program. As licensing positions are developed, such data must be identified and a qualification process conducted to determine if sufficient confidence in these data can be established to permit their use for specific licensing purposes. If the data cannot be qualified for the specified use, alternative licensing strategies must be established.

4.5.1.3.2 Information Management (WBS 1.2.12)

The Licensing Data Management System demonstration and evaluation will be completed, and necessary system maintenance will be provided. Development of Licensing Support System requirements and strategy will be supported. A make-versus-buy and financial analysis will be conducted to support Licensing Support System configuration and construction decisions.

4.5.1.3.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through the maintenance of the Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description document and the development and maintenance of the Office of Quality Assurance's and the affected organizations' implementing documents. Quality assurance will consist of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with the Code of Federal Regulations. This will be accomplished by continuously improving the Quality Assurance Requirements and Description and implementing documents, performing independent quality assurance verification functions and management reviews; increased support to the field and associated site-related activities; maintaining traceability of Program requirements and their implementation via the Requirements Traceability Network database; continued review of implementing documents and records for compliance; ensuring personnel are adequately trained and qualified; ensuring adequate implementation of corrective action for identified conditions adverse to quality and evaluating corrective action documents for potential adverse trends; maintaining related computer tracking systems and data bases; and ensure records are maintained in accordance with Federal Regulations.

4.5.1.3.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

The Exploratory Studies Facility design and construction efforts, as well as site facilities and ongoing services continue to support all site characterization field activities, are allocated to the site suitability product in fiscal year 1995.

4.5.1.4 Metrics - Fiscal Year 1995

In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less-tangible progress such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions.

Outputs:

1. Issue Revision 0 of the license application annotated outline to complete Chapter 3, "The Natural Systems of the Geologic Setting," as well as update Chapter 6, "Overall System Performance Assessment," to incorporate the results of Total System Performance Assessment-1993.

2. Complete a preliminary regional three dimensional hydrogeologic framework model which provides boundary conditions for site-scale analyses.

3. The regional climate model will be calibrated.

4. A Mined Geologic Disposal System Concept of Operations will be developed and maintained.

5. Work done in waste package and Engineered Barrier System performance assessments in support of Advanced Conceptual Design will be reported.

6. Issue the first annual update of performance assessment recommendations, based on modeling and analyses, to help focus site characterization and testing on major uncertainties.

7. Submit the second seismic hazards assessment licensing topical report to the Nuclear Regulatory Commission to present the methodology for defining seismic inputs to repository design and containment performance assessment.

8. The Licensing Data Management System demonstration and evaluation will be completed, and necessary system maintenance will be provided.

9. Development of Licensing Support System requirements and strategy will be supported. A make-versus-buy and financial analysis will be completed.

Outcomes:

1. Prepare material for Revision 1 of the license application annotated outline to fully implement the license application annotated outline process.

2. The thermal effects program will continue characterization of the rock around the waste package, the effects of man-made materials on that environment, and impacts of the heat-affected zone surrounding a repository on repository performance and geochemical transport.

3. Waste Package Title I design and materials testing will continue, including providing waste package design information for development of Multi-Purpose Canister final design.

4. Estimate the potential cumulative waste isolation effects of tracers, fluids and materials used in excavation, construction and testing.

5. Continue ongoing performance assessment computer code testing, model development, uncertainty and sensitivity studies, as well as selected laboratory and natural analogue studies to address process model validity.

6. Initiate development of the Ground Water Travel Time topical report to present a methodology for demonstrating compliance with Nuclear Regulatory Commission's requirement in 10 CFR 60.113(a)(2).

7. The technical data management function will continue to compile and assure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems and the Automated Technical Data Tracking System.

8. The quality assurance controls will continue through the maintenance of the Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description document and the development and maintenance of the Office of Quality Assurance's and the affected organizations' implementing documents. Quality assurance will consist of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with the Code of Federal Regulations.

4.5.2 Fiscal Year 1996 ($79.3M)

Revision 1 of the license application annotated outline and three topical reports will be submitted to the Nuclear Regulatory Commission in fiscal year 1996. The scope of these deliverables is discussed in Sections 4.5.1.1 and 4.5.1.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessments activities being performed to provide the necessary supporting information. In fiscal year 1996 the licensing program will assume responsibility for those site characterization activities previously supporting evaluation of siting guidelines for preclosure hydrology, erosion, and surface characteristics. In addition, progress in the areas of procedural compliance and support activities is discussed in section 4.5.1.3.

4.5.2.1 License Application Annotated Outline Revision 1 (WBS 1.2.5.2)

The license application annotated outline process will be fully implemented early in fiscal year 1996 to create a comprehensive list of information needs for licensing to support annual and long range planning. Full implementation of the license application annotated outline process involves developing a licensing strategy that is consistent with the Program approach.

Revision 1 of the license application annotated outline will embody full implementation of the process by updating all chapters using the Nuclear Regulatory Commission's final Format and Content Regulatory Guide for the license application and their License Application Review Plan. Revision 1 will present Department of Energy's approach to support a reasonable assurance finding relative to 10 CFR Part 60 technical criteria, especially the subsystem and total system performance objectives. Revision 1 of the license application annotated outline will be submitted to the Nuclear Regulatory Commission to solicit Nuclear Regulatory Commission's comments on the Department of Energy's interpretation of the stepwise licensing process provided in 10 CFR Part 60.

The major information that will be incorporated into license application annotated outline Revision 1 is identified by chapter in this section. All chapters will be updated to incorporate fiscal year 1995 results from site characterization, design, and performance assessment activities and to reevaluate information needs based on the preliminary results. In addition, Nuclear Regulatory Commission's comments on previous license application annotated outline revisions will be incorporated, as appropriate.

4.5.2.1.1 Chapter 1 - General Information

General information will be developed from detailed information presented in the Safety Analysis Report (Chapters 2-11). The basis for licensing authority will be completed and the strategy for closing any unresolved safety questions after the submittal of a potential license application, consistent with the stepwise licensing process provided in 10 CFR Part 60, will be discussed. The most significant update to the chapter will consist of a comprehensive set of information needs to complete the chapter, including development of a Physical Security and Safeguard Plan.

4.5.2.1.2 Chapter 2 - General Information for the Safety Analysis Report

Revision 1 of the license application annotated outline will specifically identify Department of Energy's interpretation of all applicable Nuclear Regulatory Commission regulatory guidance, thus setting the stage for focused interactions. In addition, requirements for further technical information after the submittal of a potential license application will be presented to form the strategy for demonstrating compliance with long term performance objectives.

4.5.2.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

Results from site characterization activities supporting the evaluation of 10 CFR Part 960 siting guidelines for preclosure hydrology, erosion, and surface characteristics will be incorporated into Chapter 3. The following is a summary of the activities that are planned to support the development of Chapter 3 in fiscal year 1996:

4.5.2.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

The three-dimensional geologic description will provide error-bounded estimates of porosity, permeability, rock composition (chemistry and mineralogy), fracture characteristics, water content, and many other parameters that are required for flow and transport modeling and for engineering. The synthesis of the distribution of these properties throughout the volume of the site, provided by the suitability program, will be used to update the site description.

Requirements for performance confirmation monitoring of thermal and mechanical response of the host rock to repository thermal loads will be identified.

4.5.2.1.3.2 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

The licensing program will build on the probabilistic methodology developed to support technical site suitability evaluation to provide appropriate levels of assurance for licensing. Expert judgment studies, initiated in fiscal year 1995, will be combined and integrated to produce

distributions of the probability of volcanic disruption of the repository and the controlled area. This work provides an external and independent review of probabilistic volcanic hazard studies.

4.5.2.1.3.3 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

Analyses and interpretations of fluid movement in the unsaturated zone developed under the suitability program, will be incorporated into the site description and will be assimilated into performance analyses of subsystem and total system models. The licensing functions of the fiscal year 1996 unsaturated zone hydrology program are related to interfaces with evaluations of thermal effects and future climate change.

4.5.2.1.3.4 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

The licensing program will utilize the results of cross-hole tracer experiments at the C-well complex. Those results support estimates of ground-water travel time, sensitivities and uncertainties in the evaluation of ground-water travel time, and most importantly to assess mixing and dilution effects in the saturated zone that would limit individual and population doses. Models of fluid flow in the saturated zone and the results of their application provide information for the site description and describe the transport pathways for total system performance calculations. Because of its important role in supporting analyses of flow and transport in the saturated zone, the regional hydrology program (which provides boundary conditions for site-scale analyses) is considered to be a licensing activity.

4.5.2.1.3.5 Site Investigations: Radionuclide Transport (WBS 1.2.3)

The licensing program will utilize the radionuclide transport description developed within the site suitability program to initiate the model abstraction process for Total System Performance Assessment 1997, to provide estimates of model sensitivities and uncertainties and, ultimately, to provide recommendations for task prioritization to management. Data from prototype heater experiments will help determine how the changes in the chemistry of ground-water in the immediate vicinity of the waste packages will influence radionuclide mobility.

4.5.2.1.3.6 Site Investigations: Climate (WBS 1.2.3)

The future climate program will use computer models to simulate regional climate for a range of global conditions and provide comparisons between predictions and geologic observations for current and past climates. Through these analyses, bounds on the magnitude and duration of future climate conditions that may threaten repository integrity will be developed and supplied for use in establishing limits on water influx for site scale performance modeling.

4.5.2.1.3.7 Site Investigations: Thermal Effects (WBS 1.2.3)

In fiscal year 1996, the thermal effects program will continue characterization of the rock around the waste package, the effects of man-made materials on that environment, and impacts of the heat-affected zone surrounding a repository on repository performance and geochemical transport. Laboratory studies and field tests (in particular, the Large Block Test) will examine the coupled thermal-hydrologic-mechanical-chemical processes that interact with the waste package and may

significantly change the properties of the nearby rock relative to its natural state. Changes in permeability resulting from mineral-water reactions or silica redistribution will be examined. These results will be used to refine the range of testing conditions for waste package materials, and to develop and test hydrothermal models for design and interpretation of the North Ramp Engineered Barrier System Heater Test.

4.5.2.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

A preliminary design for the repository that is flexible enough to accommodate a range of thermal loads will be outlined. Information needs for further design development will be identified to focus these activities on compliance with the preclosure performance objectives in 10 CFR 60.111. In addition, the seismic design basis for strong ground motion and fault displacement for both surface and subsurface facilities will be incorporated into the design criteria sections by reference to the Seismic Hazards Methodology Topical Report # 2, which will be sent to the Nuclear Regulatory Commission in fiscal year 1995.

The following is a summary of the activities that are planned to support the development of Chapter 4 in fiscal year 1996:

4.5.2.1.4.1 Systems Engineering (WBS 1.2.1)

Systems Engineering will perform an analysis to classify the permanent and temporary Exploratory Studies Facility items and their effects on repository design. Two Design Summary Reports will be prepared to validate Exploratory Studies Facility design efforts. This validation will ensure that appropriate requirements from the design requirements baseline were incorporated in the design.

4.5.2.1.5 Chapter 5 - Engineered Barrier System

An outline for information on a robust waste package design consistent with the level of detail required for final design that maintains substantially complete containment for at least 1,000 years will be presented. A comprehensive list of information needs will be developed to focus further waste package design and performance assessments activities on compliance with the postclosure subsystem performance objectives in 10 CFR 60.113.

The following is a summary of fiscal year 1996 activities that are planned to support the development of Chapter 5:

4.5.2.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Activities will continue on the development of techniques for containment barrier closure, critical waste package component fabrication, non-destructive examination and in-service inspection, as well as stress reduction. Continuing Waste Package Title I design. Provide waste package design information for development of Multi-Purpose Canister final design.

4.5.2.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.5)

The waste package materials testing in fiscal year 1996 supports Advanced Conceptual Design waste package design and review and definition of the Engineered Barrier System source term. Limited, long-term spent fuel oxidation tests plus unsaturated condition and flow-through dissolution tests will be expanded to resume saturated spent fuel stagnant condition tests. Characterization of approved test materials will be completed. Borosilicate waste glass air/steam alteration, unsaturated condition tests will continue. Spent fuel and borosilicate waste glass degradation predictive models will be refined. The Waste Form Characteristics Report will be updated to support prediction of the Engineered Barrier System source term for performance assessments. Ongoing, long-term air/steam, pitting, crack propagation, unsaturated (drip) and saturated condition general corrosion tests on containment barrier materials will be expanded to include tests to measure crevice and microbiologically influenced corrosion. Short-term parametric degradation tests on materials to be used for the basket components of the waste package will be continued.

4.5.2.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

Code testing, model development, uncertainty and sensitivity studies, as well as, selected laboratory and natural analogue studies to address process model validity are ongoing performance assessments activities every year for the waste package/Engineered Barrier System performance assessments effort.

4.5.2.1.5.4 Systems Engineering (WBS 1.2.1)

A System Element Performance Allocation Study will be performed. The study will provide the basis for performance allocation to the waste form, waste package, and natural barriers. The Engineered Barrier Design Requirements Baseline will be revised to reflect results of the completion of Safety Analysis Report design for the multi-purpose canister, and the release of the new Environmental Protection Agency Standard.

4.5.2.1.6 Chapter 6 - Overall System Performance Assessment (WBS 1.2.5)

The results from Total System Performance Assessment 1995 will be incorporated into Chapter 6. Comprehensive information needs will be developed for conservative, bounding performance assessments to provide reasonable assurance that the long term, postclosure total system performance objectives in 10 CFR 60.112 can be met.

The following is a summary of the activities that are planned to support the development of Chapter 6 in fiscal year 1996:

4.5.2.1.6.1 Total System Performance Assessment (WBS 1.2.5)

The Total System Performance Assessment implications of the preliminary areal power density assumed in the Advanced Conceptual Design effort will be evaluated. The performance assessment function will formally prepare the second annual update of recommendations, based on modeling and analyses, to help focus site characterization and testing on major uncertainties.

An updated estimate is to be made of the potential cumulative waste isolation effects of tracers, fluids and materials used in excavation, construction and testing. Computer code testing, model development, uncertainty and sensitivity studies, as well as selected laboratory and natural analogue studies to address process model validity are ongoing performance assessment activities every year for the Total System Performance Assessment effort.

4.5.2.1.7 Chapter 7 - Conduct of Repository Operations

The preliminary Repository Concept of Operations developed in support of Advanced Conceptual Design will be incorporated and information needs will be developed to ensure enough detail on repository operations are developed to support Nuclear Regulatory Commission's independent review of preclosure safety.

The following is a summary of the activities that are planned to support the development of Chapter 7 in fiscal year 1996:

4.5.2.1.7.1 Systems Engineering (WBS 1.2.1)

Systems Engineering will update the Repository Concept of Operations.

4.5.2.1.8 Chapter 8 - Performance Confirmation Program

A performance confirmation program exceeding the 50 year requirement in 10 CFR 60 Subpart F, and perhaps up to 100 years, will be outlined in sufficient detail to facilitate Nuclear Regulatory Commission's guidance on the reasonable assurance compliance strategy. Requirements for performance confirmation monitoring of thermal and mechanical response of the host rock to repository thermal loads will be identified.

4.5.2.1.9 Chapter 9 - Land Ownership and Control

Information needs will be presented to develop plans for restricting controlled area access and regulating land use outside the controlled area. No additional information will be developed for Chapter 9 in fiscal year 1996 beyond that being acquired to support the National Environmental Policy Act program.

4.5.2.1.10 Chapter 10 - Quality Assurance

A description of the quality assurance program for site characterization and design and information needs for the quality assurance programs for construction, performance confirmation, operations, and decommissioning will be presented in enough detail to support Nuclear Regulatory Commission's independent review of preclosure safety.

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.1.3.3.

4.5.2.1.11 Chapter 11 - Emergency Plan

Chapter 11 will remain a planning package pending issuance of 10 CFR 60, Subpart I, Emergency Planning Criteria, which is currently reserved.

4.5.2.2 Topical Reports

The Ground Water Travel Time licensing topical report is planned to be submitted to the Nuclear Regulatory Commission.

The purpose of the ground-water travel time topical report is to develop a methodology for demonstrating compliance with Nuclear Regulatory Commission's requirement in 10 CFR 60.113(a)(2) and receive Nuclear Regulatory Commission acceptance.

4.5.2.2.1 Performance Assessment (WBS 1.2.5)

The performance assessment function will complete the content of the ground-water travel time Topical Report. More detail regarding the specific computer codes being used to address this site subsystem regulatory requirement will be presented in the Subsystem Modeling Topical Report to be issued in fiscal year 1998.

4.5.2.3 Procedural Compliance and Support Activities

The following procedural compliance and support activities will be performed in fiscal year 1996:

4.5.2.3.1 Technical Data Management (WBS 1.2.5)

The technical data management function will continue to compile and assure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems and the Automated Technical Data Tracking System.

Specifically, in fiscal year 1996, the Technical Data Base will support preparation of the topical reports identified in Section 4.5.1.2.

4.5.2.3.2 Information Management (WBS 1.2.12)

The Licensing Support System design will continue to implement requirements developed in fiscal year 1995. Interfaces with records systems will be developed.

4.5.2.3.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal Regulations.

4.5.2.3.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

Heater testing to be conducted in the North Ramp of the Exploratory Studies Facility (Heater Test #1), as well as in the repository horizon adjacent to the North Ramp Extension (Heater Test #2), supports the licensing function by providing data for site performance modeling. During fiscal year 1996, the test area drifts off the North Ramp will be excavated, providing access to the first heater test area. Other required heater test drifting off the North Ramp Extension, using drill-and-blast, will be done in fiscal year 1999.

The Exploratory Studies Facility final design efforts will consist of start and finish of the design on the south portal surface site preparation, utilities and facilities.

Site facilities and ongoing services continue to support all site characterization field activities. Those services include: operating and maintenance of all site buildings, roads, utilities, and services; access and visitor control services; bus transportation for all field activities; management of the operations and maintenance and capital asset systems; transportation and services for public tours; light duty vehicles; rehabilitation/upgrades required to existing facilities and utilities as required for compliance; direct and administrative support to project participants at the site; field permitting programs; occurrence reporting; energy management programs; Geographic Information System; annual Site Development Plan; and general field engineering support. In fiscal year 1996, access road upgrades will be designed.

4.5.2.4 Metrics - Fiscal Year 1996

In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less-tangible progress such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions.

Outputs:

1. Issue Revision 1 of the license application annotated outline to embody Nuclear Regulatory Commission's final Format and Content Regulatory Guide for the license application and their License Application Review Plan.

2. Complete a Systems Engineering analysis to classify the permanent and temporary Exploratory Studies Facility items and their effects on repository design.

3. Prepare two Exploratory Studies Facility Design Summary Reports to validate that appropriate requirements from the design requirements baseline were incorporated in the designs.

4. Issue a summary report describing work done in waste package and Engineered Barrier System performance assessment in support of Advanced Conceptual Design addressing the performance requirements of substantially complete

containment, and the controlled release subsystem performance requirements of 10 CFR 60.113.

5. Complete a System Element Performance Allocation Study to allocate performance, with regards to substantially complete containment, to the waste form, waste package, and natural barriers.

6. Revise the Engineered Barrier Design Requirements Baseline to reflect results of the completion of Safety Analysis Report design for the multi-purpose canister, and the release of the new Environmental Protection Agency Standard.

7. Issue the second annual update of recommendations, based on performance assessment modeling and analyses, to help focus site characterization and testing on major uncertainties.

8. Issue the initial Topical Report Long Term Criticality Control for the repository waste package to gain the Nuclear Regulatory Commission review and acceptance of the initial basis, methodology, and analysis for determining the Long Term Criticality Control for the waste package design which will be submitted as part of the license application.

9. Issue the ground-water travel time Topical Report to develop a methodology for demonstrating compliance with Nuclear Regulatory Commission's requirement in 10 CFR 60.113(a)(2).

10. During fiscal year 1996, the test area drifts off the North Ramp will be excavated, providing access to the first heater test area. Other required heater test drifting off the Topopah Spring Level main drift, using drill-and-blast, will be started late in fiscal year 1996 and continue into fiscal year 1997.

11. The Exploratory Studies Facility final design efforts will consist of start and finish of the design on the south portal surface site preparation, utilities and facilities.

Outcomes:

1. Update the site description with parameters required for flow and transport modeling and for engineering based on the distributions of these properties throughout the volume of the site as provided by the suitability program.

2. Requirements for performance confirmation monitoring of thermal and mechanical response of the host rock to repository thermal loads will be identified.

3. Expert judgment studies, initiated in fiscal year 1995, will be combined and integrated to produce distributions of the probability of volcanic disruption of the repository and the controlled area.

4. The licensing program will utilize the radionuclide transport description developed within the site suitability program to initiate the model abstraction process for Total System Performance Assessment-1997, to provide estimates of model sensitivities and uncertainties and, ultimately, to provide recommendations for task prioritization to management.

5. Changes in permeability resulting from mineral-water reactions or silica redistribution due to thermal effects on repository horizon rock will be examined. These results will be used to refine the range of testing conditions for waste package materials, and to develop and test hydrothermal models for design and interpretation of the North Ramp Engineered Barrier System Heater Test.

6. Computer code testing, model development, uncertainty and sensitivity studies, as well as, selected laboratory and natural analogue studies to address process model validity are ongoing performance assessment activities every year for the waste package/Engineered Barrier System performance assessment and total system performance assessment efforts.

7. Update the estimate of the potential cumulative waste isolation effects of tracers, fluids and materials used in Exploratory Studies Facility excavation, construction and testing.

8. Evaluate the total system performance assessment implications of the preliminary areal power density assumed in the Advanced Conceptual Design effort.

9. Studies will be undertaken and a progress report prepared for the postclosure tectonics program describing the development of scenarios for the effects of earthquake faulting on the repository and waste isolation system.

10. A performance confirmation program extending well beyond the 50 year requirement in 10 CFR 60, Subpart F will be outlined in sufficient detail to facilitate Nuclear Regulatory Commission's guidance on the reasonable assurance compliance strategy.

11. The technical data management function will continue to compile and assure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems and the Automated Technical Data Tracking System.

12. The Licensing Support System design will continue to implement requirements developed in fiscal year 1995. Interfaces with records systems will be developed.

13. The quality assurance controls will continue through the maintenance of the Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description document and the development and maintenance of the Office of Quality Assurance's and the affected organizations' implementing documents. Quality assurance will consist of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with the Code of Federal Regulations.

4.5.3 Fiscal Year 1997 ($230.0M)

Revision 2 of the license application annotated outline and two topical reports will be submitted to the Nuclear Regulatory Commission in fiscal year 1997. The scope of these deliverables is discussed in Sections 4.5.2.1 and 4.5.2.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessment activities being performed to provide the necessary supporting information. In addition, progress in the areas of procedural compliance and support activities is discussed in Section 4.5.2.3.

4.5.3.1 License Application Annotated Outline Revision 2

Revision 2 of the license application annotated outline will consist of major update to chapters 4 and 5 to incorporate the results of repository Advanced Conceptual Designs. In addition, Chapter 7 will be updated to reflect the impact of conceptual design on the repository concept of operations. Other major changes that will be incorporated into license application annotated outline Revision 2 are identified by chapter in this section. All other chapters will be updated to incorporate results from site characterization and performance assessment activities and to reevaluate information needs based on the preliminary results. In addition, Nuclear Regulatory Commission's comments on license application annotated outline Revision 1 will be incorporated, as appropriate.

4.5.3.1.1 Chapter 1 - General Information

No major update is anticipated.

4.5.3.1.2 Chapter 2 - General Information for the Safety Analysis Report

No major update is anticipated. General information will be summarized from the detailed information incorporated into the Safety Analysis Report.

4.5.3.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

The ground-water travel time Topical Report will be incorporated into Chapter 3 by reference. In addition, significant changes will be made to incorporate the results from fiscal year 1996 site investigations. Results from site characterization activities supporting the evaluation of siting guidelines will be incorporated into Chapter 3, as will preliminary information from long-lead-time activities such as heater tests. Additional information needs will be presented to obtain the information needed in licensing beyond that needed to reach higher-level findings, as appropriate.

A summary of the fiscal year 1997 activities that support the development of Chapter 3 follows:

4.5.3.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

In fiscal year 1997, altered zone and near-field environment information, updated geometries of sorptive mineral zones, intermediate unsaturated-zone and saturated-zone modeling results, and refined representations of site boundary conditions from the regional ground water model will be incorporated into the site description. The three-dimensional geologic description will incorporate the results of ground-water chemistry modeling and observations of mineral alteration in Exploratory Studies Facility samples to provide a refined representation of geochemical conditions throughout the site. Framework information will be provided to the radionuclide transport task (Section 4.5.2.1.3.5) to support Total System Performance Assessment-1997.

4.5.3.1.3.2 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

Postclosure tectonic studies will continue to focus on the effects of earthquakes, ground breakage and volcanism on the waste isolation system. The combined results of faulting and volcanism effects studies will be provided as data feeds to ongoing performance assessment. Additionally, the volcanism data will be modeled as cumulative probability distributions to formulate a probabilistic risk assessment. The volcanic effects data will be incorporated in an assessment of whether the probability of radiological releases from future surface and subsurface volcanic activity through or near a repository would exceed regulatory limits.

4.5.3.1.3.3 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

Syntheses and abstractions of unsaturated zone hydrologic models for licensing analyses will be supported by refined process models and by more extensive field and laboratory data, particularly with respect to thermal effects.

4.5.3.1.3.4 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

Regional saturated zone investigations will emphasize refinement of regional-scale models and improved characterization of recharge in Fortymile Wash. Experimental results from cross-hole field tests to study flow and transport in fractured rocks will be evaluated in the licensing program to provide guidance for development of a second experiment site. Results will be evaluated for their implications as to the suitability of various fractured-rock and porous-media representations for site-scale simulations. The licensing program will provide guidance to the regional hydrology task, based on sensitivity and uncertainty analyses, to allow site-scale saturated zone boundaries to be represented with greater confidence.

4.5.3.1.3.5 Site Investigations: Radionuclide Transport (WBS 1.2.3)

The sensitivity of retardation processes to variations in water and rock chemistry will be evaluated, as will the implications of uncertainties in thermodynamic constants and other parameters. The effects of a range of ground-water compositions and mineral assemblages on radionuclide transport will be evaluated in fiscal year 1997. If reducing conditions are predicted from available information on the waste package environment, the potential for retardation of

technetium will receive greater emphasis than if oxidizing conditions are expected to prevail. This is because technetium is highly soluble in oxidizing environments but immobile in reducing environments. Computer simulations supporting Total System Performance Assessment-1997 will be based on a three-dimensional geologic framework description.

4.5.3.1.3.6 Site Investigations: Climate (WBS 1.2.3)

An assessment of the magnitude and rate of climatic changes that might be reasonably expected to occur in the future will be provided. Computer simulations using validated regional climate models will be performed for several different potential future climate states, including some that may not be represented in the past record. However, these may credibly develop in the future (e.g., to address potential impacts of global warming and other effects). The results of these analyses will be synthesized into a set of reference local climate scenarios describing the evolution of potential future climate states that may impact waste isolation performance, and which will be used in the conduct of performance assessments. Data results from future-climate modeling studies are expected to set realistic bounds on the timing, duration, and magnitude of expected future climatic change.

4.5.3.1.3.7 Site Investigations: Thermal Effects (WBS 1.2.3)

A description of the waste package environment will be provided by preliminary altered-zone and near-field environment reports. The preliminary altered-zone report will summarize current information regarding the body of rock surrounding the repository where thermal effects would be sufficient to significantly change mechanical, geochemical or hydrological processes or properties relative to their natural state. Changes in permeability resulting from mineral-water reactions or silica redistribution will be predicted. Mineralogic changes will be evaluated in light of their sorptive properties in the near field. Radionuclide transport in the near-field will be evaluated. This report will further summarize the impacts of the altered zone on repository performance and geochemical transport. The preliminary near-field environment report will summarize the environment and predict coupled thermal-hydrologic-mechanical-chemical processes that interact with the waste package. The effects of man-made materials on the waste package environment will be examined. Mechanical changes due to geochemical processes and the thermal load will be evaluated. Bounding or conservative information regarding chemistry of water likely to contact the waste packages will be developed.

4.5.3.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

The final Advanced Conceptual Design Report, which includes completion of limited surface and subsurface conceptual designs, will be incorporated into Chapter 4. The update will describe the reference design, document design alternatives for the major features important to waste isolation as required by 10 CFR 60.21, and develop detailed information needs to focus License Application Design on compliance with 10 CFR Part 60 technical criteria. The information needs will identify uncertainties associated with the reference design and their potential impacts on licensing. The identified uncertainties will be accompanied by a discussion of the need for additional development work, additional data and analyses, or backup design features.

The seismic design basis for strong ground motion and fault displacement for both surface and subsurface facilities will be incorporated into the design criteria sections of Chapter 4 by reference to the Third Seismic Hazards Methodology Topical Report.

A summary of the fiscal year 1997 activities that support the development of Chapter 4 follows:

4.5.3.1.4.1 Design: Repository (WBS 1.2.4)

The initial License Application Design Report will be issued, which includes the limited scope interim surface and initial subsurface preliminary designs. During License Application Design, the repository design specifications will be developed for those design features subject to Nuclear Regulatory Commission evaluation in the Safety Analysis Report. The License Application Design represents the design upon which the Safety Analysis Report and Environmental Impact Statement are based.

4.5.3.1.4.2 Systems Engineering (WBS 1.2.1)

Systems Engineering will perform an "Allocation of Shielding" system study to develop and analyze requirements between the waste transporter, waste handling repository conceptual design, and underground subelements of the Mined Geologic Disposal System. The results of that study will contribute to the Chapter 4 presentation of design alternatives and description of the Geologic Repository Operations Area. The Thermal Loading Study will provide input and data to the ongoing Total System Performance Assessment activities, which require definition of the repository system.

4.5.3.1.5 Chapter 5 - Engineered Barrier System

The Design Summary Report to validate Waste Package preliminary design efforts will be incorporated into Chapter 5. In addition, waste form and criticality sections will be updated to incorporate updates to the Long Term Criticality Control Topical Report.

A summary of the fiscal year 1997 activities that support the development of Chapter 5 follows:

4.5.3.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Detailed criticality, thermal, shielding, structural and component degradation analyses for waste packages to accommodate multi-purpose canisters, high-level waste glass canisters, and uncanistered spent fuel will be performed. The waste package preliminary design will be completed and the final design of the waste package will be initiated. These activities are required to help provide the Engineered Barrier System source term for Engineered Barrier System subsystem performance assessments. Containment barrier closure development will be completed and other waste package component fabrication development to support preliminary design will be continued.

4.5.3.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.2)

The waste package/engineered barrier degradation predictive models to support the preliminary waste package design and performance assessments will be refined. These improved predictive models will be based on the results from ongoing, long-term spent fuel and borosilicate glass tests, and corrosion and degradation tests on waste package and engineered barrier materials. Revision 1 of the Preliminary Waste Form Characteristics Report to support prediction of the Engineered Barrier System source term for site performance assessments will be issued. Long-term degradation tests on Engineered Barrier System materials will be initiated. Revision 1 of the Preliminary Engineered Materials Characteristics Report will be issued to support substantially complete containment compliance analyses and prediction of the Engineered Barrier System source term for site performance assessments.

4.5.3.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

The Engineered Barrier System performance assessment effort will continue to develop a focused set of calculations to address the Substantially Complete Containment, and the controlled release subsystem performance requirements of 10 CFR 60.113. The results of these analyses will be used to improve the definition of the source term for the ongoing total system performance assessment effort.

4.5.3.1.5.4 Systems Engineering (WBS 1.2.1)

Systems Engineering will perform an "Allocation of Shielding" system study to develop and analyze requirements between the waste transporter, waste handling repository conceptual design, and underground subelements of the Mined Geologic Disposal System. The results of these studies will clarify requirements for waste package final design.

4.5.3.1.6 Chapter 6 - Overall System Performance Assessment

A summary of the fiscal year 1997 activities that support the development of Chapter 6 follows:

4.5.3.1.6.1 Total System Performance Assessment (WBS 1.2.5)

An updated estimate is to be made of the potential cumulative waste isolation effects of tracers, fluids and materials used in excavation, construction and testing. At the end of the year, the performance assessment function will formally transmit the third annual update of recommendations, based on its modeling and analyses, to help focus site characterization and testing on major uncertainties.

4.5.3.1.7 Chapter 7 - Conduct of Repository Operations

Systems Engineering will update the Repository Concept of Operations. A summary of the fiscal year 1997 activities that support the development of Chapter 7 follows:

4.5.3.1.7.1 Systems Engineering (WBS 1.2.1)

Systems Engineering will perform an "Allocation of Shielding" system study to develop and analyze requirements between the waste transporter, waste handling repository conceptual design, and underground subelements of the Mined Geologic Disposal System. The results of this study will further define specific repository operations.

4.5.3.1.8 Chapter 8 - Performance Confirmation Program

The licensing function plans and coordinates the performance confirmation program mandated by 10 CFR 60 Subpart F. Those tests that are being started in the Exploratory Studies Facility in fiscal year 1997, and which will not produce significant results in time for incorporation into the descriptions and analyses of the 2000 draft license application, are to be identified as components of performance confirmation. The long-term second heater test, to be conducted in the Topopah Spring unit, is an example of performance confirmation testing.

4.5.3.1.9 Chapter 9 - Land Ownership and Control

No major updates are anticipated in fiscal year 1997.

4.5.3.1.10 Chapter 10 - Quality Assurance

No major updates are anticipated in fiscal year 1997.

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.2.3.

4.5.3.1.11 Chapter 11 - Emergency Plan

Chapter 11 will remain a planning package pending issuance of 10 CFR 60, Subpart I, Emergency Planning Criteria, which is currently reserved.

4.5.3.2 Topical Reports

Submittal of the Process Models Topical Report to the Nuclear Regulatory Commission is planned for fiscal year 1997. This report will demonstrate the acceptability of those models and codes upon which to base regulatory compliance. Of the primary, site-scale process-level models, three are to be used directly in performance assessment: the unsaturated zone flow model, based on the code TOUGH2; the site scale radionuclide transport model, based on the FEHM code; and the saturated zone flow model. The need for the Process Models Topical Report does not impose a requirement for synthesis and modeling activities beyond those designed to address performance issues.

The objective of the Third Seismic Hazards Methodology Topical Report is to gain the Nuclear Regulatory Commission review and acceptance of the seismic inputs to repository design and containment performance assessment. In the absence of regulatory guidance, such acceptance will

provide confidence that Advanced Conceptual Design is based on criteria acceptable to the regulator.

4.5.3.2.1 Site Performance Assessment (WBS 1.2.5)

Although the three process-level models to be described in the Process Models Topical Report are identified as being important to performance assessment, the actual models are being created by the site characterization function. The site characterization function interprets and analyzes its data as it is obtained and adjusts its models to accommodate that data. Those models are then exercised and tested, sensitivity and uncertainty analyses are performed, and further data-gathering recommendations may be made if indicated by these results. The burden of showing that the geology of the site, its hydrology, and its geochemistry are adequately represented in the process-level site and regional scale models lies with the developers of these models. It is this continuous development and testing process, as well as the resulting models, their capabilities and limitations, that are the subject of this topical report. The performance assessment function will rely on these models to provide the technical basis for its subsystem and system-level models.

4.5.3.3 Procedural Compliance and Support Activities

The following procedural compliance and support activities will be performed in fiscal year 1997:

4.5.3.3.1 Technical Data Management (WBS 1.2.5)

The technical data management function will continue to compile and ensure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems. Specifically, in fiscal year 1997, the Technical Data Base will support preparation of the topical reports identified in Section 4.5.2.2.

4.5.3.3.2 Information Management (WBS 1.2.12)

The Licensing Support System design will continue.

4.5.3.3.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

4.5.3.3.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

During fiscal year 1997, site preparation will be completed for the South Portal area pad and access road. The main drift in the Topopah Spring Level and the South Ramp from the Topopah Spring Level to the surface will be completed. This will complete the initial five mile loop of the Exploratory Studies Facility under the Program approach. Design package 8B - North Ramp

Extension will be started in mid-1997. The North Ramp Extension will provide access for heater test #2, and also provide access across the North end of the repository block for geologic mapping and examination of the Solitario Canyon fault. A second smaller diameter tunnel boring machine will be ordered in 1997 for delivery in mid-1998. Test alcoves will be excavated to support the Exploratory Studies Facility test program. Utilities required to support the test program will be installed, and Exploratory Studies Facility construction test support will assist the Principal Investigators in the installation and set-up of the test apparatus. This activity should result in the initiation of long-term heater testing.

Site facilities and ongoing services continue to support all site characterization field activities.

4.5.3.4 Metrics - Fiscal Year 1997

In performance based budgeting, metrics are measures of progress, both tangible and intangible. Outputs are those discrete, tangible items such as reports and physical advance of the Exploratory Studies Facility construction. Outcomes are less-tangible progress such as refining models to reduce uncertainty, continuing to collect otherwise irretrievable monitoring data, and providing management and compliance functions.

Outputs:

1. Revision 2 of the license application annotated outline will consist of major update to chapters 4 and 5 to incorporate the results of repository Advanced Conceptual Designs, and to Chapter 7 to reflect the impact of conceptual design on the repository concept of operations. In addition, Nuclear Regulatory Commission's comments on license application annotated outline Revision 1 will be incorporated, as appropriate.

2. The initial License Application Design Report will be issued, which includes the limited scope interim surface and initial subsurface preliminary designs.

3. Systems Engineering will complete an "Allocation of Shielding" system study to develop and analyze requirements between the waste transporter, waste handling repository conceptual design, and underground subelements of the Mined Geologic Disposal System.

4. The Thermal Loading Study will be completed to provide input and data to the ongoing Total System Performance Assessment activities, which require definition of the repository system.

5. The waste package preliminary design will be completed and the final design of the waste package will be initiated. Containment barrier closure development and other waste package component fabrication development to support preliminary design will be completed.

6. The third annual update of performance assessment recommendations, based on its modeling and analyses, will be issued to help focus site characterization and testing on major uncertainties.

7. The Process Models Topical Report will be submitted to the Nuclear Regulatory Commission. This report will demonstrate the acceptability of those site-scale flow and radionuclide transport models and codes upon which to base regulatory compliance.

8. Issue the Third Seismic Hazards Methodology Topical Report to gain the Nuclear Regulatory Commission review and acceptance of seismic inputs to repository design and containment performance assessment.

9. Site preparation will be completed for the South Portal area pad and access road. The main drift in the Topopah Spring Level and the South Ramp from the Topopah Spring Level to the surface will be completed. A second tunnel boring machine will be ordered. Approximately eight to ten test alcoves will be excavated.

10. During fiscal year 1997, the test area drifts off the North Ramp will be excavated, providing access to the first heater test area. Other required heater test drifting off the Topopah Spring Level main drift, using drill-and-blast, will be started late in fiscal year 1997 and continue into fiscal year 1998.

Outcomes:

1. Altered zone and near-field environment information, updated geometries of sorptive mineral zones, intermediate unsaturated-zone and saturated-zone modeling results, and refined representations of site boundary conditions from the regional ground water model will be incorporated into the site description.

2. The volcanic effects data will be incorporated in an assessment of whether the probability of radiological releases from future surface and subsurface volcanic activity through or near a repository would exceed regulatory limits.

3. Syntheses and abstractions of unsaturated zone hydrologic models for licensing analyses will be supported by refined process models and by more extensive field and laboratory data, particularly with respect to thermal effects.

4. Regional saturated zone investigations will emphasize refinement of regional-scale models and improved characterization of recharge in Fortymile Wash.

5. The sensitivity of retardation processes to variations in water and rock chemistry will be evaluated, as will the implications of uncertainties in thermodynamic constants and other parameters.

6. An assessment of the magnitude and rate of climatic changes that might be reasonably expected to occur in the future will be provided.

7. A description of the waste package environment will be provided by preliminary altered-zone and near-field environment reports.

8. The waste package/engineered barrier degradation predictive models to support the preliminary waste package design and performance assessments will be refined. Revision 1 of the Preliminary Waste Form Characteristics Report to support prediction of the Engineered Barrier System source term for site performance assessments will be issued. Long-term degradation tests on Engineered Barrier System materials will be initiated. Revision 1 of the Preliminary Engineered Materials Characteristics Report will be issued to support substantially complete containment compliance analyses and prediction of the Engineered Barrier System source term for site performance assessments.

9. An updated estimate is to be made of the potential cumulative waste isolation effects of tracers, fluids and materials used in excavation, construction and testing.

10. The technical data management function will continue to compile and ensure the consistency and traceability of technical data, using the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System database systems.

11. The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

12. The Licensing Support System design will continue.

4.5.4 Fiscal Year 1998 ($348.8M)

Revision 3 of the Mined Geologic Disposal System license application annotated outline and three topical reports will be submitted to the Nuclear Regulatory Commission in fiscal year 1998. The scope of these deliverables is discussed in Sections 4.5.3.1 and 4.5.3.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessment activities being performed to provide the necessary supporting information. In addition, progress in the areas of procedural compliance and support activities is discussed in Section 4.5.3.3.

4.5.4.1 License Application Annotated Outline Revision 3

Information from site characterization will be evaluated for use in licensing and incorporated into the license application annotated outline sections, as appropriate. A significant update will be made to Chapter 3 to reflect the fiscal year 1997 site investigation results supporting technical site suitability evaluation. The major changes that will be incorporated into the license

application annotated outline Revision 3 are identified by chapter in this section. All other chapters will be updated to incorporate results from site characterization, design, and performance assessment activities and to reevaluate information needs based on the preliminary results. In addition, Nuclear Regulatory Commission's comments on the license application annotated outline Revision 2 will be incorporated, as appropriate.

4.5.4.1.1 Chapter 1 - General Information

No major update is anticipated.

4.5.4.1.2 Chapter 2 - General Information for the Safety Analysis Report

No major update is anticipated. General information will be summarized from the detailed information incorporated into the remaining chapters.

4.5.4.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

Results from site characterization activities supporting the evaluation of siting guidelines will be incorporated into Chapter 3. Additional information needs will be presented to obtain the information needed in licensing beyond that needed to reach higher-level findings, as appropriate.

Drilling activities (Work Breakdown Structure 1.2.3.5) will include drilling of 3 Unsaturated Zone-holes to provide hydrologic information from the unsaturated zone, 2 SD-holes to provide rock characteristics information, 1 water table-hole to support characterization of the uppermost saturated zone, initiation of drilling at the southern tracer complex, instrumentation of 2 Unsaturated Zone and 2 Systematic Drilling boreholes, geophysical logging, and well cleanout and reconfiguration activities.

A summary of the fiscal year 1998 activities that support the development of Chapter 3 follows:

4.5.4.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

In fiscal year 1998, information from the report on site-scale flow and transport will be incorporated, and will be reviewed for consistency with the postclosure tectonics topical report. A synthesis report will be generated to update the Engineered Barrier System performance assessment for License Application Design.

4.5.4.1.3.2 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

A final review will be conducted of the continuing results of seismic monitoring, and site geophysical studies in support of a topical report to be submitted to the Nuclear Regulatory Commission on postclosure tectonics (faulting and volcanic activity). Additionally, recommendations will be prepared identifying priority long-term site monitoring activities including seismic, geodetic, gravity, and strain monitoring for the postclosure tectonics program to support subsequent licensing and performance confirmation. These data will be reviewed periodically to assess the site performance, the validity of alternative tectonic models used in the topical report, and the need to develop new or revised tectonic models.

4.5.4.1.3.3 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

The emphasis on field and laboratory activities will shift in fiscal year 1998 from surface-based to underground testing, monitoring, and sampling in recently constructed testing alcoves. Testing will range from small rock samples removed during excavation for hydrochemical and moisture characterization, through large blocks isolated for water-percolation testing, to room-size gas permeability tests. Lateral drilling from the underground excavation will extend the volume of exploration, with particular emphasis on permeability testing and developing evaluations of past and/or present water flow in faults, which is pertinent to the evaluation of preferential flow paths in the host rock. A comparison of LIDAR and thermal imaging techniques will be conducted to provide better definition of pneumatic pathways.

4.5.4.1.3.4 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

The syntheses of data and interpretations will be maintained and updated for eventual inclusion in the final saturated zone description planned for fiscal year 2000 and for input to the performance assessment activity. Modeling emphasis will shift from development to application. The effects of postulated climatic and tectonic scenarios on the saturated zone hydrologic system will be evaluated, as will the sensitivity of flow simulations to fracture-network and porous-medium assumptions. Drilling operations will begin at the Southern Tracer complex. A deep borehole in Rock Valley will be drilled and tested to explore a key hydrologic boundary.

4.5.4.1.3.5 Site Investigations: Radionuclide Transport (WBS 1.2.3)

Geochemical studies on mineral distribution and alteration will continue as new samples become available. Ground water chemistry modeling will emphasize examination of interactions between waters modified by the repository system and the natural rock/water system. Field tests will continue to test applicability of sorption, matrix diffusion and other transport data obtained in the laboratory for modeling radionuclide migration. Radionuclide transport studies (sorption, solubility/speciation, diffusion, dynamic transport) will shift their emphasis to non-actinide radionuclides. The biological sorption study will evaluate the possible impact of microorganisms present on radionuclide transport. Sorption modeling will incorporate new information on the controls on sorption variability.

In situ transport experiments in the Calico Hills unit and at the Peña Blanca natural analog site will be initiated.

Gaseous radionuclide retardation will be evaluated as required. Solubility/ speciation and sorption studies on technetium will be conducted if reducing conditions in the near field are predicted. Studies on both actinide and natural colloids will continue. Retardation sensitivity analysis will integrate gaseous and aqueous flow system data with radionuclide transport, mineral distribution, and ground-water chemistry data to produce process level models of radionuclide movement. Analog studies of radionuclide release and migration will be initiated to provide information against which models for radionuclide release can be validated.

4.5.4.1.3.6 Site Investigations: Climate (WBS 1.2.3)

The synthesis of past (Quaternary) climate will be evaluated for inclusion in the license application; emphasis in the climate program will shift to bound future climatic extremes to address siting criteria in 10 CFR 60.122.

4.5.4.1.3.7 Site Investigations: Thermal Effects (WBS 1.2.3)

Continue ongoing characterization of the waste package near-field environment, the effects of man-made materials on that environment, and altered zone impacts on repository performance and geochemical transport. Laboratory studies and field tests (North Ramp - Engineered Barrier System Heater Test) will examine the coupled thermal-hydrologic-mechanical-chemical processes that interact with the waste package and may significantly change the properties of the host rock relative to their ambient state. These results will be used to refine the range of testing conditions for the waste package materials, to update the predictive models and to support performance analyses.

4.5.4.1.3.8 Environmental (WBS 1.2.13)

Environmental data generated for the draft Environmental Impact Statement will be provided to support the license application annotated outline. Such data includes (1) water sources, quality, and users; (2) climate and meteorology; (3) population and attendant activities and potential impact on the ground-water flow system; (4) radiological monitoring; and (5) land ownership and control. The environmental data will also be used in Chapters 4, 6, 7 and 8.

4.5.4.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

The Initial License Application Design Report will be incorporated to update Chapter 4. In addition, the allocation of shielding system study will be incorporated into Chapter 4, as appropriate.

A summary of the fiscal year 1998 activities that support the development of Chapter 4 follows:

4.5.4.1.4.1 Design: Repository (WBS 1.2.4)

The first Interim License Application Design Report will be issued, which includes interim surface and subsurface designs. A major contribution will be made to the Report on Performance Assessment Implications of the Areal Power Density Options and constraints imposed by the usable area available for the repository.

4.5.4.1.4.2 Systems Engineering (WBS 1.2.1)

In fiscal year 1998, Systems Engineering will perform a Repository Capacity Study to support the development of design alternatives for underground layout.

4.5.4.1.5 Chapter 5 - Engineered Barrier System

The waste package preliminary design and the revision to the Long Term Criticality Topical Report will be incorporated into Chapter 5.

A summary of the fiscal year 1998 activities that support the development of Chapter 5 follows:

4.5.4.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Perform detailed criticality, thermal, shielding, structural and component degradation analyses for waste packages to accommodate multi-purpose canister, high-level waste glass canisters, and uncanistered spent fuel. Conduct the initial final waste package design as part of the continuing License Application Design. Complete containment barrier closure and component development and refine the prototype waste package test plan.

4.5.4.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.2)

Refine waste package/engineered barrier and spent fuel and borosilicate waste glass degradation predictive models to support the waste package design review and performance assessments.

4.5.4.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

A report will be issued on the performance assessment implications of the areal power density options and constraints imposed by the usable area available for the repository. It is anticipated that this report will become a part of the License Application Design documentation.

4.5.4.1.5.4 Systems Engineering (WBS 1.2.1)

In fiscal year 1998, a revision to the Engineered Barrier Design Requirements baseline to reflect the results of waste package Title I design activities will occur. Systems Engineering will also conduct a Repository Capacity Study to support the development of design alternatives for underground layout, and ensure coordination between repository and waste package design efforts.

4.5.4.1.6 Chapter 6 - Overall System Performance Assessment

The Process Models Topical Report and Total System Performance Assessment 1997 will be incorporated into Chapter 6.

A summary of the fiscal year 1998 activities that support the development of Chapter 6 follows:

4.5.4.1.6.1 Total System Performance Assessment (WBS 1.2.5)

An updated Waste Isolation Evaluation of cumulative impacts of tracers, fluids and materials report will be issued. This report will recommend how databases being used to perform subsystem and total system performance assessment calculations should be updated, and where

additional testing is needed to refine uncertainties introduced through the use of Tracers, Fluids and Materials.

A second annual report to be issued is the Report on Performance Assessment Recommendations to Site Characterization & Testing, describing uncertainties that may be addressable through further site characterization or testing. The objective is the reduction of uncertainties in analyses supporting the license application Safety Analysis Report.

4.5.4.1.7 Chapter 7 - Conduct of Repository Operations

The update to the Repository Concept of Operations and the allocation of shielding system study will be incorporated into Chapter 7.

A summary of the fiscal year 1998 activities that support the development of Chapter 7 follows:

4.5.4.1.7.1 Systems Engineering (WBS 1.2.1)

In fiscal year 1998, Systems Engineering will complete a Repository Capacity Study to support the development of design alternatives for underground layout and the implications for repository operations.

4.5.4.1.8 Chapter 8 - Performance Confirmation Program

A summary of the fiscal year 1998 activities that support the development of Chapter 8 follows:

A draft Performance Confirmation Program Plan will be prepared based on interim subsurface designs. The licensing function will continue to plan and coordinate the performance confirmation program mandated by 10 CFR 60 Subpart F. Sensitivity and uncertainty analyses are to be performed by the performance assessment function to support the continuation of ongoing tests and to identify additional performance confirmation requirements.

4.5.4.1.8.1 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

A long-term monitoring program in postclosure tectonics extending beyond the suitability and licensing periods of site characterization studies will be established. This program will consist of at a minimum the continuation of the seismic network capability and subsurface strain measurements, and the installation of a geodetic monitoring system that incorporates the rapidly improving measurement precision in Global Positioning System, and super-precision monitoring sites measuring the earth's gravity field. Due to the extended time periods of repository operations and waste isolation, the assessment of the impact of tectonic processes on waste isolation and radiological safety must be evaluated periodically. Data from this confirmation monitoring system together with periodic reviews of the state-of-the-science will provide the necessary confidence that tectonic processes and their effects have been adequately assessed. Tectonic events are commonly clustered in time and space. Questions can always be raised of the adequacy of data gathered during a sub-decade site characterization program to represent long time spans. Long-term base level monitoring that measures rates of operation of tectonic

processes for intervals extending beyond the construction, and waste-emplacement period of a potential repository will directly address this uncertainty.

4.5.4.1.9 Chapter 9 - Land Ownership and Control

No major update is anticipated.

4.5.4.1.10 Chapter 10 - Quality Assurance

No major updates are anticipated.

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.3.3.

4.5.4.1.11 Chapter 11 - Emergency Plan

No major update is anticipated.

4.5.4.2 Topical Reports

Two licensing topical reports are planned for fiscal year 1998 to resolve issues with the Nuclear Regulatory Commission.

The Subsystem Models Topical Report will demonstrate the acceptability of those models and codes upon which to base regulatory compliance. This topical report is to describe the content, organization, and scientific basis for the site subsystem model to be used to evaluate the ground-water travel time regulatory requirement, as well as the model or models to be used to address the waste package substantially complete containment, and the Engineered Barrier System controlled release performance requirements. The need for this report does not impose a requirement for any site investigations activities beyond those designed to address performance issues.

The Topical Report on Long Term Criticality Control for the repository waste package will be submitted to the Nuclear Regulatory Commission. The purpose of the report is to gain review and acceptance of the basis, methodology and analysis for determining criticality control. The report will compile the experimental isotopic testing data and present the analyses used to support the license application waste package design.

4.5.4.2.1 Design: Waste Package Engineering (WBS 1.2.2)

Compile isotopic data into Long Term Criticality Control topical report for Nuclear Regulatory Commission.

4.5.4.2.2 Engineered Barrier System and Site Subsystem Performance Assessment (WBS 1.2.5)

The performance assessment function is to prepare the technical content of the Subsystem Models Topical Report. The subject matter will be the codes and models used to address site and engineered subsystem regulatory performance objectives of 10 CFR 60.112 and 60.113. The content will be a description of the codes and data that constitute the models being used. Special emphasis will be on the scientific processes being simulated by these models. This will entail a description of the ongoing process-model testing and abstraction activity that is designed to identify those process-model features that must be rolled up into the subsystem level models.

4.5.4.3 Procedural Compliance and Support Activities

The following procedural compliance and support activities will be performed in fiscal year 1998:

4.5.4.3.1 Technical Data Management (WBS 1.2.5)

The Technical Data Management function will assure that all technical data from the site suitability evaluation efforts which are also pertinent to the license application are incorporated into the Reference Information Base by the end of this year, and is consistent and traceable. In addition, data incorporation into the Geologic and Environmental Nodal Information Study and Evaluation System data management system will also be completed this year, as appropriate. Specifically, in fiscal year 1998, the Technical Data Base will support preparation of the topical reports identified in Section 4.5.3.2.

4.5.4.3.2 Information Management (WBS 1.2.12)

The Licensing Support System design will be completed, equipment purchased and installed and records processing initiated to support system acceptance testing and approval.

4.5.4.3.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

4.5.4.3.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

During fiscal year 1998, design package 8B - North Ramp Extension, will be completed. The final design of the Calico Hills access and drifting will be started and completed. Design of drifting for heater test #2 will be started and completed. The second tunnel boring machine will be delivered to the site, taken underground, and assembled. The North Ramp Extension (Figure 1-2), approximately 1600 meters in length, will be excavated. The Exploratory Studies Facility operations and maintenance will accept control of the completed portions of the Exploratory

Studies Facility from construction and the cost of operations and maintenance will be shifted from construction and carried in the operations budget.

Site facilities and ongoing services continue to support all site characterization field activities.

4.5.4.4 Metrics - Fiscal Year 1998

Outputs:

1. Information from site characterization will be evaluated for use in licensing and incorporated into Mined Geologic Disposal System license application Annotated Outline Revision 3 sections, as appropriate, including a significant update to Chapter 3 to reflect the fiscal year 1997 site investigation results supporting technical site suitability evaluation.

2. A synthesis report containing framework information supporting site-scale flow and transport, postclosure tectonics and rock properties will be generated to update the Engineered Barrier System performance assessment for License Application Design.

3. The first Interim License Application Design Report will be issued, which includes interim surface and subsurface preliminary designs.

4. A Repository Capacity Systems Engineering Study will be completed to support the development of design alternatives for underground layout.

5. A report will be issued on the performance assessment implications of the areal power density options and constraints imposed by the usable area available for the repository.

6. A revision to the Engineered Barrier Design Requirements baseline to reflect the results of waste package preliminary design activities will be completed.

7. An Updated Waste Isolation Evaluation of cumulative impacts of tracers, fluids and materials report will be issued to identify additional testing needed to refine uncertainties introduced through the use of tracers, fluids and materials.

8. A fourth annual report will be issued on performance assessment recommendations, describing uncertainties that may be addressable through further site characterization or testing.

9. A draft Performance Confirmation Program Plan will be prepared to implement 10 CFR 60 Subpart F.

10. The Subsystem Models Topical Report will be issued to describe the content, organization, and scientific basis for the site subsystem model to be used to evaluate the ground-water travel time regulatory requirement, as well as the model

or models to be used to address the waste package substantially complete containment, and the Engineered Barrier System controlled release performance requirements.

11. The topical report on Long Term Criticality Control for the waste package will be submitted to the Nuclear Regulatory Commission, including the isotopic data and analyses used to support the license application waste package design.

12. Systems Engineering will complete the Waste Package Prototype Development, Fabrication and Testing Study, which supports the development of the fiscal year 2000 Waste Package Topical Report.

13. A 5.5 meter diameter tunnel boring machine will be delivered. In the Exploratory Studies Facility, the North Ramp Extension (1600 meters of 5.5 meter diameter tunnel), will be completed. Design of heater test #2 will be completed. Final design of access and drifting in the Calico Hills unit will be completed.

14. The Licensing Support System design will be completed, equipment purchased and installed and records processing initiated to support system acceptance testing and approval.

Outcomes:

1. Recommendations will be prepared identifying priorities long-term site monitoring including seismic, geodetic, gravity, and strain monitoring for the postclosure tectonics program to support subsequent licensing and performance confirmation.

2. The effects of postulated climatic and tectonic scenarios on the unsaturated zone and saturated zone hydrologic systems will be evaluated, as will the sensitivity of flow simulations to fracture-network and porous-medium assumptions.

3. Geochemical studies on mineral distribution and alteration and ground water chemistry will continue as new samples become available. Field tests will continue to test at the scale of the site, applicability of sorption, matrix diffusion and other transport data obtained in the laboratory for modeling radionuclide migration.

4. Laboratory studies and field tests (North Ramp - Engineered Barrier System Heater Test) will be used to continue ongoing characterization of the waste package near-field environment, the effects of man-made materials on that environment, and altered zone impacts on repository performance and geochemical transport .

5. Environmental data generated for the Draft Environmental Impact Statement will be provided to support the license application Annotated Outline including (1) water sources, quality, and users; (2) climate and meteorology; (3) population and attendant activities and potential impact on the ground-water flow systems; (4) radiological monitoring; and (5) land ownership and control.

6. Conduct the initial final waste package design as part of the continuing License Application Design, including detailed criticality, thermal, shielding, structural and component degradation analyses for waste packages to accommodate multi-purpose canister, high-level waste glass canisters, and uncanistered spent fuel.

7. Sensitivity and uncertainty analyses are to be performed by the performance assessment function to support the continuation of ongoing tests and to identify additional performance confirmation requirements.

8. A long-term monitoring program in postclosure tectonics extending beyond the suitability and licensing periods of site characterization studies will be established.

9. The Technical Data Management function will assure that all technical data from the site suitability evaluation efforts which are also pertinent to the license application are incorporated into the Reference Information Base and Geologic and Environmental Nodal Information Study and Evaluation System by the end of this year, and is consistent and traceable.

10. The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

11. The Exploratory Studies Facility activity related to licensing in fiscal year 1998 will be limited to continuation, as needed, of the construction test support function.

4.5.5 Fiscal Year 1999 ($340.6M)

Revision 4 of the license application annotated outline and two topical reports will be submitted to the Nuclear Regulatory Commission in fiscal year 1999. The scope of these deliverables is discussed in Sections 4.5.4.1 and 4.5.4.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessment activities being performed to provide the necessary supporting information. In addition, progress in the areas of procedural compliance and support activities is discussed in Section 4.5.4.3.

4.5.5.1 License Application Annotated Outline Revision 4

The major changes that will be incorporated into license application annotated outline Revision 4 are identified by chapter in this section. All other chapters will be updated to incorporate results from site characterization and performance assessment activities and to reevaluate information needs based on the preliminary results. In addition, Nuclear Regulatory Commission's comments on license application Annotated Outline Revision 3 will be incorporated, as appropriate.

4.5.5.1.1 Chapter 1 - General Information

The physical security plan and safeguards sections will be updated to incorporate new information from the repository design.

4.5.5.1.2 Chapter 2 - General Information for the Safety Analysis Report

No major update is anticipated. General information will be summarized from the detailed information incorporated into the Safety Analysis Report.

4.5.5.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

Results from site characterization activities supporting the evaluation of siting guidelines will be incorporated into Chapter 3. Additional information needs will be presented to obtain the information needed in licensing beyond that needed for the technical site suitability evaluation. The Postclosure Tectonics Hazard Assessment Topical Report will be incorporated.

Drilling activities (Work Breakdown Structure 1.2.3.5) will include drilling of 2 Unsaturated Zone-holes to provide hydrologic information from the unsaturated zone, up to 3 SD-holes to provide rock characteristics information, up to 3 water-table holes to support characterization of the uppermost saturated zone, one G-hole northeast of Yucca Mountain to further constrain the regional geologic and hydrologic setting, stemming of 5 Unsaturated Zone/Systematic Drilling holes, geophysical logging, completion of drilling at the southern tracer complex, and well cleanout and reconfiguration activities.

A summary of the fiscal year 1999 activities that support the development of Chapter 3 follows:

4.5.5.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

In fiscal year 1999, the final mineralogic and petrologic framework will be input into the standard three-dimensional data model and spatial data analysis system. A synthesis report will be generated to support the radionuclide transport task and to support the ground-water travel time performance assessment and Total System Performance Assessment-1999 for the final Environmental Impact Statement.

4.5.5.1.3.2 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

Testing in the Exploratory Studies Facility will continue to dominate the field effort as the underground testing Program approaches full implementation. Tests that are amenable to producing results soon after they are initiated (such as pneumatic-permeability tests) will receive priority in data analysis to support development of the final unsaturated zone Hydrologic Description and performance assessment calculations.

Synthesis of available surface-based, Exploratory Studies Facility-based, and laboratory monitoring and testing results will be completed for final refinements of process models for elements of the unsaturated zone system. Long-term monitoring data (e.g., meteorological conditions, infiltration moisture) will be analyzed to detect and interpret trends. Geostatistical

analysis will be applied to testing and monitoring data to assist in interpretations. Updating of the unsaturated zone hydrologic system model to final status will be initiated. Evaluation of pneumatic pathways using LIDAR and thermal imaging will continue.

4.5.5.1.3.3 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

Final field and experimental data will be compiled for inclusion in the final saturated zone description. The principal effort will be the development of this report, which forms the basis for the saturated zone part of the site description and the saturated zone pathway for ground-water travel time and transport calculations. Monitoring of potentiometric levels in selected drill holes and periodic hydrochemical sampling network will continue in order to increase confidence in system characteristics for licensing support and to establish baseline conditions for later confirmation studies. Drilling operations at the Southern Tracer Complex will be completed and cross-hole testing initiated. A deep borehole will be drilled to determine the nature of the hydrologic boundary along the East flank of the Funeral Mountains.

4.5.5.1.3.4 Site Investigations: Radionuclide Transport (WBS 1.2.3)

In-situ transport experiments in the Calico Hills unit and at the Peña Blanca natural analog site will continue.

Geochemical studies on mineral distribution and alteration will summarize data. The ground-water chemistry model will be completed. Field tests will continue to test applicability of sorption, diffusion, and other transport data obtained in the laboratory. Radionuclide transport studies (sorption, solubility/speciation, diffusion, dynamic transport) will focus on non-actinide radionuclides and on experiments needed to complete assessment of the dependence of sorption on mineralogy, mineral surface alteration, and ground water chemistry. Microorganisms in the Exploratory Studies Facility will be recharacterized to assess the impact of construction activity. Sorption modeling will incorporate new information on the controls on sorption variability. Studies on both actinide and natural colloids will continue. Retardation sensitivity analysis will integrate gaseous and aqueous flow system data with radionuclide transport, mineral distribution, and ground-water chemistry data to produce process level models of radionuclide movement. Analog studies of radionuclide release and migration will continue.

4.5.5.1.3.5 Site Investigations: Climate (WBS 1.2.3)

An overview of past, present, and expected future climatological and meteorological conditions of the geologic setting and the site will be provided. Baseline climatological and meteorological conditions of the site will be described. The final report will provide a demonstration that the areas studied provide a representative description of the conditions throughout the region around the site and at the site. Detailed justification for the limits placed on regional studies will be presented.

A final climate report will provide analyses to demonstrate that average annual historical precipitation and average annual potential water loss have been characterized, and of the extent to which the deficit between precipitation and potential water loss contributes to waste isolation.

Additional numerical climate simulations will be performed using supportable regional climate models and the synthesis of future climate refined in response to performance assessment and licensing needs.

4.5.5.1.3.6 Site Investigations: Thermal Effects (WBS 1.2.3)

Continue ongoing characterization of the waste package near-field environment, the effects of man-made materials on that environment, and of altered zone impacts on repository performance and geochemical transport. Laboratory studies and field tests (North Ramp Engineered Barrier System Heater Test, and repository-level long-term Engineered Barrier System Heater Test) will continue to examine the coupled thermal-hydrologic-mechanical-chemical processes that interact with the waste package and may significantly change the properties of the host rock relative to their ambient state. These results will be used to refine the range of testing conditions for the waste package materials, to update the predictive models and to support the performance analyses.

4.5.5.1.3.7 Natural Barrier Subsystem Performance Assessment (WBS 1.2.5)

The final report on Pre-Waste Emplacement Natural Barrier System Performance will be issued. This report will incorporate the Subsystem Models Topical Report.

4.5.5.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

The first Interim License Application Design Report will be incorporated into Chapter 4.

A summary of the fiscal year 1999 activities that support the development of Chapter 4 follows:

4.5.5.1.4.1 Design: Repository (WBS 1.2.4)

The second Interim License Application Design Report will be issued, which includes interim surface and subsurface preliminary designs.

4.5.5.1.5 Chapter 5 - Engineered Barrier System

The Repository Capacity Study to support the development of design alternatives for the underground layout will be incorporated into Chapter 5 which will incorporate the final topical report on criticality control.

A summary of the fiscal year 1999 activities that support the development of Chapter 5 follows:

4.5.5.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Perform detailed criticality, thermal, shielding, structural and component degradation analyses for waste packages to accommodate multi-purpose canister, high-level waste glass canisters, and uncanistered spent fuel. Conduct the interim Title II waste package design as part of the continuing License Application Design.

4.5.5.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.2)

Refine waste package/engineered barrier and spent fuel and borosilicate waste glass degradation predictive models to support the interim final waste package design review and performance assessment.

4.5.5.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

The Engineered Barrier Subsystem performance assessment will continue the focused calculations in support of the License Application Design report. The models and data will be updated to include interim results from design and material testing activities. The performance requirements to be addressed in these calculations are the substantially complete containment, and the controlled release subsystem performance requirements of 10 CFR 60.113. The results of these analyses will also be used to improve the definition of the source term for the Total System Performance Assessment.

4.5.5.1.6 Chapter 6 - Overall System Performance Assessment

The fiscal year 1997 Total System Performance Assessment and Engineered Barrier System Subsystem performance assessment will be incorporated into Chapter 6.

A summary of the fiscal year 1999 activities that support the development of Chapter 6 follows:

4.5.5.1.6.1 Total System Performance Assessment (WBS 1.2.5)

Total System Performance Assessment-1999 will build on 1997 Total System Performance Assessment-1997 which supported technical site suitability evaluation, and will benefit from the results of its peer review. Total System Performance Assessment-1999 will be a dual purpose total system performance assessment since some results will be used in the Site Recommendation Report. The bulk of the work, however, will be in support of the license application Safety Analysis Report.

To be issued in final form for license application purposes are two annual reports: (1) Updated Waste Isolation Evaluation of cumulative impacts of tracers, fluids and materials; and (2) Report on Performance Assessment Recommendations to Site Characterization and Testing. These reports are both concerned with focusing activities on the reduction of uncertainties in analyses supporting the license application Safety Analysis Report.

4.5.5.1.7 Chapter 7 - Conduct of Repository Operations

The Repository Capacity Study to support the development of design alternatives for underground layout will be incorporated into Chapter 7.

A summary of the fiscal year 1999 activities that support the development of Chapter 7 follows:

4.5.5.1.7.1 Systems Engineering (WBS 1.2.1)

In fiscal year 1999, Systems Engineering will update the Repository and Engineered Barrier System Concept of Operations.

4.5.5.1.8 Chapter 8 - Performance Confirmation Program

A summary of the fiscal year 1999 activities that support the development of Chapter 8 follows:

The licensing function continues to coordinate with the Nuclear Regulatory Commission the performance confirmation program mandated by 10 CFR 60 Subpart F in terms of its scope, its sufficiency in terms of the intent of Subpart F, and in terms of the content of the 2001 license application. Sensitivity and uncertainty analyses are to be continued by the performance assessment function, as an addendum to its Total System Performance Assessment 1999, to support the continuation of ongoing tests and the planning for potential new tests to be added to the Performance Confirmation program.

4.5.5.1.8.1 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

Acquisition of data from the tectonics program will continue with analyses of the data performed at the end of the fiscal year. Based on the results of interim Total System Performance Assessments, additional investigations at analog sites may be required for the final evaluation of potential secondary effects of volcanism.

4.5.5.1.9 Chapter 9 - Land Ownership and Control

Environmental data generated for the Draft and Final Environmental Impact Statements will be incorporated into Chapter 9.

4.5.5.1.10 Chapter 10 - Quality Assurance

No major updates are anticipated.

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.4.3.

4.5.5.1.11 Chapter 11 - Emergency Plan

The emergency plan is updated to comply with the criteria in 10 CFR 60 Subpart I, assuming the standard has been promulgated.

4.5.5.2 Topical Reports

Two licensing topical reports are planned to be submitted in fiscal year 1999 to resolve issues with the Nuclear Regulatory Commission: The Total System Performance Assessment Model Topical Report and the Volcanism Probability and Effects Topical Report.

The Total System Performance Assessment Model Topical Report will demonstrate the acceptability of the model and codes upon which to base regulatory compliance. The primary purpose of this report is to allow an early look at the technical basis of the total system performance assessment model that is to be used to address the total system regulatory compliance argument. This topical report will include the testing, abstraction and incorporation of salient structural and design features into the total system performance assessment model.

The objective of the Volcanism Probability and Effects Topical Report is to obtain Nuclear Regulatory Commission review and approval of the calculation of the probability of volcanism at the Yucca Mountain repository and the resultant impact on repository performance. The output of the report will also be used by performance assessment to assess the overall performance of the Yucca Mountain site relative to regulatory requirements.

4.5.5.2.1 Total System Performance Assessment (WBS 1.2.5)

The total system performance assessment models are at the top of the modeling hierarchy, suggesting they represent processes and coupled processes at the least detailed level so as to allow efficient modeling of total system performance. Of necessity, however, the coupling of processes, and the need to provide detail of the performance of the system in terms of processes and coupled-processes over several spatial scales, make total system performance assessment models very complex. This topical report will describe the total system performance assessment model to be used to develop the demonstration of compliance with the 10 CFR 60.111 and 60.112 system performance objectives. This report will also discuss the ongoing effort to demonstrate that these models are adequately representing the processes and coupled processes important to system performance. The approach to showing the adequacy of a total system performance assessment model is to show that it properly and adequately represents the important results of process-level modeling.

4.5.5.3 Procedural Compliance and Support Activities

The following procedural compliance and support activities will be performed in fiscal year 1999:

4.5.5.3.1 Technical Data Management (WBS 1.2.5)

The technical data management function will update, as needed, the compilations of technical data. Specifically, in fiscal year 1999 the Technical Data Base will support preparation of the topical reports identified in Section 4.5.4.2.

4.5.5.3.2 Information Management (WBS 1.2.12)

Records capture into Licensing Support System will continue. Department of Energy will request certification from the Licensing Support System Administrator documenting Department of Energy's substantial compliance with 10 CFR 2 Subpart J obligations.

4.5.5.3.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

4.5.5.3.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

The second tunnel boring machine will be disassembled in the completed North Ramp Extension, transported to the Calico Hills access starting point, and reassembled. The Calico Hills access ramp will be started and completed. The Calico Hills drifting will be started, and the first Ghost Dance fault intercept in the Calico Hills unit will be made late in the year. Drifting for the second heater test will be started and completed.

Other activities in the Exploratory Studies Facility for fiscal year 1999 will include basic operations and maintenance of the facility, including the Integrated Data & Control System, and construction test support. Construction test support will include excavation of test alcoves, installation of utilities, and assistance in installation of testing mechanisms as required by the test organizations.

4.5.5.4 Metrics - Fiscal Year 1999

Outputs:

1. The license application annotated outline Revision 4 will be issued to incorporate updated information from site characterization and performance assessment activities as well as Nuclear Regulatory Commission comments on Revision 3.

2. The ground-water chemistry model will be completed.

3. A final Climate Report will provide overview of past, present, and expected future climatological and meteorological conditions of the geologic setting and the site.

4. The final report on Pre-Waste Emplacement Natural Barrier System Performance will be issued and will incorporate the fiscal year 1998 Subsystem Models Topical Report.

5. The second Interim License Application Design Report will be issued, which includes interim surface and subsurface Title I designs.

6. Total System Performance Assessment-1999 will be completed to support the updated conclusions in the license application annotated outline as well as the Site Recommendation Report.

7. To be issued in final form for license application purposes are two annual reports: (1) Updated Waste Isolation Evaluation of cumulative impacts of tracers, fluids and materials; and (2) Report on Performance Assessment Recommendations to Site Characterization and Testing. These reports are both concerned with focusing activities on the reduction of uncertainties in analyses supporting the license application Safety Analysis Report.

8. The emergency plan will be updated to comply with the criteria in 10 CFR 60 Subpart I, assuming the standard has been promulgated.

9. The Volcanism Probability and Effects Topical Report will be completed to obtain Nuclear Regulatory Commission review and approval of the calculation of the probability of volcanism at the Yucca Mountain repository and the resultant impact on repository performance.

10. The Total System Performance Assessment Model Topical Report will be submitted to the Nuclear Regulatory Commission to allow an early look at the technical basis of the total system performance assessment model that is to be used to address the total system regulatory compliance argument. This topical report will include the testing, abstraction and incorporation of salient structural and design features into the total system performance assessment model.

11. Department of Energy will request certification from the Licensing Support System Administrator documenting the Department of Energy's substantial compliance with 10 CFR 2 Subpart J obligations.

12. In the Exploratory Studies Facility, approximately 4,000 meters of 5.5 meter diameter tunnel will be completed to support evaluation of the Calico Hills unit. Drifting for access to the second heater test area in the Topopah Spring unit will be completed.

Outcomes:

1. In fiscal year 1999, the final mineralogic and petrologic framework will be input into the standard three-dimensional data model and spatial data analysis system. A synthesis report will be generated to support the radionuclide transport task and to support the ground-water travel time Performance Assessment and Total System Performance Assessment-1999 for the final Environmental Impact Statement.

2. Synthesis of available surface-based, Exploratory Studies Facility-based, and laboratory monitoring and testing results will be completed for final refinements of process models for elements of the unsaturated zone system. Updating of the unsaturated zone hydrologic system model to final status will be initiated.

3. Final field and experimental data will be compiled for inclusion in the final unsaturated zone and saturated zone descriptions. Monitoring of potentiometric levels in selected drillholes and periodic hydrochemical sampling network will

continue in order to increase confidence in system characteristics for licensing support and to establish baseline conditions for later confirmation studies.

4. Field tests will continue to test applicability of sorption, diffusion, and other radionuclide transport data obtained in the laboratory to site-scale transport.

5. Ongoing characterization of the waste package near-field environment, the effects of man-made materials on that environment, and of altered zone impacts on repository performance and geochemical transport will be continued.

6. Conduct the interim final waste package design as part of the continuing License Application Design.

7. Refine waste package/engineered barrier and spent fuel and borosilicate waste glass degradation predictive models to support the interim final waste package design review and performance assessment.

8. The Engineered Barrier Subsystem performance assessment will continue the focused calculations in support of the License Application Design report.

9. Sensitivity and uncertainty analyses are to be continued by the performance assessment function, as an addendum to its Total System Performance Assessment-1999, to support the continuation of ongoing tests and the planning for potential new tests to be added to the Performance Confirmation program.

10. Acquisition of data from the tectonics program will continue with analyses of the data performed at the end of the fiscal year. Based on the results of interim Total System Performance Assessments, additional investigations at analog sites may be required for the final evaluation of potential secondary effects of volcanism.

11. The technical data management function will update, as needed, the compilations of technical data.

12. The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

13. Construction test support will include excavation of test alcoves, installation of utilities, and assistance in installation of testing mechanisms as required by the test organizations.

4.5.6 Fiscal Year 2000 ($256.4M)

Revision 5 of the Mined Geologic Disposal System license application Annotated Outline and one topical report will be submitted to the Nuclear Regulatory Commission in fiscal year 2000. The scope of these deliverables is discussed in Sections 4.5.5.1 and 4.5.5.2, respectively. The scope is provided in the context of the site characterization, design, and performance assessment activities being performed to provide the necessary supporting information. In addition, progress in the areas of procedural compliance and support activities is discussed in Section 4.5.5.3.

4.5.6.1 License Application Annotated Outline Revision 5

Revision 5 of the license application annotated outline will be the basis for Department of Energy's request for preliminary comments from the Nuclear Regulatory Commission related to the extent to which at-depth site characterization analysis and the waste form proposal seem to be sufficient for inclusion in any License Application. Revision 5 of the license application annotated outline will incorporate the results from Total System Performance Assessment-2000, repository preliminary design and waste package final design at the time of data freeze. All information needed for the License Application will be identified.

Other major changes that will be incorporated into license application annotated outline Revision 5 are identified by chapter in this section. All other chapters will be updated to incorporate results from site characterization and performance assessment activities and to reevaluate information needs based on the preliminary results. In addition, Nuclear Regulatory Commission's comments on license application annotated outline Revision 4 will be incorporated, as appropriate. The fiscal year 2000 site characterization, design, and performance activities identified by chapter in this section are those required to complete each chapter of the draft license application.

4.5.6.1.1 Chapter 1 - General Information

No major update is anticipated.

4.5.6.1.2 Chapter 2 - General Information for the Safety Analysis Report

No major update is anticipated. General information will be summarized from the detailed information incorporated into the Safety Analysis Report.

4.5.6.1.3 Chapter 3 - The Natural Systems of the Geologic Setting

The final report on Pre-Waste Emplacement Natural Barrier System Performance will be incorporated into the ground-water travel time section of Chapter 3. Results from the bounded unsaturated zone/saturated zone geochemistry, unsaturated zone/saturated zone hydrologic, climate, postclosure tectonics, and three-dimensional descriptions will be incorporated into Chapter 3. These descriptions contain much of the final data set for use in licensing.

Drilling activities (Work Breakdown Structure.2.3.5) supporting performance confirmation will include development of a third tracer well complex to support evaluations of radionuclide

transport in the saturated zone, one H-hole to constrain hydrologic conditions at a postulated subregional flow system boundary, and well cleanout and reconfiguration activities.

4.5.6.1.3.1 Site Investigations: Three-Dimensional Geologic Description (WBS 1.2.3)

In fiscal year 2000, final framework information and simulation results from the radionuclide transport task, saturated zone and unsaturated zone hydrology, and altered zone and near-field environment tasks will be imported. Certification will be provided as to the quality assurance qualification of all supporting data and information. A synthesis report will be generated to support Engineered Barrier System performance assessment and Total System Performance Assessment 2000.

4.5.6.1.3.2 Site Investigations: Unsaturated Zone Hydrology (WBS 1.2.3)

Data syntheses and interpretations and refined process, fracture-network, and site models will compiled and integrated for the final Unsaturated Zone Hydrologic Description, a series of reports that will be assimilated into the site description and into the performance assessment program to support subsystem and system analyses. The attributes of alternative modeling approaches will be emphasized in the context of the uses of the models in subsequent thermal response, transport, and performance evaluations.

Data collection, principally from the Exploratory Studies Facility testing, and interpretation will continue in fiscal year 2001 into the performance confirmation period. Monitoring holes and index measurements (such as humidity and gas chemistry and pressure) will be proposed for formal, long-term confirmation use. Evaluation of pneumatic pathways using LIDAR and thermal imaging will continue.

4.5.6.1.3.3 Site Investigations: Saturated Zone Hydrology (WBS 1.2.3)

Data syntheses, interpretations, and refined process and site models will be compiled and integrated for the final Saturated Zone Hydrologic Description, a series of reports that will be assimilated into the site description and into the performance assessment program to support subsystem and total system analyses. An important aspect of the process modeling will be identification of the attributes of fracture-flow and equivalent porous-medium simulations of flow, which will strongly influence the complexity of subsequent transport modeling. Applications of the modeling in evaluating the potential effects of future climate change and tectonic events on the water-table elevation and configuration, and on saturated flow characteristics, will be provided to support evaluations of the site in the context of the 10 CFR Part 60 siting criteria.

Data collection in a selected subset of the monitoring network, as well as refinement of models in light of new data and hydrogeologic information, will continue in fiscal year 2001 into the performance confirmation period. Monitoring holes and index measurements (such as water levels, water chemistry, and temperature) will be proposed for formal long-term confirmation use. A third tracer well complex will be constructed and tested to support model validation activities, and a deep borehole will be drilled to further evaluate hydrologic conditions in the carbonate aquifer.

4.5.6.1.3.4 Site Investigations: Radionuclide Transport (WBS 1.2.3)

In-situ transport experiments in the Calico Hills unit and at the Peña Blanca natural analog site will be completed.

Data from the radionuclide transport studies will be summarized for the final Total System Performance Assessment supporting the license application. Variability and uncertainty in the data will be summarized. Retardation sensitivity analysis will integrate gaseous and aqueous flow system data with radionuclide transport, mineral distribution, and ground water chemistry data to produce process level models of radionuclide movement. This process level modeling will provide a check on abstractions made in the Total System Performance Assessment to calculate radionuclide releases. All studies will assess the extent to which additional information will need to be gathered in the performance confirmation phase.

4.5.6.1.3.5 Site Investigations: Climate (WBS 1.2.3)

Numerical climate simulations will be performed using supportable regional climate models and the synthesis of future climate refined in response to performance assessment and licensing needs.

4.5.6.1.3.6 Site Investigations: Thermal Effects (WBS 1.2.3)

The description of expected repository-induced thermal effects, especially the early near-field thermal environment, will be updated and provided as altered-zone and near-field environment reports. Both reports will draw on current results obtained from the North Ramp Engineered Barrier System heater test to bound the description of the near-field and altered zone environments, including chemistry of water likely to contact the waste packages.

4.5.6.1.3.7 Natural Barrier Subsystem Performance Assessment (WBS 1.2.5)

Each analysis used in the license application Safety Analysis Report must be supported in terms of its technical basis. Any computer codes and models used must be verified and partially validated. Each prior year's scope of work includes significant effort toward this need, as noted in the fiscal year 1996 work descriptions. That effort culminates in two reports: one on the natural barrier subsystem, and one on the engineered barrier subsystem.

A report on Site Performance Assessment Code and Model Verification and Partial Validation will be issued. This report will describe the evaluation of the performance assessment codes and models used in addressing the ground-water travel time regulatory requirement, and the codes and models used to estimate flow and transport within and around Yucca Mountain.

4.5.6.1.4 Chapter 4 - Geologic Repository Operations Area: Physical Facilities

The Repository and Engineered Barrier System Concept of Operations and the second Interim License Application Design Report will be incorporated into Chapter 4.

A summary of the fiscal year 2000 activities that support the development of Chapter 4 follows:

4.5.6.1.4.1 Design: Repository (WBS 1.2.4)

The Final License Application Design Report will be issued, which includes final surface and subsurface preliminary designs and performance assessments. The License Application Design encompasses the intent of Department of Energy preliminary designs for systems, structures, and components important to safety and waste isolation.

4.5.6.1.4.2 Systems Engineering (WBS 1.2.1)

In fiscal year 2000, a major Thermal Management Study to support a preliminary decision on thermal ranges for repository design will be completed. The waste package Prototype and Demonstration Retrievability Study will also be completed. Three Design Summary Reports will be prepared to validate repository and waste package design efforts.

4.5.6.1.5 Chapter 5 - Engineered Barrier System

The Engineered Barrier Design Requirements baseline will be revised to reflect the results of Waste Package final design activities. Interim results from waste package final design will be used to update Chapter 5. A summary of the fiscal year 2000 activities that support the development of Chapter 5 follows:

4.5.6.1.5.1 Design: Waste Package Engineering (WBS 1.2.2)

Final criticality, thermal, shielding, structural and component degradation analyses for waste packages will be performed to accommodate multi-purpose canister, high-level waste glass canisters, and uncanistered spent fuel. The final waste package design will be completed for input to the License Application Design. Risk analysis studies of criticality and other hazards to waste isolation will be completed. Fabrication and testing to ensure compliance with preclosure performance requirements will be completed.

4.5.6.1.5.2 Design: Waste Package Materials Testing (WBS 1.2.2)

Spent fuel and borosilicate waste glass and waste package/engineered barrier degradation predictive models will be refined to support completion of final waste package design. The updated Waste Form Characteristics Report will be issued to support prediction of the Engineered Barrier System source term for license application. The updated Engineered Materials Characteristics Report will be issued to support substantially complete containment compliance analyses and prediction of the Engineered Barrier System source term for the license application.

4.5.6.1.5.3 Engineered Barrier Subsystem Performance Assessment (WBS 1.2.5)

A Final Report on License Application Design waste package/Engineered Barrier System performance assessments will be issued. This will be the background document for the regulatory compliance argument for the aggregated waste packages, and describes the expected radionuclide source term used in Total System Performance Assessment-2000.

A Report on Waste Package/Engineered Barrier System Performance Assessment Code and Model Verification and Validation is to be issued. This report will describe the verification and validation of the deterministic performance assessment codes used in the Engineered Barrier System performance assessment for the License Application Design. The verification and validation work will include assessments and explanations of code applicability to the various analyses conducted for the license application.

4.5.6.1.6 Chapter 6 - Overall System Performance Assessment

The results of Total System Performance Assessment-1999, the Total System Performance Assessment Model Topical Report and the topical report on dose assessment and radiological release methodologies will be incorporated into Chapter 6.

A summary of the fiscal year 2000 activities that support the development of Chapter 6 follows:

4.5.6.1.6.1 Total System Performance Assessment (WBS 1.2.5)

A summary report will be issued describing Total System Performance Assessment-2000, including results and qualitative descriptions of the uncertainties in the assessment and results. This total system performance assessment will be an update and refinement of Total System Performance Assessment-1999. Portions of this document may be directly incorporated into the license application Safety Analysis Report.

4.5.6.1.7 Chapter 7 - Conduct of Repository Operations

The Repository and Engineered Barrier System Concept of Operations will be provide a major update to Chapter 7.

A summary of the fiscal year 2000 activities that support the development of Chapter 7 follows:

4.5.6.1.7.1 Systems Engineering (WBS 1.2.1)

In fiscal year 2000, descriptions of repository operations will be updated to reflect the Thermal Management Study and the waste package Prototype and Demonstration Retrievability Study.

4.5.6.1.8 Chapter 8 - Performance Confirmation Program

A summary of the fiscal year 2000 activities that support the development of Chapter 8 follows:

The licensing function continues to coordinate the performance confirmation program with the Nuclear Regulatory Commission in terms of the content of the license application being submitted next year. The performance assessment descriptions and analyses will be generated to support the 2008 update of the license application to receive and possess waste with performance confirmation tests and their results. Sensitivity and uncertainty analyses are to be continued by the Performance Assessment function, as part of its response to comments on Total System Performance Assessment-1999, to support the continuation of ongoing tests and the planning for potential new tests to be added to the performance confirmation program.

4.5.6.1.8.1 Site Investigations: Postclosure Tectonics (WBS 1.2.3)

The acquisition of data from the postclosure monitoring program will be continued and analyses of the data will be completed at the end of the fiscal year. The results of tests of model versus drillhole data will be compared and will provide a formal test of the suitability of volcanic effects models for performance assessment.

4.5.6.1.9 Chapter 9 - Land Ownership and Control

Environmental data generated for the Draft Environmental Impact Statement will be incorporated into Chapter 9.

A summary of the fiscal year 2000 activities that support the development of Chapter 9 follows:

4.5.6.1.9.1 Environmental (WBS 1.2.13)

Environmental data generated for the draft Environmental Impact Statement will be confirmed or updated as required for use in Chapters 3, 4, 6, 7 and 8 as well as Chapter 9.

4.5.6.1.10 Chapter 10 - Quality Assurance

No major updates are anticipated.

The activities necessary to implement a quality assurance program for site characterization are described in Section 4.5.5.3.

4.5.6.1.11 Chapter 11 - Emergency Plan

The Emergency Plan will be updated as necessary.

4.5.6.2 Procedural Compliance and Support Activities

Nuclear Regulatory Commission comments on the sufficiency of at-depth site characterization analysis and waste form proposal for inclusion in any repository license application are incorporated into Site Recommendation Report as required under Nuclear Waste Policy Act Section 114(a)(1)(E).

The following procedural compliance and support activities will be performed in fiscal year 2000:

4.5.6.2.1 Technical Data Management (WBS 1.2.5)

The technical data management function will update, as needed, the compilations of technical data.

4.5.6.2.2 Information Management (WBS 1.2.12)

The Department of Energy will incorporate Licensing Support System Administrator certification into the draft license application.

4.5.6.2.3 Quality Assurance (WBS 1.2.11)

The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

4.5.6.2.4 Exploratory Studies Facility/Test Facilities (WBS 1.2.6, 1.2.7)

Drifting in the Calico Hills unit will be completed. Approximately 1500 meters of tunneling will be completed, ending with a second encounter of the Ghost Dance fault in the Calico Hills unit. This will complete the primary tunneling required in the Exploratory Studies Facility. The capability to drive additional tunnel will be maintained by keeping the tunnel boring machine and supporting equipment in operational condition.

Other activities in the Exploratory Studies Facility for fiscal year 2000 include basic operations and maintenance of the facility, including the Integrated Data and Control System, and construction test support. Construction test support will include excavation of test alcoves, installation of utilities, and assistance in installation of testing mechanisms as required by the test organizations.

4.5.6.3 Metrics - Fiscal Year 2000

Outputs:

1. Revision 5 of the license application annotated outline will be submitted to the Nuclear Regulatory Commission as the basis for the Department of Energy's request for preliminary comments related to the extent to which at-depth site characterization analysis and the waste form proposal seem to be sufficient for inclusion in any license application. Revision 5 of the license application annotated outline will incorporate the results from Total System Performance Assessment-2000, repository preliminary design and waste package final design at the time of data freeze. All information needed for the license application will be included.

2. In fiscal year 2000, final framework information and simulation results from the radionuclide transport task, saturated zone and unsaturated zone hydrology, and altered zone and near-field environment tasks will be issued as the final Three-Dimensional Geologic Description. Certification will be provided as to the quality assurance qualification of all supporting data and information. A synthesis report

will be generated to support Engineered Barrier System performance assessment and Total System Performance Assessment-2000.

3. Data syntheses and interpretations and refined process, fracture-network, and site models will be compiled, integrated and issued as the final Unsaturated Zone Hydrologic Description, a series of reports that will be assimilated into the site description and into the performance assessment program to support subsystem and system analyses.

4. The final Saturated Zone Hydrologic Description will be issued.

5. Data from the radionuclide transport studies will be issued for the final total system performance assessment supporting the license application.

6. The description of expected repository-induced thermal effects, especially the early near-field thermal environment, will be updated and issued as Final Altered-zone and Near-field Environment Reports. Both reports will draw on current results obtained from the North Ramp Engineered Barrier System heater test to bound the description of the near-field and altered zone environments, including chemistry of water likely to contact the waste packages.

7. A report on Site Performance Assessment Code and Model Verification and Partial Validation will be issued. This report will describe the evaluation of the performance assessment codes and models used in addressing the ground-water travel time regulatory requirement, and the codes and models used to estimate flow and transport within and around Yucca Mountain.

8. The Final License Application Design Report will be issued, which includes final surface and subsurface preliminary designs and performance assessments. The License Application Design encompasses the intent of Department of Energy preliminary designs for systems, structures, and components important to safety and waste isolation.

9. In fiscal year 2000, a major Thermal Management Study to support a preliminary decision on thermal loading ranges for repository design will be completed.

10. The waste package Prototype and Demonstration Retrievability Study will be completed.

11. Three Design Summary Reports will be prepared to validate Repository and waste package design efforts.

12. The Title II waste package design will be completed for input to the License Application Design. Risk analysis studies of criticality and other hazards to waste isolation will be completed.

13. A Final Report on License Application Design waste package/Engineered Barrier System performance assessments will be issued. This will be the background document for the regulatory compliance argument for the aggregated waste packages, and describes the expected radionuclide source term used in Total System Performance Assessment-2000.

14. A Report on Waste Package/Engineered Barrier System Performance Assessment Code and Model Verification and Validation is to be issued. This report will describe the verification and validation of the deterministic performance assessment codes used in the Engineered Barrier System performance assessment for the License Application Design.

15. A summary report will be issued describing Total System Performance Assessment-2000, including results and qualitative descriptions of the uncertainties in the assessment and results. This total system performance assessment will be an update and refinement of Total System Performance Assessment-1999.

16. Environmental data generated for the draft Environmental Impact Statement will be confirmed or updated as required for use in license application Annotated Outline Chapters 3, 4, 6, 7, 8 and 9.

17. Nuclear Regulatory Commission comments on the sufficiency of at-depth site characterization analysis and waste form proposal for inclusion in any repository license application are incorporated into Site Recommendation Report as required under Nuclear Waste Policy Act Section 114(a)(1)(E).

18. Approximately 1500 meters of Exploratory Studies Facility tunnel will be excavated completing drifting in the Calico Hills unit. A second intercept of the Ghost Dance fault in the Calico Hills unit will be made.

19. The final License Application Design report will be completed. This report will document the subsurface and nuclear-related surface facility preliminary designs and the waste package final design. Non-nuclear surface facility design will be 80% complete.

Outcomes:

1. Numerical simulations of future climate will be performed to support performance assessment for licensing.

2. Spent fuel and borosilicate waste glass and waste package/engineered barrier degradation predictive models will be refined to support completion of final waste package design.

3. The acquisition of seismic data from the postclosure tectonics monitoring program will be continued and analyses of the data will be completed at the end of the fiscal year.

4. The technical data management function will update, as needed, the compilations of technical data.

5. The quality assurance controls will continue through development and maintenance of affected organizations' quality assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository will be sufficient to comply with Federal regulations.

6. Activities in the Exploratory Studies Facility for fiscal year 2000 will consist of basic operations and maintenance of the facility, including the Integrated Data and Control System, and construction test support. Construction test support will include excavation of test alcoves, installation of utilities, and assistance in installation of testing mechanisms as required by the test organizations.

4.6 LICENSING COST ESTIMATE

The cost profile for individual elements of the licensing product area is provided in Figure 4-3, in terms of total costs and percentage distributions for fiscal year 1995 through fiscal year 2000. The fiscal year 1995 cost profile is based on actual budget allocation.

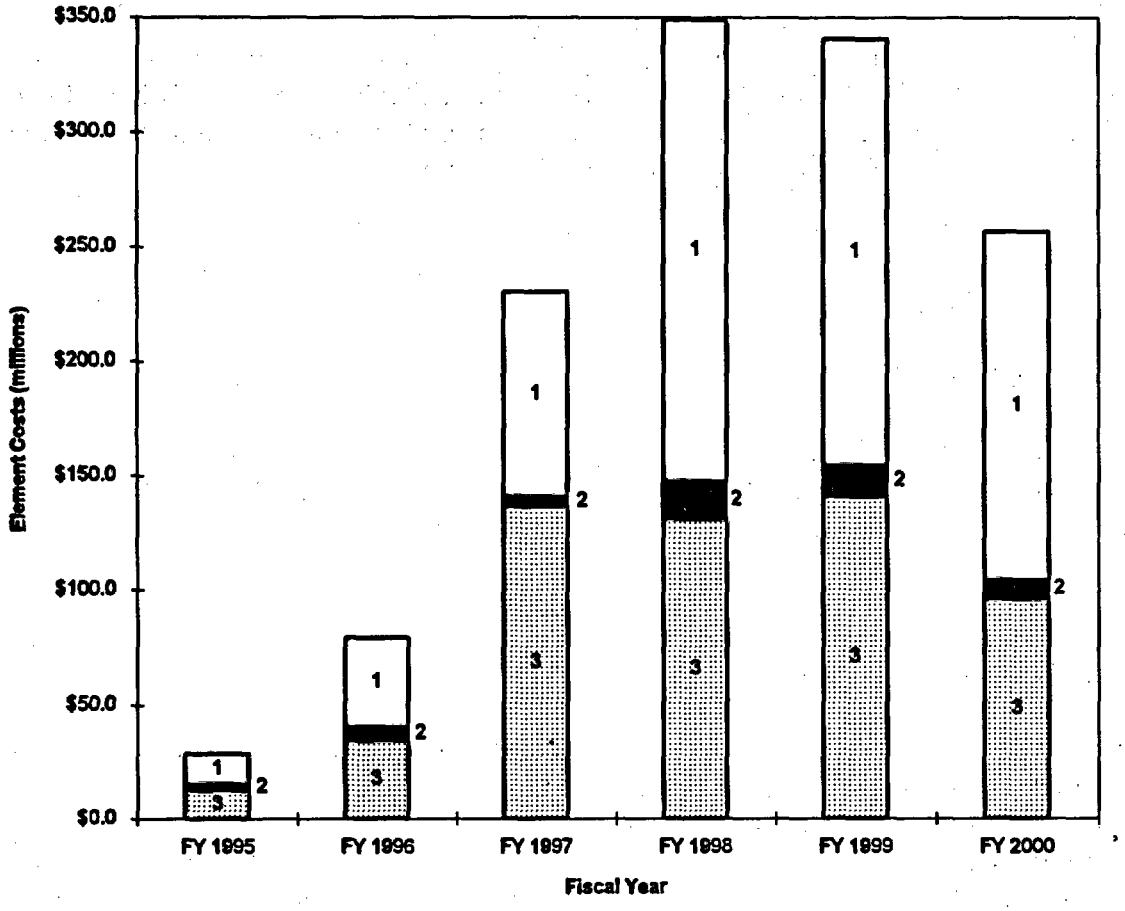
4.6.1 Licensing Assumptions and Methodology

4.6.1.1 General Assumptions

Allocation of costs between suitability and licensing is not clear cut because activities often support both products and there is no clear way to delineate support. Therefore assumptions used for the allocation are as noted below. The cost estimates for the licensing section of this plan were developed in a "tops-down" manner as follows: (1) Workscope necessary to support the fiscal year 2001 License Application was identified and has been presented in the previous sections; (2) a detailed schedule of milestones that show progress toward the license application were then identified; (3) work breakdown structure third level costs were estimated "tops-down," with increases over fiscal year 1995, as appropriate to meet the licensing milestones; and (4) these work breakdown structure third level "control totals" were then allocated to the licensing subelements. Specific assumptions that were "cost-drivers" for selected work breakdown structure elements are discussed below.

4.6.1.2 Exploratory Studies Facility (WBS 1.2.6)

The exploratory studies facility is an underground network of tunnels and alcoves which will be excavated to provide access to the potential repository horizon in the Topopah Spring Level to conduct tests (see work breakdown structure 1.2.3 for testing in the exploratory studies facility). Approximately one-third of the exploratory studies facility excavation in the exploratory studies facility "loop", all of the North Ramp extension, and the Calico Hills drifting will directly support licensing. This also includes the two heater test areas. Construction of a limited number of surface facilities is required at the south portal. Excavation of the exploratory studies facility will provide the access necessary for geologic mapping of the exposed rock. The early heater test



Licensing (millions)		Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1	Annotated Outline / Draft License Application	$13.5	$39.0	$89.4	$201.6	$186.3	$152.4	$682.2
2	Topical Reports	$3.0	$6.1	$4.4	$16.4	$13.7	$8.5	$52.1
3	Procedural Compliance & Support Activities	$12.2	$34.1	$136.2	$130.8	$140.6	$95.5	$549.4
	Total:	$28.7	$79.2	$230.0	$348.8	$340.6	$256.4	$1,283.7

Figure 4-3. Licensing: Preliminary Cost Profile

results will provide performance observations to support demonstration of compliance with 10 CFR Part 60 technical criteria required for the license application.

4.6.1.3 Site Investigations (WBS 1.2.3)

The Site investigations include all surface-based geology, hydrology, geochemistry, and climatology investigations, synthesis and modeling, as well as the drilling program for fiscal years 1998-2000. In fiscal years 1996 and 1997 activities related to regional hydrology, future climate, and thermal effects are allocated to the licensing function. It also includes surface and subsurface (e.g., in the exploratory studies facility) testing.

5. MANAGEMENT AND COMPLIANCE

5.1 INTRODUCTION

Management and Compliance includes normal management activities required for direction and control of the Project, and functions that ensure compliance with applicable statutes and regulations. This product area also includes the special allocations required by law to facilitate external agencies and the public in their review and interactions with the Project.

The Management and Compliance category is comprised of two main sub-elements: general management, which includes the Nevada Test Site allocation; and compliance, which includes Project outreach and other actions mandated by the Secretary of Energy's stakeholder policy and the Nuclear Waste Policy Act, as amended. General management and compliance support the other three Program approach product areas of Site Suitability, Licensing, and National Environmental Policy Act process. Although the Management and Compliance workscope is integral to all site characterization, design, and construction activities, it is included in a separate category to identify the indirect costs of "doing business" in the unique regulatory and oversight environment created by the Nuclear Waste Policy Amendments Act.

The General Management sub-element of Management and Compliance includes those essential management functions that would be required by any design, construction, and research program of this magnitude. Specifically, this element includes: overall Project direction; planning, coordination, baseline development and change management; support services (e.g., procurement, contract management); provision of office facilities, vehicles, utilities and security; and information management.

The Nevada Test Site Allocation is included in General Management. This is a payment for the Yucca Mountain Site Characterization Project portion of the facilities and services provided by Nevada Test Site at the Yucca Mountain Site.

The Compliance sub-element of Management and Compliance includes those functions necessary to comply with federal, state and local statutes and Department of Energy Orders, as well as the Nuclear Waste Policy Amendments Act requirements to conduct the site characterization program in an open and informative manner. Specifically, this element includes activities to comply with the Nuclear Waste Policy Amendments Act, Nuclear Regulatory Commission and Environmental Protection Agency regulations, Occupational Safety & Health Administration, mining requirements equivalent to those of the Federal Mine Safety & Health Act, and federal and state permitting requirements.

Also included in the Compliance sub-element are those funds appropriated by Congress for oversight by the State of Nevada and Affected Units of Local Government; technical studies by Nevada Universities; and Payments Equal To Taxes in accordance with the Nuclear Waste Policy Amendments Act.

The Yucca Mountain Site Characterization Office is located in Las Vegas, Nevada. The Yucca Mountain site is approximately 100 miles northwest of Las Vegas, on the southwestern border of the Nevada Test Site. Other organizations (national laboratories and the U.S. Geological

Survey) involved with the Project are in such widely dispersed geographic locations as Los Alamos, New Mexico; Albuquerque, New Mexico; Denver, Colorado; and Livermore, California. The Management and Compliance function includes support to the Las Vegas Yucca Mountain Site Characterization Office and to the organizations at their locations, as well as to the remote Yucca Mountain Site through the Field Operations Center located at the Nevada Test Site.

5.2 MANAGEMENT AND COMPLIANCE OBJECTIVES

The objective of the Management and Compliance support is to provide the necessary Project planning and direction--as well as the human resources, facilities, equipment, and budget and financial management--to accomplish the restructured Project priorities while complying with applicable statutes and regulations.

5.3 STRATEGY FOR ACHIEVING MANAGEMENT AND COMPLIANCE

The strategy for achieving the objectives is to continuously improve Project management, performance measurement, and cost control methods to facilitate efficient and effective accomplishment of Project priorities. Expenditures will be planned, controlled, and allocated in greater detail, focused on facilitating the scheduled delivery of Program approach products. Total Quality Management processes will be incorporated into strategic decisions, including the identification of the ultimate "customer" and assuring that only the work sufficient to meet this "customer's" needs is planned and executed.

5.4 MANAGEMENT AND COMPLIANCE ASSUMPTIONS

Management and compliance that directly support the other three major Program approach products have been allocated to suitability, licensing, and National Environmental Policy Act, as appropriate. This includes the coordination and planning Work Breakdown Structure fourth level elements for Waste Package, Site Investigations, Repository, Regulatory, Exploratory Studies Facility, and the Environmental program.

Two challenges face the Management and Compliance area during this period:

1. Planning for an appropriate share of the Nevada Test Site fixed costs as the weapons testing activities diminish.

2. Obtaining the necessary office facilities for current and future Project staff.

As other Nevada Test Site defense program activities are reduced, the Yucca Mountain Site Characterization Project may be expected to absorb an increasingly larger share of the total Nevada Test Site operating costs. What the Yucca Mountain Site Characterization Project's "appropriate" share should be is under discussion with Nevada Test Site management. For the planning period, Nevada Test Site allocation cost estimates are based on the assumption of a significant increase in fiscal years 1995 and 1996, a smaller increase in fiscal year 1997, remaining constant through fiscal year 2000.

The lease on the current Las Vegas Bank of America office facilities expires during March 1997. This current office facility can accommodate only limited future staff growth. Additional office space will be leased and occupied in fiscal year 1995. It is anticipated that the Bank of America lease will be renewed. Additionally, it is assumed that the termination clauses in both these leases will be written to mitigate the need for full lease termination liability to be included in the budget authority in the year the leases are renewed.

The funding level for the State of Nevada and Affected Units of Local Government is based on their fiscal year 1995 budget request. It is assumed that the funding level will remain constant throughout the period.

To date, the State of Nevada has not been responsive to entering into a Benefits Agreement with the Department of Energy, as provided by the Nuclear Waste Policy Amendments Act. Therefore, no cost estimate for a benefits agreement has been included in the Compliance sub-element.

In July 1994, an agreement was signed between the Office of Civilian Radioactive Waste Management and Nye County regarding Payments Equal To Taxes for the period from May 1989, through September 1999. It is assumed that the fiscal year 2000 Payments Equal To Taxes payment will be at the same level as fiscal year 1999, and that Payments Equal To Taxes payments to the other Affected Units of Local Government will not exceed $1M per year during the period.

Project management, administrative and support services (excluding the renewed lease costs), and information management are assumed to remain at fiscal year 1995 levels, with cost increases at a fixed rate (3 percent) annually for inflation only.

Quality Assurance activities include the quality concerns program, implementation of quality management principles, and the development and maintenance of controls to assure quality achievement in the technical programs. The remaining Quality Assurance workscope is allocated to the licensing program.

5.5 MANAGEMENT AND COMPLIANCE PLAN

Management and Compliance costs average approximately 29 percent of the Yucca Mountain Site Characterization Project cost estimate for the period. Nearly one-third of Management and Compliance costs (about 10 percent of the Yucca Mountain Site Characterization Project cost estimate) are provided to the state of Nevada, Affected Units of Local Government and State Universities for oversight and technical research. Payments for the Nevada Test Site allocation are in the General Management element of Management and Compliance. Oversight payments to the State of Nevada and Affected Units of Local Government are in the Compliance element of Management and Compliance.

The General Management sub-element of Management and Compliance is essential for the control and administration of a Project of this magnitude. Its primary purpose is to provide a disciplined and systematic approach to project management -- resulting in quality products

through efficient planning, organization, performance measurement, coordination, budgeting, and cost control.

Management and administration costs do not vary significantly whenever scientific investigation activities increase or decrease. General Management costs range from 19 percent in fiscal year 1995 to 15 percent in fiscal years 1996 and 1997 and 30 percent in fiscal year 2000 of the Yucca Mountain Site Characterization Project annual cost estimate and average about 19 percent of the Yucca Mountain Site Characterization Project cost estimate.

The Compliance sub-element is composed of those activities necessary to meet requirements of federal, state, or local laws and regulations applicable to ongoing site characterization activities at Yucca Mountain. Compliance activities include some workscope from systems engineering, quality assurance, protection of the environment, and maintenance of employee and public safety and health. These costs are controllable by Yucca Mountain Site Characterization Project, but funding levels must be sufficient to maintain viable compliance processes. Continued operation of the Project may be in jeopardy if violations of statutes were to occur.

The Compliance sub-element also includes compliance with Nuclear Waste Policy Amendments Act provisions, which include programs to provide funds to the State of Nevada and Affected Units of Local Government for their oversight responsibilities. Mandatory University of Nevada funding and Payments Equal To Taxes are administered in this sub-element, as well as the institutional programs for public interactions pursuant to the Secretary of Energy's Stakeholder Policy.

5.5.1 Management and Compliance for Fiscal Year 1995 ($101.2M)

5.5.1.1 General Management (WBS 1.2.7, 1.2.9, 1.2.12, 1.2.15)

General management includes project management, information management, administrative support services, and the Nevada Test Site allocation. The Nevada Test Site allocation pays for the Yucca Mountain Site Characterization Project portion of shared facilities and services at the Nevada Test Site. Shared facilities and services include office space, roadways, radiological control, site security, motor pool, general emergency services, on-site housing, and cafeteria facilities.

The Project management system was developed in compliance with Department of Energy Order 4700.1 and later augmented by Department of Energy Order 4700.5 which imposes a rigorous management approach requiring the establishment of procedures, processes, and baseline management. Baseline management includes planning, scheduling, cost estimating, performance measurement, and change control.

Information management is implemented in response to requirements mandated by the Paperwork Reduction Act (Public Law 99-591), the Computer Security Act (Public Law 100-235), and Office of Management and Budget Circular No. A-130, Management of Federal Information Resources, and as published in applicable Department of Energy Orders. This function handles the operation and maintenance of computer networks, standardized office automation tools, telecommunications systems, and protection and retrievability of records. Development of the

Licensing Support System is allocated to the Licensing product, since it will directly support the license application and subsequent hearings.

Administrative support services include procurement and contract management in accordance with the Federal Acquisition Regulation, legal services, personnel/clerical support, mail distribution, logistical support for off-site Participants, property and vehicle management in accordance with 41 CFR Chapter 101, facilities rent, telephone services, office equipment acquisition, motor pool operations, security services in accordance with 10 CFR Part 860, and audio-visual/publications services.

5.5.1.2 Compliance (WBS 1.2.1, 1.2.10, 1.2.11, 1.2.13, 1.2.14)

The Compliance sub-element of Management and Compliance includes those activities necessary to comply with applicable statutes and regulations. This function consists of some workscope of systems engineering and quality assurance, environmental protection, and all the workscope in financial/technical assistance to the State of Nevada and Affected Units of Local Government, institutional interactions, and safety and health programs.

5.5.1.2.1 Systems Engineering (WBS 1.2.1)

Systems Engineering activities in support of Management and Compliance mainly consist of Program and Project level systems integration (e.g., value engineering studies, integration workshops) and scheduled revisions to Project plans to maintain a current project management baseline.

In fiscal year 1995, major system engineering activities will consist of completion and delivery of the fiscal year 1995 thermal loading study, Calico Hills data needs and access study, multi-purpose canister systems study and repository preliminary transportation strategy.

5.5.1.2.2 Quality Assurance (WBS 1.2.11)

Activities include core Quality Assurance oversight, coordination, and planning of systematic actions by affected organizations responding to the non-regulatory aspects of quality assurance outlined in Department of Energy Order 4700.1. These activities include identification and resolution of quality concerns, implementation of quality management principles, and the development and maintenance of controls that aid in assuring quality achievement in Department of Energy programs.

Quality Assurance activities by affected organizations during the period will include support of audits and surveillance, coordination and tracking of internal nonconformance and corrective action processes in support of lab and field testing, Quality Assurance document reviews, and general implementation of Quality Assurance program guidance from Yucca Mountain Site Characterization Office.

5.5.1.2.3 Environment, Safety and Health (WBS 1.2.13)

The Environmental Compliance Program ensures protection of the environment from hazards that may result from Yucca Mountain Site Characterization Project site characterization and construction activities. Failure to comply with environmental laws and regulations is likely to cause damage to the environment, and precipitate regulatory enforcement actions that may include the levying of fines and other penalties that could shut down the project work activities.

Environmental compliance program activities during the period will consist of identifying changes to applicable environmental laws and regulations; obtaining and maintaining necessary permits to construct and operate; hazardous materials and solid waste management; environmental compliance self appraisals, audits, and surveillance. There will be continued preparation and maintenance of Yucca Mountain Site Characterization Project environmental plans, administrative procedures and other documents, and preparation of annual site environmental reports as required by Department of Energy Order 5400.1.

The Safety and Health compliance program provides protection for the health and safety of Project employees, members of the public, and Yucca Mountain Site Characterization Project facilities and equipment. Starting in fiscal year 1996 and continuing for the next s, the Yucca Mountain Site Characterization Project Safety and Health program will expand in scope and magnitude to effectively support increased site characterization and construction activities.
The Safety and Health program includes a management and administration function providing oversight and integration of Safety and Health requirements within the Project. Specific tasks during the period include performance of engineering design reviews, development of Safety and Health procedures, performance of program assessments, inspections and surveillance, overseeing the development of Safety and Health training programs and contractor Safety and Health programs, accident investigations, and managing the federal employee Occupational Safety and Health Program.

The Occupational Safety and Health function develops Yucca Mountain Site Characterization Project Participant programs to implement Safety and Health programs in conformance with applicable regulations and Department of Energy Orders. This function manages and administers the Safety and Health programs for all Yucca Mountain Site Characterization Project affected Organizations. Specific activities during the period include job safety analysis, employee information and training, underground construction safety, occurrence reporting and investigations, oversight of tunnel boring activities, industrial hygiene functions, and Safety and Health self appraisals and assessments.

5.5.1.2.4 Financial/Technical Assistance (WBS 1.2.10)

This function provides direct payments to State of Nevada and Affected Units of Local Government for their oversight responsibilities pursuant to Nuclear Waste Policy Amendments Act. The actual amount provided to these entities is determined by Congress. Funding is also provided through cooperative agreements with the University of Nevada System to conduct studies and other research and development work as directed.

Payments-Equal-to-Taxes funds are provided in compliance with provisions of the Nuclear Waste Policy Amendments Act. Payments Equal To Taxes compensates the affected units of government for taxes they would have collected had they been authorized to tax Yucca Mountain Site Characterization Project site characterization activities the same as they would tax a private entity.

5.5.1.2.5 Institutional (WBS 1.2.14)

This function performs the planning, coordination, integration, and conduct of Project interactions with the public and stakeholders in compliance with the Secretary of Energy's stakeholder policy. Concerns identified in public interactions are integrated into the technical and management process. The Institutional function supports Yucca Mountain Site Characterization Project interactions with the State of Nevada, public interest groups, the Nevada business community, local government agencies, and other stakeholders. Rural outreach programs and interactions with affected counties are conducted, including support of transportation activities. Public outreach is performed through educational programs, a speaker's bureau, site tours, awareness enhancement program, release of Yucca Mountain Site Characterization Project information to external parties, and operation and update of exhibits in three science centers. Audiovisuals, publications, models, commercial print/electronic media announcements, and exhibits are either developed or acquired.

5.5.2 Management and Compliance for Fiscal Years 1996 - 2000 ($735.6M)

5.5.2.1 General Management (WBS 1.2.7, 1.2.9, 1.2.12, 1.2.15)

General project management will continue as described in Section 5.5.1.1.

5.5.2.2 Compliance (WBS 1.2.1, 1.2.10, 1.2.11, 1.2.13, 1.2.14)

In fiscal year 1996, major Systems Engineering activities will consist of development and implementation of two engineering plans. The Project Engineering Specialty Plan will integrate specialty engineering disciplines during design development and when design changes are proposed. The Project Systems Studies Plan will provide a methodical approach to the definition and implementation of timely systems studies. Planned work will also include support to the Total Systems Life Cycle Costs effort.

In fiscal year 1997, four major Project management and Systems Engineering plans will be revised to maintain a current project management baseline: Yucca Mountain Site Characterization Project Plan, Project Management Plan, Project Systems Engineering Management Plan, and the Project Systems Engineering Long-Range Plan.

In fiscal year 1998 and continuing through fiscal year 2000, institutional costs are increased in anticipation of extensive public interactions resulting from issuance of the technical site suitability evaluation report and the draft Environmental Impact Statement for review and comment.

5.6 MANAGEMENT AND COMPLIANCE METRICS

5.6.1 Outcomes:

Effectiveness of the Management and Compliance function is demonstrated by the following four outcomes:

1. Yucca Mountain Project activities are planned, funded, and scheduled to meet Office of Civilian Radioactive Waste Management goals and objectives.

2. Planned work is accomplished in accordance with budget allocations, milestones, and schedules.

3. Continued compliance with applicable statutes, regulations, and Department of Energy Orders in a cost effective manner.

4. The Secretary of Energy's Stakeholder Policy is fully implemented; open and informative interactions with the public and stakeholders accompany the site characterization process.

5.6.2 Outputs:

None.

5.7 MANAGEMENT AND COMPLIANCE COST ESTIMATES

The cost profile for individual elements of the management and compliance product area are provided in Figure 5-1, in terms of total costs and the percentage distributions of these costs for fiscal year 1995 through fiscal year 2000. Appendix A provides additional detail on distribution of cost estimates to lower level Work Breakdown Structure numbers.

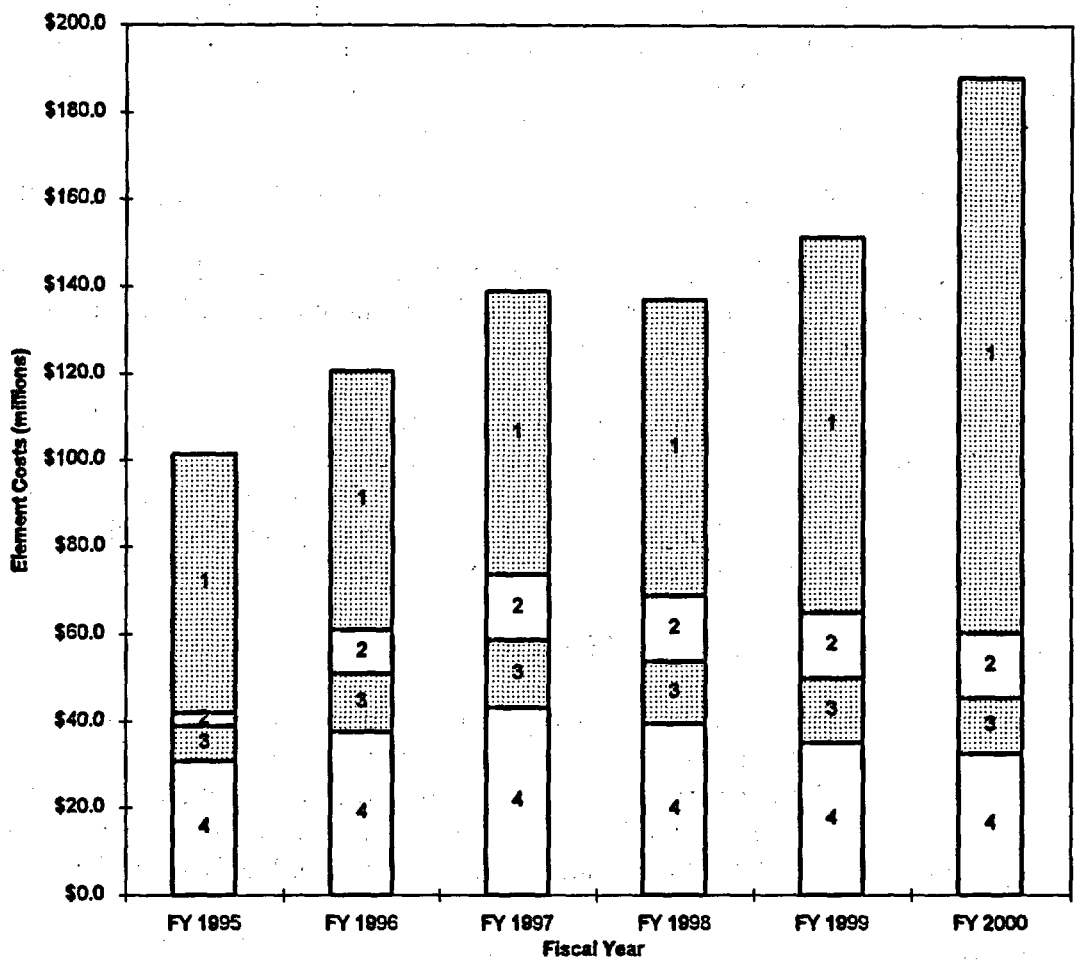
5.7.1 Management and Compliance Cost Estimate Assumptions and Methodology

5.7.1.1 General Assumptions

The cost estimates for the Management and Compliance part of this plan were developed in a "tops-down" manner as follows: (1) Workscope necessary to support the Program approach was identified. This has been presented in the previous sections; (2) Work Breakdown Structure third level costs were estimated "tops-down," with increases over fiscal year 1994, as appropriate, to meet the Program approach milestones; and (3) these Work Breakdown Structure third level "control totals" were allocated to the Management and Compliance sub-elements. Specific assumptions that were "cost-drivers" for selected Work Breakdown Structure elements are discussed below.

5.7.1.2 Nevada Test Site Allocation (WBS 1.2.7)

A fixed amount of $3M in fiscal year 1995, $10M in fiscal year 1996 and $15M annually from fiscal year 1997 through fiscal year 2000 was assumed. Discussions with Nevada Test Site management are ongoing, with the understanding that these estimates are subject to change when discussions are completed.



Management & Compliance (millions)	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1 General Management	$59.4	$59.6	$65.4	$68.2	$86.5	$127.9	$467.0
2 Nevada Test Site Allocation	$3.0	$10.0	$15.0	$15.0	$15.0	$15.0	$73.0
3 Compliance	$8.1	$13.4	$15.5	$14.3	$14.9	$12.6	$79.0
4 Oversight / Stakeholders	$30.7	$37.5	$43.0	$39.4	$34.9	$32.4	$217.9
Total	$101.2	$120.5	$138.9	$136.9	$151.3	$188.1	$836.9

Figure 5-1. Management and Compliance: Preliminary Cost Profile

5.7.1.3 Financial and Technical Assistance: Benefits Agreements (WBS 1.2.10)

In accordance with the Nuclear Waste Policy Act, Subtitle F-"Benefits," the Secretary may enter into a benefits agreement with the State of Nevada concerning a repository. In addition to the negotiated benefits, the Secretary shall make payments to the State as follows: $10M a year prior to first spent fuel receipt, $20M upon first spent fuel receipt, and $20M annual payments after first spent fuel receipt until closure of the facility. To date, the State of Nevada has not been responsive to entering into a Benefits Agreement with the Department of Energy; therefore, no cost estimate for benefits has been included in this plan.

5.7.1.4 Financial and Technical Assistance: State and Local Governments (WBS 1.2.10)

The Nuclear Waste Policy Act requires funding to the State of Nevada for the purpose of conducting its scientific oversight responsibilities, and funding to affected local governments to conduct appropriate oversight and other activities.

This cost estimate is based on their fiscal year 1995 budget request. It is assumed that the fund level will remain constant throughout the period. However, it should be recognized that the actual amount provided to the state affected units of local government are determined by Congress. For fiscal year 1995, Congress established the funding level for both the State and counties at the same level as fiscal year 1994: $5.5M and $7.0M, respectively.

5.7.1.5 Payments Equal to Taxes (WBS 1.2.10)

The payments equal to taxes estimate by fiscal year is based on a July 1994 signed agreement between Office of Civilian Radioactive Waste Management and Nye County covering payments equal to taxes payments for the period from May 1986, through September 1999. Payments equal to taxes payments to the other affected units of government (State of Nevada and nine other counties) will not exceed $1M per year. For fiscal year 2000, PETT will be at the same level as fiscal year 1999.

5.7.1.6 University Funding (WBS 1.2.10)

This cost estimate assumes that combining the three existing cooperative agreements (University of Nevada, Las Vegas, University of Nevada, Reno; and Desert Research Institute) into one contractual instrument with the University of Nevada System will not have an impact on funding; and that Congress will continue to establish the funding level for the university system. Congress had specified a fiscal year 1994 $3.7M ceiling on the Nuclear Waste Fund amounts that could be provided to the Universities. In their conference report, Congress also limited the University funding to $3.7M in fiscal year 1995, even though the Project's requested budget has increased significantly over fiscal year 1994 appropriation. Based on these Congressional actions, it is assumed that the estimates for the periods fiscal year 1996 through fiscal year 2000 are flat at $3.7M.

APPENDIX A

PRODUCT MAPPING TO YUCCA MOUNTAIN PROJECT WORK BREAKDOWN STRUCTURE

PRODUCT MAPPING TO YUCCA MOUNTAIN PROJECT WORK BREAKDOWN STRUCTURE

A.1 PRODUCT COST MAPPING TO WORK BREAKDOWN STRUCTURE

Table A-1 shows the mapping of the four major product areas to the Project Work Breakdown Structure.

Third Level Work Breakdown Structure Summary by Year (in thousand dollars)	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
1.2.1 Systems Engineering	9,100	15,031	17,036	17,626	14,982	10,012	83,787
1.2.2 Waste Package	9,400	13,000	14,000	17,000	17,000	14,000	84,400
1.2.3 Site Investigations	85,782	110,000	120,000	139,680	117,000	91,000	663,462
1.2.4 Repository	9,400	25,000	39,116	39,000	40,000	35,000	187,516
1.2.5 Regulatory	26,649	30,555	42,040	44,485	48,860	39,360	231,949
1.2.6 Exploratory Studies Facility	99,901	103,000	103,000	81,600	84,500	39,500	511,501
1.2.7 Test Facilities	12,200	19,500	20,100	19,000	19,000	20,500	110,300
1.2.7.8 Nevada Test Site Allocation	3,000	10,000	15,000	15,000	15,000	15,000	73,000
1.2.9 Project Management	16,450	16,500	17,000	17,500	18,000	18,500	103,950
1.2.10 Financial / Technical Assistance	26,200	32,473	37,451	33,378	28,418	25,888	183,808
1.2.11 Quality Assurance	9,590	10,500	11,000	11,600	13,000	13,500	69,190
1.2.12 Information Management	15,010	25,759	26,232	24,719	25,220	24,737	141,677
1.2.13 Environment, Safety & Health	19,100	30,000	33,480	30,500	28,000	23,500	164,580
1.2.14 Institutional	4,500	5,000	5,500	6,000	6,500	6,500	34,000
1.2.15 Support Services	28,988	27,383	32,189	34,020	51,255	91,643	265,478
Total:	375,270	473,701	533,144	531,108	526,735	468,640	2,908,598

Table A-1. Third Level Work Breakdown Structure Summary by Year

Summary by Product Area and Third Level Work Breakdown Structure (in thousand dollars)	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
Site Suitability	**230,324**	**248,736**	**136,211**	**18,585**	**10,855**	**7,210**	**651,921**
1.2.1 Systems Engineering	7,425	8,051	7,106	250	0	0	22,832
1.2.2 Waste Package	9,400	12,000	7,000	0	0	0	28,400
1.2.3 Site Investigations	76,361	78,630	81,606	0	0	0	236,597
1.2.4 Repository	9,400	25,000	9,779	0	0	0	44,179
1.2.5 Regulatory	16,837	15,555	21,620	11,335	7,855	5,210	78,412
1.2.6 Exploratory Studies Facility	99,901	99,000	0	0	0	0	198,901
1.2.7 Test Facilities	11,000	10,500	9,100	7,000	3,000	2,000	42,600
National Environmental Policy Act	**15,066**	**25,163**	**28,086**	**26,813**	**23,980**	**16,988**	**136,096**
1.2.1 Systems Engineering	420	2,279	2,189	4,480	3,139	789	13,296
1.2.5 Regulatory	1,069	3,000	2,750	2,750	3,350	2,830	15,749
1.2.7 Test Facilities	600	1,000	1,000	1,000	1,000	0	4,600
1.2.13 Environment, Safety & Health	12,977	18,884	22,147	18,583	16,491	13,369	102,451
Licensing	**28,718**	**79,261**	**229,979**	**348,830**	**340,620**	**256,380**	**1,283,788**
1.2.1 Systems Engineering	630	3,891	5,078	11,650	10,415	7,935	39,599
1.2.2 Waste Package	0	1,000	7,000	17,000	17,000	14,000	56,000
1.2.3 Site Investigations	9,421	31,370	38,394	139,680	117,000	91,000	426,865
1.2.4 Repository	0	0	29,337	39,000	40,000	35,000	143,337
1.2.5 Regulatory	8,743	12,000	17,670	30,400	37,655	31,320	137,788
1.2.6 Exploratory Studies Facility	0	4,000	103,000	81,600	84,500	39,500	312,600
1.2.7 Test Facilities	600	8,000	10,000	11,000	15,000	18,500	63,100
1.2.11 Quality Assurance	8,245	9,000	9,500	10,000	11,050	11,625	59,420
1.2.12 Information Management	1,079	10,000	10,000	8,000	8,000	7,000	44,079
1.2.13 Environment, Safety & Health	0	0	0	500	0	500	1,000
Management & Compliance	**101,162**	**120,541**	**138,868**	**136,880**	**151,280**	**188,062**	**836,793**
1.2.1 Systems Engineering	625	810	2,663	1,246	1,428	1,288	8,060
1.2.7.8 Nevada Test Site Allocation	3,000	10,000	15,000	15,000	15,000	15,000	73,000
1.2.9 Project Management	16,450	16,500	17,000	17,500	18,000	18,500	103,950
1.2.10 Financial / Technical Assistance	26,200	32,473	37,451	33,378	28,418	25,888	183,808
1.2.11 Quality Assurance	1,345	1,500	1,500	1,600	1,950	1,875	9,770
1.2.12 Information Management	13,931	15,759	16,232	16,719	17,220	17,737	97,598
1.2.13 Environment, Safety & Health	6,123	11,116	11,333	11,417	11,509	9,631	61,129
1.2.14 Institutional	4,500	5,000	5,500	6,000	6,500	6,500	34,000
1.2.15 Support Services	28,988	27,383	32,189	34,020	51,255	91,643	265,478
Total:	**375,270**	**473,701**	**533,144**	**531,108**	**526,735**	**468,640**	**2,908,598**

Table A-2. Summary by Product Area and Third Level Work Breakdown Structure

	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
Site Suitability Summary by Element and Year (in thousand dollars)							
Site Suitability Total	**230,324**	**248,736**	**136,211**	**18,585**	**10,855**	**7,210**	**651,921**
Surface Processes	**2,900**	**0**	**0**	**0**	**0**	**0**	**2,900**
1.2.5 Regulatory	2,900	0	0	0	0	0	2,900
Preclosure Radiological Safety	**6,315**	**14,511**	**10,604**	**0**	**0**	**0**	**31,430**
1.2.2 Waste Package	723	1,108	825	0	0	0	2,656
1.2.4 Repository	4,700	12,500	9,779	0	0	0	26,979
1.2.5 Regulatory	892	903	0	0	0	0	1,795
Preclosure Rock Characteristics	**10,195**	**10,714**	**1,048**	**0**	**0**	**0**	**21,957**
1.2.3 Site Investigations	9,115	9,386	0	0	0	0	18,501
1.2.5 Regulatory	1,080	1,328	1,048	0	0	0	3,456
Reasonably Available Technology	**681**	**0**	**1,848**	**0**	**0**	**0**	**2,529**
1.2.5 Regulatory	681	0	1,848	0	0	0	2,529
Tectonics	**8,110**	**8,340**	**1,048**	**0**	**0**	**0**	**17,498**
1.2.3 Site Investigations	6,810	7,012	0	0	0	0	13,822
1.2.5 Regulatory	1,300	1,328	1,048	0	0	0	3,676
Geochemistry, Postclosure Rock Characteristics	**27,392**	**28,299**	**35,856**	**0**	**0**	**0**	**91,547**
1.2.3 Site Investigations	26,192	26,971	34,808	0	0	0	87,971
1.2.5 Regulatory	1,200	1,328	1,048	0	0	0	3,576
Geohydrology/Transport	**34,342**	**35,553**	**37,068**	**0**	**0**	**0**	**106,963**
1.2.1 Systems Engineering	3,713	4,025	3,553	0	0	0	11,291
1.2.3 Site Investigations	29,329	30,200	32,367	0	0	0	91,896
1.2.5 Regulatory	1,300	1,328	1,148	0	0	0	3,776
Total System Performance Assessment	**29,488**	**41,819**	**39,639**	**7,875**	**3,900**	**2,080**	**124,801**
1.2.1 Systems Engineering	3,712	4,026	3,553	0	0	0	11,291
1.2.2 Waste Package	8,677	10,892	6,175	0	0	0	25,744
1.2.3 Site Investigations	4,915	5,061	14,431	0	0	0	24,407
1.2.4 Repository	4,700	12,500	0	0	0	0	17,200
1.2.5 Regulatory	7,484	9,340	15,480	7,875	3,900	2,080	46,159
Technical Site Suitability Evaluation	**0**	**0**	**0**	**3,710**	**0**	**0**	**3,710**
1.2.1 Systems Engineering	0	0	0	250	0	0	250
1.2.5 Regulatory	0	0	0	3,460	0	0	3,460
Site Recommendation Report	**0**	**0**	**0**	**0**	**3,955**	**3,130**	**7,085**
1.2.5 Regulatory	0	0	0	0	3,955	3,130	7,085
Support Activities	**110,901**	**109,500**	**9,100**	**7,000**	**3,000**	**2,000**	**241,501**
1.2.6 Exploratory Studies Facility	99,901	99,000	0	0	0	0	198,901
1.2.7 Test Facilities	11,000	10,500	9,100	7,000	3,000	2,000	42,600

Table A-3. Site Suitability Summary by Element and Year

	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
National Environmental Policy Act Summary by Element and Year (in thousand dollars)							
National Environmental Policy Act Total	**15,066**	**25,163**	**28,086**	**26,813**	**23,980**	**16,988**	**136,096**
Manage Environmental Impact Statement Activities	**750**	**1,180**	**1,710**	**2,080**	**1,230**	**540**	**7,490**
1.2.1 Systems Engineering	0	100	650	1,000	150	150	2,050
1.2.13 Environment, Safety & Health	750	1,080	1,060	1,080	1,080	390	5,440
Issue Notice of Intent	**150**	**0**	**0**	**0**	**0**	**0**	**150**
1.2.13 Environment, Safety & Health	150	0	0	0	0	0	150
Issue Environmental Impact Statement Implementation Plan	**429**	**259**	**50**	**0**	**0**	**0**	**738**
1.2.1 Systems Engineering	129	129	0	0	0	0	258
1.2.13 Environment, Safety & Health	300	130	50	0	0	0	480
Prepare Baseline	**291**	**4,360**	**4,353**	**1,268**	**150**	**0**	**10,422**
1.2.1 Systems Engineering	291	2,050	1,150	1,268	150	0	4,909
1.2.13 Environment, Safety & Health	0	2,310	3,203	0	0	0	5,513
Write Preliminary Environmental Impact Statement / Draft Environmental Impact Statement	**0**	**2,500**	**2,889**	**2,645**	**0**	**0**	**8,034**
1.2.1 Systems Engineering	0	0	389	0	0	0	389
1.2.13 Environment, Safety & Health	0	2,500	2,500	2,645	0	0	7,645
Write Final Environmental Impact Statement / Record of Decision	**0**	**0**	**0**	**2,812**	**5,219**	**939**	**8,970**
1.2.1 Systems Engineering	0	0	0	2,212	2,839	639	5,690
1.2.13 Environment, Safety & Health	0	0	0	600	2,380	300	3,280
Associated Environmental Impact Statement Studies / Efforts	**2,867**	**5,206**	**5,017**	**4,820**	**5,302**	**3,530**	**26,742**
1.2.5 Regulatory	1,069	3,000	2,750	2,750	3,350	2,830	15,749
1.2.7 Test Facilities	600	1,000	1,000	1,000	1,000	0	4,600
1.2.13 Environment, Safety & Health	1,198	1,206	1,267	1,070	952	700	6,393
National Environmental Policy Act Related Activities	**10,579**	**11,658**	**14,067**	**13,188**	**12,079**	**11,979**	**73,550**
1.2.13 Environment, Safety & Health	10,579	11,658	14,067	13,188	12,079	11,979	73,550

Table A-4. National Environmental Policy Act Summary by Element and Year

Licensing Summary by Element and Year (in thousand dollars)	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
Licensing Total	**28,718**	**79,261**	**229,979**	**348,830**	**340,620**	**256,380**	**1,283,788**
Annotated Outline / Draft License Application	**13,544**	**38,996**	**89,400**	**201,597**	**186,283**	**152,395**	**682,215**
1.2.1 Systems Engineering	630	3,691	5,078	11,650	9,515	7,035	37,599
1.2.2 Waste Package	0	0	6,541	15,400	15,400	12,500	49,841
1.2.3 Site Investigations	8,983	29,910	37,894	132,947	116,188	90,740	416,662
1.2.4 Repository	0	0	29,337	24,600	24,600	24,600	103,137
1.2.5 Regulatory	3,931	5,395	10,550	16,500	20,580	17,520	74,476
1.2.13 Environment, Safety & Health	0	0	0	500	0	0	500
Topical Reports	**2,973**	**6,140**	**4,409**	**16,433**	**13,712**	**8,460**	**52,127**
1.2.1 Systems Engineering	0	200	0	0	900	900	2,000
1.2.2 Waste Package	0	1,000	109	400	400	400	2,309
1.2.3 Site Investigations	438	1,460	500	6,733	812	260	10,203
1.2.5 Regulatory	2,535	3,480	3,800	9,300	11,600	6,900	37,615
Procedural Compliance & Support Activities	**12,201**	**34,125**	**136,170**	**130,800**	**140,625**	**95,525**	**549,446**
1.2.2 Waste Package	0	0	350	1,200	1,200	1,100	3,850
1.2.4 Repository	0	0	0	14,400	15,400	10,400	40,200
1.2.5 Regulatory	2,277	3,125	3,320	4,600	5,475	6,900	25,697
1.2.6 Exploratory Studies Facility	0	4,000	103,000	81,600	84,500	39,500	312,600
1.2.7 Test Facilities	600	8,000	10,000	11,000	15,000	18,500	63,100
1.2.11 Quality Assurance	8,245	9,000	9,500	10,000	11,050	11,625	59,420
1.2.12 Information Management	1,079	10,000	10,000	8,000	8,000	7,000	44,079
1.2.13 Environment, Safety & Health	0	0	0	0	0	500	500

Table A-5. Licensing Summary by Element and Year

Management & Compliance Summary by Element and Year (in thousand dollars)	Fiscal Year 1995	Fiscal Year 1996	Fiscal Year 1997	Fiscal Year 1998	Fiscal Year 1999	Fiscal Year 2000	Total
Management & Compliance Total	**101,162**	**120,541**	**138,868**	**136,880**	**151,280**	**188,062**	**836,793**
General Management	**59,369**	**59,642**	**65,421**	**68,239**	**86,475**	**127,880**	**467,026**
1.2.9 Project Management	16,450	16,500	17,000	17,500	18,000	18,500	103,950
1.2.12 Information Management	13,931	15,759	16,232	16,719	17,220	17,737	97,598
1.2.15 Support Services	28,988	27,383	32,189	34,020	51,255	91,643	265,478
Compliance	**8,093**	**13,426**	**15,496**	**14,263**	**14,887**	**12,794**	**78,959**
1.2.1 Systems Engineering	625	810	2,663	1,246	1,428	1,288	8,060
1.2.11 Quality Assurance	1,345	1,500	1,500	1,600	1,950	1,875	9,770
1.2.13 Environment, Safety & Health	6,123	11,116	11,333	11,417	11,509	9,631	61,129
Oversight / Stakeholders	**30,700**	**37,473**	**42,951**	**39,378**	**34,918**	**32,388**	**217,808**
1.2.10 Financial / Technical Assistance	26,200	32,473	37,451	33,378	28,418	25,888	183,808
1.2.14 Institutional	4,500	5,000	5,500	6,000	6,500	6,500	34,000
Nevada Test Site Allocation	**3,000**	**10,000**	**15,000**	**15,000**	**15,000**	**15,000**	**73,000**
1.2.7.8 Nevada Test Site Allocation	3,000	10,000	15,000	15,000	15,000	15,000	73,000

Table A-6. Management & Compliance Summary by Element and Year

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